KEYWORDS project planning complexity forecasting stakeholder management knowledge sharing

PROJECT PLANNING AND CONTROL: EARLY ENGAGEMENT OF PROJECT STAKEHOLDERS

Franco Caron
Department of Management Economics and Engineering, Politecnico di Milano, Milan, Italy
franco.caron@polimi.it

ABSTRACT

The paper focuses on the importance of an early engagement of stakeholders in order to manage the project along its entire life cycle. An increasing level of complexity tends to generate an increasing level of unpredictability, since it is difficult to anticipate all the possible dynamics in a complex project. Improving the forecasting/planning process requires using all the knowledge available to the project team, in particular when facing a high level of project complexity. In fact, stakeholders are the main sources of knowledge about the project and their early engagement may significantly increase the amount of knowledge available both for project planning and control. As a consequence, project planning may be considered as resulting from the interaction of the project team with all the stakeholders involved in the project.

INTRODUCTION

When complexity increases, project planning and control becomes an increasingly hard task. On the one hand, it is impossible to approach a journey, and a project may be thought of as a journey, without figuring out some sort of schedule and budget. On the other hand, planning should be a continuous process during the project life cycle entailing a sequence of re-planning steps in order to address new conditions as they emerge *("Planning is everything, the Plan is nothing") (Dvir and Lechler, 2004)*. In fact, instead of "project planning", "project re-planning" should be considered as the actual process extending throughout the project life cycle. Moreover, continuous re-planning implies a "scenario building" exercise, i.e., making assumptions about the future in order to anticipate possible project's issues *(Soderholm, 2008)*. For instance, a resource loaded schedule, which is a very common planning tool, may anticipate a future work overload requiring outsourcing measures.

Since the project plan reflects a set of assumptions about the future *(Dvir and Lechler 2004)*, planning and forecasting are strictly intertwined since forecasting corresponds to making assumptions about the future and consequently fix milestones for the project's stakeholders, so that they can coordinate their contribution to the project *(Kleim and Ludin, 1998)*.

Forecasting capability remains at the heart of project planning and control, both in the early stage when the project baseline must be determined and throughout the entire project life cycle when the final project performance is forecasted. In particular, the concept of "estimate to complete" corresponds to the core of the planning and control process which is based on a feed forward control mechanism, since only the actions affecting the Work Remaining can influence overall project performance.

At each Time-Now *(TN)*, a part of the work is completed *(WC)* and a part of the work is the Work Remaining *(WR)* that is still to be done. Based on Earned Value Management System *(EVMS) (Fleming, 1992)*,

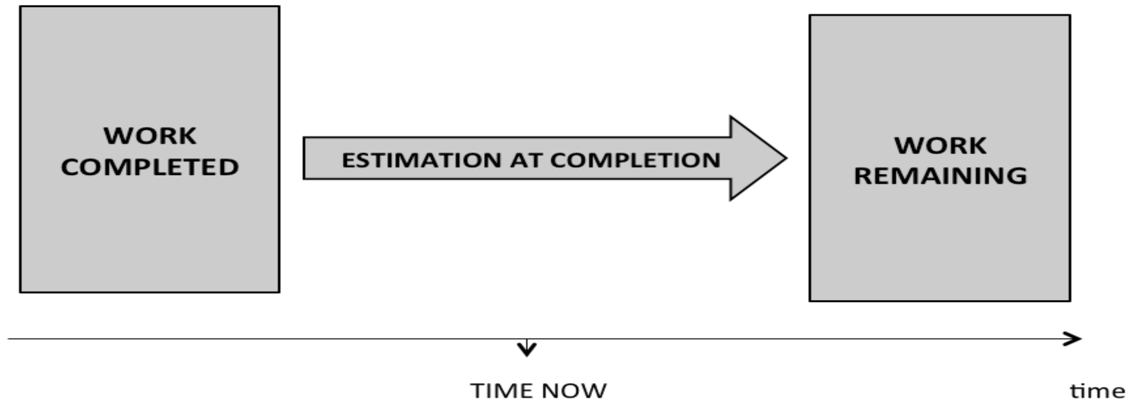


FIGURE 1. *Estimation at completion at time now (internal view)*

the two components of the estimate at completion *(EAC)*, i.e. the overall final cost of the project, are given by Actual Cost *(AC)* of the WC plus the Estimate To Complete *(ETC)* of the WR. Similar considerations may be applied to the estimate of Time at Completion *(TAC)*. In the project control process the role of ETC is critical, since the only way to influence the overall project performance is to take actions affecting the WR. The information drawn from the ETC, in comparison with the project baseline, may highlight the need for and the type of corrective actions that can change the project plan. This approach corresponds to a feed-forward type control loop *(Anbari, 2003; Christensen, 1996)* (**Figure 1**).

As a consequence, during the project control process, the project manager plays a twofold role: the "historian", attempting to grasp the drivers that have determined the past evolution of the project, and the "wizard", attempting to foresee the future evolution of the project and to exploit all the lessons learned from the past. The "historian" should help the "wizard" in forecasting the future. *(Makridakis and Taleb, 2009; Makridakis et al., 2009)*. An effective process of forecasting/planning depends on utilizing all the available knowledge, in particular when facing a high level of project complexity. Since stakeholders are the main sources of knowledge about the project, their early engagement may increase significantly the amount of knowledge available.

In the first section the dimensions of complexity are analyzed with reference to large engineering projects, focusing on the interdependence between the operational, managerial and organizational processes. Such interdependence is stressed when a "fast track" approach is needed. The second section focuses on the knowledge sources that may allow for an improvement of the forecasting/planning process in the case of a complex project. The third section introduces stakeholders as knowledge sources and stakeholder management as a means for fostering knowledge contribution of stakeholders, particularly aiming at obtaining an early engagement of stakeholders in the project planning and control. Finally, some conclusions are drawn.

1. Project Complexity

In general, a project will be exposed to uncertainty, ambiguity and complexity. Uncertainty is mainly related to a lack of knowledge about the future development of the project and requires gathering further information in order to better address the future. From uncertainty may derive risks – both threats and opportunities – for the project *(Perminova et al., 2008)*. Ambiguity is mainly related to the possible existence of multiple interpretations of the project situation which requires a consensus building process, based on the direct interaction of the stakeholders involved, in order to identify common objectives and strategies *(Weick, 1995)*. In this context leadership plays a decisive role. For instance, the same situation may be interpreted as a threat or an opportunity, depending on the risk taking attitude of the decision maker. Complexity is mainly related to the high number of elements normally involved in the project and, specifically, the high number of interrelationships between them *(Williams, 1999)*. Complexity may be the source of unexpected events or conditions during the project life cycle, depending on the interaction pattern among the different project processes. Moreover, uncertainty, complexity and ambiguity are interacting and mutually reinforcing each other.

When considering project complexity *(Williams, 1999)* and the basic structure of Large Engineering Projects *(LEPs)*, we can distinguish between an internal complexity which relates to the interdependences between the different processes accomplished during the project life cycle and an external complexity which is related to the interactions of the project with its environment. When considering the internal complexity in a LEP, for instance in the oil and gas sector, we can distinguish three kinds of process:

- operational processes
- managerial processes
- organizational processes

The interdependences between these processes are a major source of complexity. Operational processes *(i.e., design, procurement, construction, commissioning)* determine the physical progress of the project and generate the required deliverables, such as technical documents, purchase orders, deliveries at site, materials installed, testable systems, etc. Managerial processes aim to plan and control the operational processes in order to obtain specific objectives in terms of cost, time and quality. For instance, with reference to the PMI Body Of Knowledge *(Project Management Institute, 2013)*, we can identify a sequence of managerial processes *(i.e., initiating, planning, monitoring, controlling, closing up)* for each knowledge area *(cost, time, quality, risk, etc.)*. Organizational processes deal with human resources *(selection, training, empowerment, coordination, compensation, etc.)*, since project objectives can be achieved only by the joint contribution of the people involved in the project. During the project development, operational, managerial and organizational processes are interwoven, further increasing project complexity.

Focusing for instance on the operational aspects, LEPs are characterized by complex interdependences between the various operational phases, such as design, procurement, construction, commissioning. The most relevant interdependences are highlighted in **Figure 2**, comprising three loops each describing a particular pattern of dependence.

The inner loop indicates the interaction between detailed engineering and procurement. Detailed engineering delivers the technical specifications necessary to solicit offers from the suppliers and supports the procurement process until the issue of purchase orders. In turn, suppliers' offers are a source of information for the detailed engineering in order to improve the technical specifications. This kind of interaction implies a continuous exchange of information between detailed engineering and potential suppliers and, consequently, an overlapping between the two processes.

The middle loop shows the interaction between detailed engineering and construction on site. Detailed engineering provides the authorized technical documents necessary to install items and bulk materials provided by procurement and, in turn, field engineering provides the "as built" technical documentation, comprising the changes deriving from issues that emerged on site. This exchange of information allows the project team to keep a complete and updated description of the plant during the construction phase. Also in this case the interaction implies a continuous exchange of information between detailed engineering and the construction site and, consequently, an overlapping between the two processes.

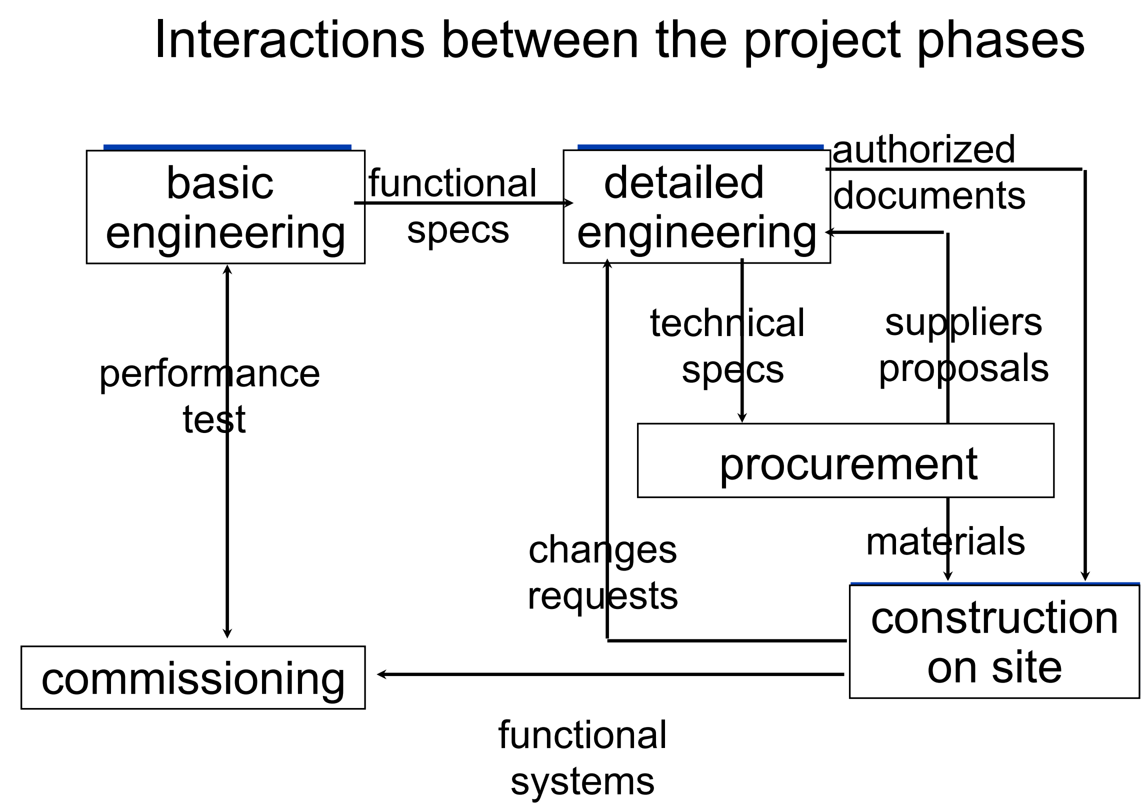


FIGURE 2. *Interdependencies between project operational phases*

The outer loop is the most critical and describes the interaction between basic engineering and commissioning. Basic engineering aims at obtaining the functional performance expected from the system, assigning a set of technical requirements to all the engineering disciplines involved. This functional performance corresponds to the output of the asset to be delivered to the client and the final test verifies whether actual performance levels meet expected performance. If not, radical and expensive changes may be required in order to avoid contractual penalties. It should be noted that throughout these interconnected loops, any unexpected event may spread across the overall project, creating an unpredictable impact.

Moving from the internal to the external complexity, other political, economic, social, technological, legal, environmental interdependences come out between the project and its context. For instance, a project aiming at building an infrastructure may suffer from the social opposition of the local community.

In summary, overlapping is the process of starting the following activity before completing the leading activity. As shown above, the phases of a project are interdependent and consequently overlapping, since two overlapping project phases allow for exploiting the feedback from the following phase in order to improve the decision making process in the leading one. For instance, if engineering and construction phases overlap, possible future constructability issues which may emerge on site can be anticipated during the elaboration of the related technical documents. This exchange of information will aid in the earlier detection of issues and will effectively reduce the future need for changes of the project plan.

Focusing on the engineering phase, the development of the design process is based on the progressive and iterative elaboration of the technical documentation until it is frozen and authorized for construction. At each new issue of a technical document, the comments coming from the different disciplines involved in the design process are discussed and included in the document, allowing for a progressively better definition of the deliverable and a corresponding reduction of project uncertainty. At the end of the process a hopefully robust result should be obtained, making any rework less likely.

Such a "Concurrent Engineering" approach needs a rather homogeneous progress of the different disciplines involved in the design process in order to provide the consistency and completeness of the technical output and to avoid any possible rework or underperforming deliverable. When the leading discipline achieves a sufficient progress, all the involved disciplines can start. Through this approach, both "end" uncertainty *(i.e., related to the deliverables)* and "means" uncertainty *(i.e., related to the processes)* are solved gradually, allowing for agreed upon and robust decisions to be taken. Concurrent Engineering helps to minimize the risk associated with the un-freezing of many hitherto frozen issues and resolving any relevant interdependencies between the different disciplines involved. Hence, the best overlapping occurs between a "fast evolving" leading process and a "low sensitivity" following process *(Hossain and Chua, 2013)*.

Also the interdependence between engineering and construction is very critical. Firstly, at a given moment the progressive elaboration of a technical document by the engineering specialists should be interrupted, the document frozen, authorized for construction and sent to the site. If the document is frozen too early it may be an incomplete document or based on wrong assumptions, otherwise, if it is frozen too late, a delay may derive for the construction process. In addition, the technical documents should be delivered to the site in line with the construction sequence, for instance, engineering should be "construction driven", and hopefully the document should be sufficiently "robust" to avoid possible rework during construction.

In summary, the interactions between the different processes of the project and with the project's context, generate a high level of complexity and may cause an unexpected impact on the project. Moreover, the complexity may be increased by a fast track approach, due to strict schedule constraints. As a consequence, all the knowledge available should be used in order to address the planning and control processes for a complex project.

2. Planning and forecasting

The lack of a reliable project plan is strictly due to the inability of the project team to exploit all the available knowledge sources in order to anticipate the future issues of the project *(Williams and Samset, 2010; Williams et al., 2009)*.

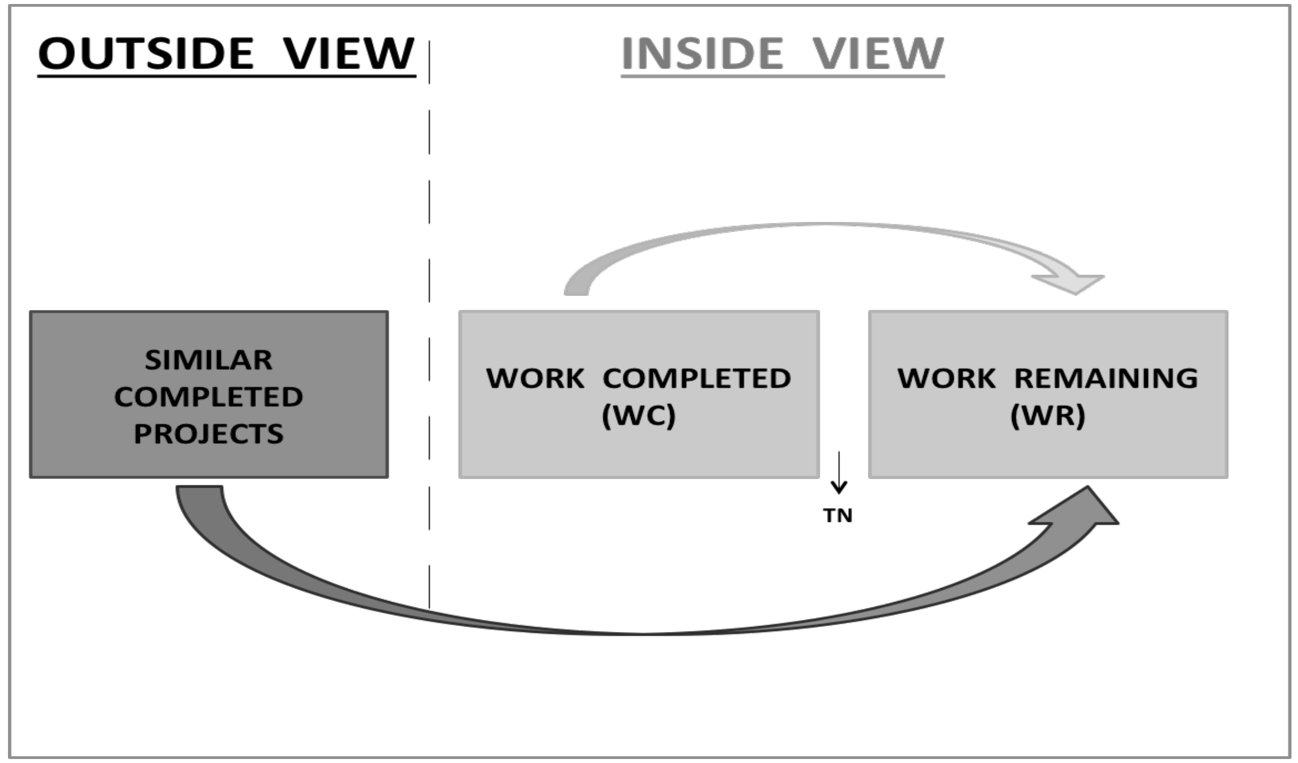


FIGURE 3. *Interactions between project phases*

On the one hand the project stakeholders are the main sources of project complexity, and on the other hand they are the main sources of the knowledge required for the project. This section will address how to integrate their different knowledge contributions in order to improve the forecasting capability during the project control process.

In general, the knowledge available to the project stakeholders may be classified in two ways: explicit/tacit and internal/external. Explicit external knowledge corresponds to data records about projects completed in the past. Taking into account past experience should mitigate possible "optimistic" bias in estimating future performance *(Lovallo and Kahneman, 2003)*. Explicit internal knowledge corresponds to data records concerning the current project, i.e. the work completed, allowing for an evaluation of project performance at Time Now and, through a trend analysis, an estimate of future performance. Tacit external knowledge concerns the identification of similarities between the current project and some past projects in order to allow for the transferability of past lessons learned and performance data to the current project. Tacit internal knowledge entails the experts' judgments about possible events/conditions affecting the project's work remaining.

The basic approaches available in order to improve the forecasting/ planning process may be summarized:

- Pattern analysis; exploiting the identification of typical patterns, e.g., in terms of S-curves describing the progress of a given class of similar projects (Bar-Yam & Bialik, 2013). For instance, it should be remembered that productivity naturally falls towards the end of a project in order to avoid an "over optimistic" view.
- Simulation of the future development of the project, starting from the current status; a mathematical/ logical model of the project allows for building possible future scenarios.
- Trend analysis; based on the extrapolation of the project performance until Time Now, for instance productivity, such as in the Earned Value Management for forecasting purposes.

Focusing for instance on trend analysis, different performance indexes may be used in order to highlight current trends and estimate the future performance during the WR *(Anbari, 2003)*. It should be noted that performance trend may not remain steady and consequently future performance values may significantly differ from current performance *(Davidson, 1991)*. In fact, relying only on past performance while developing a forecast could be misleading, since looking only to the work completed is similar to driving a car whilst looking just in the rear view mirror, thereby making it impossible to dodge the obstacles that may lie on the route ahead.

As a consequence, forecasting capability can be improved by integrating all the knowledge sources available to the project team *(Liu & Zu, 2007; Goodwin, 2005)*. While data records are typically related to the WC, experts' judgments are typically oriented to the WR.

We can classify the knowledge sources that may be used for evaluating the Estimate to Complete into three types:

- data records related to the current project, i.e. to work completed;
- experts' judgments related to the current project, i.e. to work remaining;
- data records related to similar projects completed in the past.

According to the above classification of the knowledge sources, three different approaches to linear trend analysis may be identified:

- utilizing data records related to the WC, by extrapolating the current performance trend into the future;
- adjusting the performance trend stemming from data records related to the WC through experts' judgment;
- integrating the internal view of the project, such as data records related to the WC and experts' judgment related to the WR, with data records deriving from similar projects completed in the past.

In the last approach, based on a holistic consideration of all the information generated inside and outside the project, data records are integrated with the experts' judgments, in order to estimate the actual trend of the project *(Palomo et al., 2006)*. In this approach the stakeholders' knowledge can play a decisive role *(**Figure 3**)*.

The Bayes Theorem represents a rigorous and formal approach allowing for an update of a prior distribution, which expresses the experts' preliminary opinion, by means of the data records gathered in the field. For instance, the project team may assume a prior estimate of the final budget overrun, based on subjective expectations about the development of the current project, and this prior estimate may be updated based on the actual performance of the current project at Time Now *(Caron et al., 2013)*. In a Bayesian framework, the experts' preliminary opinions are an example of subjective probability, the only statistical approach applicable to non-repetitive processes such as projects. Subjective probability is defined as the degree of belief in the occurrence of an event, by a given person at a given time and with a given set of information. It should be noted that increasing the level of knowledge available may modify the value of subjective probability assigned to a future event *(De Finetti, 1937; D'Agostini, 1999; Caron et al., 2013)*.

The contribution given by tacit knowledge, i.e. by the stakeholders, about the future development of the project, may concern:

- the impact from drivers which explain the project development during the WC, and also presumably affecting the WR, such as what kind of plausible drivers may have generated the actual development of the project until Time Now and how will they also influence the future? (e.g., schedule aggressiveness, engineering completeness, owner involvement, turnover in project leadership, unsatisfied stakeholders, new technology, project team integration, project team staffing, front end engineering adequacy, etc.) (Merrow, 2011). For instance, possible learning effects deriving from project progress or differences in scope of work between the WR and the WC may generate a consequent impact on productivity;
- possible behavior of the stakeholders involved in the project, e.g. committed, non collaborative, opportunistic behavior, in other words, whether they make available or not the knowledge required for project control. It should be noted that in this case the focus moves from risk events to risk sources, i.e. to the stakeholders;
- certain/uncertain events or conditions affecting project performance during the WR which may originate both internally and externally to the project. Certain events may include planned corrective actions or contractual constraints, while uncertain events, such as risks, may arise both in terms of threats (i.e. adverse weather conditions) or opportunities (i.e. more efficient solutions deriving from suppliers collaboration);
- weak signals indicating emerging situations which could possibly affect project performance (anomalous bid from a subcontractor, scope creep, subcontractors' work overload, permits delay, engineering not driven by construction, rework rate, missing data, etc.) (Merrow, 2011; Williams et al., 2012).

Besides the use of internal knowledge, both explicit and tacit, external knowledge related to similar projects completed in the past may also be useful. Note that most of the lessons learned from previous similar projects in a project oriented company proceed through a well defined process into the current project. The use of data records related to similar past projects has been introduced both with reference to the project outset in order to improve the initial estimate of the project baseline, or for proposal purposes, and with reference to the project control process at a generic Time Now, in order to identify suitable corrective measures *(Caron et al., 2013)*.

Note that the selection of the cluster of similar projects is basically subjective since it depends on the similarity criteria adopted *(Savio and Nikoloupolos, 2011; Green and Armstrong, 2007)*, just as the estimation given by experts about future events that may impact the project success. Some cases, in fact, may express strong ambiguity. For example, if a company has to estimate the costs of an investment in a new technology and in an unfamiliar context, should it take into account the set of highly innovative projects developed in different contexts or the set of barely innovative projects but belonging to the same context? Neither the former nor the latter option may be the best solution but both might be considered *(Kahneman and Tversky, 1979)*.

In summary, the use of data related to past similar projects should reduce significantly the bias of the forecasting/ planning process. In fact, even though project management systems have been extensively implemented in recent years, project failures in meeting planned objectives are common, in particular in large engineering and construction projects such as in the oil and gas industry *(Merrow, 2011)*. However, it remains an open question whether these failures are due to a lack of project efficiency during execution or to a lack of forecasting accuracy during the planning phase. In the former case, both positive and negative deviations against the baseline should be expected, depending on the evolution of each project. However, a systematic overrun in terms of cost and time may be explained as a weakness of the forecasting process since the project's outset, which is normally due to an optimistic bias *(Hogarth and Makridakis, 1981)*.

Kahneman's studies *(1977)* show that a major source of planning failure, which influences the forecast of final cost and duration, is linked to an exclusively "internal" view approach, i.e. based only on data deriving from inside the current project. Subsequently, the focus has moved to the psychological and political factors affecting the internal view *(Lovallo and Kahneman, 2003)*, and, in particular, two main sources of influence have been identified *(Flyvbjerg, 2006; Flyvbjerg, 2009)*.

Firstly, the cognitive illusions. These entail two major aspects: over-optimism, i.e. the common attitude to assess future projects with greater optimism than justified from previous actual experience, and anchoring, i.e. to deal with complex decisions by selecting an initial reference point *(the anchor stemming from past experience)* and anchoring the estimate onto it.

Secondly, the strategic and political pressures. These may typically emerge during proposal preparation. Indeed, the approval of a project pre-supposes a competition involving different proposals, which often causes a voluntary underestimation of cost and duration by the project proposers in order to make their own proposal as attractive as possible.

In response to the above risk of bias in forecasting/ planning, it is necessary to exploit all the available knowledge, i.e. to engage all the stakeholders from the project outset. Innovative and creative approaches to handling project complexity require input from many knowledge sources, internal and external. Cooperation among the stakeholders is essential since potentially problematic interfaces between many and interrelated project elements may constitute the source of unexpected events unless they are identified and properly managed.

3. Stakeholder management

The process of stakeholder analysis and management is a critical success factor for the project. It has been included as an additional knowledge area in PMI's 'A guide to the project management body of knowledge' *(PMI, 2013)*, consisting of two basic processes: planning of stakeholder management and managing stakeholder engagement. According to PMI BoK *(PMI, 2013)*, "Managing stakeholder engagement is the process of communicating and working with stakeholders to meet their needs/expectations, address issues as they occur and foster appropriate engagement in project activities throughout the project life cycle".

In fact, LEPs are characterized by a large number of stakeholders *(Flybvjerg, 2009)*. Project stakeholders may be defined as organizations or groups that have an interest or a functional role in the project and can contribute to, or be impacted by, the outcomes of the project *(PMI, 2013)*. Examples of project stakeholders can be sponsors, managers, suppliers, subcontractors, partners, clients, shareholders, financial institutions, insurance companies, governments, labour unions, mass media, pressure groups, consumers, local communities, etc.

Stakeholders are probably the major source of complexity for the project but on the other hand they are the major source of knowledge for the project. Therefore, a major output of stakeholder management should be knowledge sharing.

The contribution of the project stakeholders in terms of knowledge may affect both initial planning and subsequent project control throughout the project life cycle. Engaging the stakeholders in the planning process from the project outset increases the accuracy of initial and subsequent estimates, since a larger amount of knowledge becomes available earlier both in terms of data records and experts' judgment *(Zuber, 2013)*. In particular, the early engagement of stakeholders allows for anticipating threats and opportunities possibly affecting the project throughout its life cycle.

In reacting to an uncertain, complex and ambiguous project status, the process of making sense of the situation and then building consent about an agreed response strategy is critical *(March, 1978; Daft and Weick, 1984; Weick, 1988; Weick, 1995; Kaplan, 2008; Alderman et al., 2005)*. A consensus from the key stakeholders is needed about what should be done and how it should be done. Uncertainty, complexity and ambiguity can result in different interpretations about what is going on and what actions should be undertaken. Moreover, weak signals may be interpreted in different ways which makes it difficult to take timely measures. For instance, will a decrease in construction productivity be interpreted as a radical shift in project performance or just a short term downturn? To deal with uncertainty, complexity and ambiguity, people interact, search for meaning, settle for a plausible solution and, eventually, take action *(Weick et al., 2005)*.

As a consequence, project planning may be thought of as resulting from the interaction of the project team with all the stakeholders involved in the project. This interaction may be described in political terms, the project being a coalition of interest groups characterized by political interaction *(Newcombe, 2003)*. In general, stakeholders should have common objectives but may also have different interests. Moreover, in a network of complex interrelationships, the behavior of a single stakeholder may often depend on the interactions with the other stakeholders. One of the most critical tasks for a project is to handle the different and often competing expectations from the stakeholders and obtain the engagement of project stakeholders, particularly with reference to knowledge sharing.

Obtaining the engagement of stakeholders in the project, and consequently the contribution of their knowledge, is the main objective of stakeholder management. In particular, stakeholder management aims at reducing the probability of actions carried out by the stakeholders that might adversely affect the project, and encouraging support to project objectives particularly in knowledge sharing *(Cleland, 1998; Aaltonen, 2011)*. In general, the process of project stakeholder analysis and management can be broken down into the following basic sub-processes: stakeholder identification, classification, assessment and management.

Firstly, the focus is on identifying who the stakeholders really are, rather than relying on a generic stakeholder list or a generic Stakeholder Breakdown Structure, deriving from similar past projects.

For effective stakeholder identification, a detailed breakdown is required in order to identify specific stakeholders that can be effectively managed. For instance the government as a whole can rarely be managed but a particular department probably can be. A newspaper may generally be against a project but after breakdown it may become clear which specific staff is positive, neutral or negative and what is the newspaper's potential for interfering with the project's development *(Ackermann and Eden, 2010)*. Early involvement of stakeholders allows for a more comprehensive stakeholder identification, based on multiple different perspectives.

Secondly, in order to classify the project stakeholders, different criteria may be applied. Based on their type of involvement in the project, it is possible to differentiate stakeholders into either primary or secondary *(Clarkson, 1995)*. Primary stakeholders should have a contractual or legal obligation to the project team *(Cleland, 1998)*, such as client, main contractor, suppliers, subcontractors, etc. Secondary stakeholders include, for instance, government *(note that government can be a client as well)*, local authorities, media, consumers, competitors, local communities, etc. Project management has normally focused only on primary stakeholders that are important with regard to the financial project performance. The current trend is toward an increasing importance of, and consequently an increasing attention to, the secondary stakeholders, such as the local community living around the plant to be built. Secondary stakeholders may also be classified into: external champions, economic actors, competitors, technological actors, socio-cultural actors, political/ regulatory actors.

The level of attention devoted by the project team to each stakeholder depends on the stakeholder's salience. Firstly, the salience of the individual stakeholders can be assessed in terms of the presence of one or more of the following attributes: power, legitimacy and urgency *(Mitchell et al., 1997)*. Power refers to the ability of a stakeholder to influence the decision-making process; legitimacy refers to the legal context supporting a stakeholder's claims, normally legitimate claims are often emphasized in connection with secondary stakeholders, and urgency refers to the criticality and time sensitivity of the claims raised by a stakeholder. Secondly, the level of salience usually depends not only on the individual attributes of a single stakeholder, but more generally on the type of interaction it has with other stakeholders. As long as a complete picture of the stakeholders' interrelationship is obtained, analysis can be conducted on which stakeholders or groups of stakeholders play more central roles and which are more peripheral. Stakeholders' influence patterns may be complex and involve other stakeholders. For example, if a secondary stakeholder lacks resource based power in its relationship with the project, it is more likely to employ indirect strategies through an ally that has power to influence the project.

The assessment of a stakeholder requires a thorough analysis of all possible processes starting from the stakeholder and causing an impact on the project. In order to analyze such a process, firstly it should be acknowledge that each stakeholder has general interests and, consequently, specific objectives concerning the project. Based on these objectives, the stakeholder formulates the corresponding explicit requirements and implicit expectations. Depending on whether or not these requirements and expectations are taken into account and satisfied, the stakeholder shows different attitudes and consequent behaviors, co-operative or obstructive, with respect to the project. Note that, not only a withdrawal of resources but, even a non-committed attitude might be sufficient to place the project in serious difficulty. By using the resources corresponding to its influence base, the stakeholder can take actions to inducing a possible impact on project performance and success *(Olander, 2007)*. Beyond expectations, interests are the real drivers behind stakeholders' attitude and behavior. Once the project team possesses such insight it becomes easier to predict stakeholder's behavior and press the right button to support the desired project outcome.

For instance, LEPs normally may have some sort of impact on the surrounding environment, which could possibly create a conflicting relationship with local communities and environmental groups. The main interest of a pressure group, such as a pro-environment NGO, may be to be recognized by the authorities. If some aspect of the project concerns the group's social mission, for instance the impact on the environment, or simply offers an opportunity to enhance its visibility, the group might propose an alternative technology, demand more stringent environmental constraints, or request a meeting with managers in the presence of experts and authorities. As long as these requests remain unsatisfied, the group will threaten to mobilize all its resources, local community, media, lawyers, researchers, etc., or to organize actions such as demonstrations, blockades, and media campaigns in order to increase their credibility. All these actions may lead to a potential impact on the project causing for instance an unexpected change in the scope of work and a consequent completion delay and budget overrun.

PMI *(2013)* defines project stakeholder management as "the systematic identification, analysis and planning *(and implementing)* of actions to communicate with and influence stakeholders". The influence on the stakeholders may be exercised by different ways: collaboration, bargaining and confrontation *(Chinyio and Akintoye, 2008)*.

Examples of influencing strategies are: participatory engineering, Best Available Technology solutions, standardized solutions, media exploitation, risk sharing/ allocation, introduction of incentives, communication plan, creation of alliances, etc. For instance, lobbying may be a way to exercise influence for or against laws, regulations or trade restraints. Also the stakeholder network may be used to influence, and so possibly change, stakeholders' attitudes and actions. This can be done by fostering an alliance among stakeholders having common interests.

In this context the communication strategy plays a critical role for the social acceptability of a project. Note that there are several communication approaches for sharing information among project stakeholders: interpersonal/impersonal communication and push/pull communication. A unidirectional approach to communication toward the general population, for instance a push approach without any feedback process may prevent any adjustment of the project to meet the expectations of the various social participants, each with their own opinion about what should be done. Participatory engineering is a typical approach to bidirectional communication. For example, in the case of a LEP, during the planning and design phase, the involvement process should be a two-way process allowing the stakeholders to influence the decision making process. On the contrary, during the construction phase it may be only a one-way process normally focused on the dissemination of construction-related information to the public *(El Gohary et al., 2006)*.

Shohet and Frydman *(2003)* claim that the achievement of project goals is highly dependent upon the capability of the project team to communicate effectively with the main stakeholders involved in the project. Bakens et al. *(2005)* and Young *(2006)* also point out that the key to good stakeholder management is effective communication starting at the project's outset. Olander and Landin *(2005)* claim that an important issue for project management is to identify those stakeholders who can determine a significant impact on the project and manage their expectations through a suitable communication process from the early stage of the project. Project managers must communicate and interact with stakeholders so that the perceived strengths, weaknesses, opportunities and threats of the project are identified and realistically acknowledged across the project organization *(Olander and Landin, 2008)*. Thomas et al. *(1998)* claim that the single most important lever that contributes to the project's success is communication, in particularly its accuracy, understanding, timeliness and completeness.

4. Early engagement

From the perspective of improving the planning capability of the project, stakeholder management means identifying the stakeholders that can provide a significant knowledge contribution to the project, assessing the type of knowledge contribution they may give and how to engage them in order to obtain such contribution. Note that lack of information may be a very practical issue *(information missing, documentation not completed, documentation unclear, documentation delayed, reviews not performed, contractual provisions unclear, plans unclear or missing, governance framework unclear or missing, etc.)*.

In particular, the early engagement of all the stakeholders independently from the stage of the project life cycle in which they may be involved in or be impacted by the project, is an important success factor for the project *(Rowlinson and Cheung, 2008)*. The main decisions related to a project, *(e.g., size, location, technology, financing, schedule, etc.)* are made during the early stage. After this stage is complete, it is more difficult to take into account stakeholder claims that would have a major impact on the definition of the project. The early stage of the project plays a critical role and requires active stakeholder management during the project's shaping phase in order to choose a strategy accommodating stakeholders' interests *(Miller and Lessard, 2001; Kolltveit and Gronhaug, 2004; Flybjerg et al., 2003; Aaltonen and Kujala, 2010)*.

In general the early stage of the project life cycle is the most critical, since at this time strategic decisions are to be made, notwithstanding that the available knowledge is limited. Since uncertainty arises from a lack of knowledge, it is strictly linked to the inability of the project team to exploit all the available internal/ external knowledge, in particular stemming from the stakeholders, in order to plan the deliverables of the stakeholders accordingly *(Williams and Samset, 2010; Williams et al., 2009)*.

Making stakeholders' knowledge accessible to others creates new knowledge. Regular inter-stakeholder knowledge sharing sessions allow for creation, integration and transfer of specialized knowledge and generation of innovative ideas *(Hadaya and Cassivi, 2012)*.

The robustness of the project plan may be improved by projecting the overall available knowledge provided by the stakeholders into the future and so allowing for a more accurate forecast. The stakeholders' roundtable is central to the idea of a collaborative, forward thinking project organization. Engaging the stakeholders in the planning process from the project outset increases the accuracy of initial and subsequent estimates, since a larger amount of information becomes available both in terms of data records and experts' judgment *(Zuber, 2013)*. The underlying logic is that by including different stakeholders with diverse views and interests in the project planning process, disruptions to plans during the execution phase are reduced. As a consequence, project planning may be thought of as resulting from the continuous interaction of the project team with the project stakeholders.

Without adequate stakeholder involvement, the project team may miss critical information and possible future events that may impact project performance. This information once obtained may require re-planning of the project in terms of cost and time. The project team should involve the stakeholders, including the stakeholders intervening in the last phase of the project, as early as possible. This results in anticipating possible issues that the project may face along the whole life cycle. For instance the transportation needs and constraints during the construction phase should be taken into account from the early planning of the construction sequence. Also involving construction expertise early in the design stage is a prerequisite for improving constructability.

Stakeholders play a decisive role in the project control process during the entire project life cycle in capturing the weak signals that anticipate emerging issues for the project. Focusing for instance on project risks, the risk triggers are an example of weak signals that anticipate the risk event. *(Hartono et al., 2013)*. Ansoff *(1975)* stated that a strategic surprise does not appear out of the blue; it is possible to anticipate its occurrence by the aid of weak signals *(triggers, early warnings, symptoms, clues, etc.)*. A weak signal has been defined as "...imprecise early indications about impending impactful events. All that is known of them is that some threats and opportunities will undoubtedly arise, but their shape and nature and source are not yet known". For instance, Earned Value Management uses changes in the trend of performance indicators at time now - that may be considered as early warnings – in order to anticipate future issues requiring immediate proactive measures *(Haji-Kazem et al., 2013)*.

Many weak signals may be observed along the project life cycle and must be interpreted, and made sense of, by the project team in order to take proactive measures able to minimize the impact. The precision of the signals improves in time but the time available for taking effective measures decreases, since the issue's occurrence time doesn't move farther.

In this complex context, leadership plays a critical role. Leaders who seem to be able to function very effectively in a complex environment are effective cognitive integrators. The role of the project manager is central in orchestrating the knowledge sharing among and between various organizational stakeholders. Knowledge sharing can be difficult because each profession, department and organization has its own language, ethos, organizational responsibilities and physical barriers. A plan for structuring intra organizational and inter organizational knowledge sharing is necessary. So core stakeholders may be defined as those who dominate the knowledge sharing structure in the project network.

Two different views of the role of the project manager, as project leader, may be identified:

- in the first case, the project integration relies mainly on the Project Plan, as a set of detailed planning and control procedures concerning all the stakeholders / organizational roles involved in the project. In this case the project manager performs the role of "the owner" of the Project Plan;
- in the second case, a decentralized approach to project management may be implemented, based on relevant degrees of freedom to each organizational unit. The project manager, as project leader, undertakes the role of integrator of the various autonomous groups with different culture and focus, and becomes "the bridge" between diverse "languages", supervising the interface relationships between different organizational units.

The main advantages of the second case are:

- safeguarding cultural diversity, as a way of allowing each organizational unit to monitor and adapt in a more effective way to its own environment, so improving the overall project's responsiveness;
- developing innovation opportunities through the direct interaction of different organizational units, across the project.

5. Conclusion

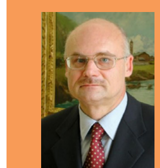
Project stakeholders are not only the main contributors to project progress and the main sources and bearers of risk but also the main knowledge sources for the project.

Since a project will be exposed to uncertainty, ambiguity and complexity, deriving from a lack of knowledge, an effective process of forecasting/planning depends on utilizing all the available knowledge. In particular, the internal complexity of the project is mainly related to the interdependences between the different processes - operational, managerial and organizational - accomplished during the project life cycle.

The role of stakeholders is very important both in project shaping at project outset and in catching weak signals in order to anticipate possible issues. In order to assess stakeholder's possible contribution in terms of knowledge, a set of attributes have been considered in a sequence: interests, objectives, requirements and expectations, attitudes and behaviors, resources controlled, possible actions.

The contribution given by the stakeholders, about the future development of the project, may concern: the impact from drivers which explain the project development during the past and also presumably affecting the future, possible behavior of the stakeholders involved in the project, certain/uncertain events or conditions affecting project performance in the future which may originate both internally and externally to the project, weak signals indicating emerging situations which could possibly affect project performance.

author



Franco Caron, Professor with the Management, Economics and Industrial Engineering Department at Politecnico di Milano, is in charge of the course "Management of Large Engineering Projects" both in the Systems Engineering and Industrial Engineering Programs. He is also in charge of the course Project Risk Analysis and Management in the Master in Strategic Project Management European - developed jointly by MIP-Politecnico di Milano, Heriot Watt University Edimburgh and UMEA University. Franco.caron@polimi.it

references

Aaltonen, K. and Kujala, J. *(2010)* 'A project lifecycle perspective on stakeholder influence strategies in global projects', Scandinavian Journal of Management, 26, 4, 381-397

Aaltonen, K. *(2011)* 'Project stakeholder analysis as an environmental interpretation process', International Journal of Project Management, 29, 165-183

Ackermann, F. and Eden, C. *(2010)* 'Strategic Management of Stakeholders: Theory and Practice', Long Range Planning, 44, 3, 179-196

Alderman, N., Ivory, C., McLoughlin, I. and Vaughan, R. *(2005)*, 'Sense-making as a process within complex service-led projects', International Journal of Project Management, 23, 380-385

Anbari, F. *(2003)*'Earned Value: Project management method and extension', Project Management Journal, 34, pp. 12-23.

Ansoff, H.I. *(1975)*, Managing strategic surprise by response to weak signals, California Management Review, 17 *(2)*, 21-23

Bar-Yam, Y. and Bialik, M. *(2013)* 'Beyond big data: identifying important information for real world challenges, December 17, 2013, arXiv in press

Bosch-Rekvedelt, M., Jongkind, Y., Mooi, H., Bakker, H. and Verbraek, A. *(2011)*, 'Grasping complexity in large engineering projects: the TOE *(Technical, Organizational and Environmental)* framework', International Journal of Project Management, 29, 728-739

Cagno, E., Caron, F. and Mancini, M. *(2008)* 'Dynamic analysis of project risk', International Journal of Risk Assessment and Management, 10, 1/2, 70-87

Caron F., Ruggeri F., Merli A. *(2013)* 'A Bayesian approach to improve estimate at completion in Earned Value Management', Project Management Journal, 44*(1)*, 3-16

Caron F., Ruggeri F., Borgarucci C. *(2013)* 'Bayesian integration of internal and external views in forecasting project performance', Journal of Modern Project Management, 1, 2

Caron F., *(2013)* 2013) 'Managing the continuum: certainty, uncertainty, unpredictability in large engineering projects', Springer,

Caron, F. *(2014)* 'What does project stakeholder mean?', in Bassi A. *(ed)*, Gli stakeholder di progetto, Il Mio Libro *(Feltrinelli)*, 2014

Chinyio, E.A. and Akintoye A. *(2008)*, 'Practical approaches for engaging stakeholders: findings from the UK', Construction Management and Economics, 26, 591-599

Christensen D. *(1996)*, 'Project Advocacy and the estimate at completion problem', Journal of Cost Analysis and Management, pp. 35-60, spring 1996

Clarkson, M. B. E. *(1995)* 'A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance', Academy of Management Review, 20, 92-117.

Cleland, D.I. *(1998)* Project Management Handbook, Jossey-Bass, San Francisco

Daft, R.L. and Weick, K.E. *(1984)*, 'Toward a model of organizations as interpretation systems', Academy of Management Review, 9, 1, 284-295

Davidson P. *(1991)*, Is probability theory relevant for uncertainty? A post Keynesian perspective, Journal of Economic Perspectives, 5, 1, Winter 1991, pp. 129-143

De Finetti B. *(1937)* 'La prévison: ses lois logiques, ses sources subjectives, Annales de l'Institut Henri Poincaré', 7, 1, pp. 1-68.

Dvir D. and Lechler T. *(2004)*, 'Plans are nothing, changing plans is everything: the impact of changes on project success', Research Policy, 33, 1-15

El-Gohary, N.M., Osman, H. and El-Diraby, T.E. *(2006)* 'Stakeholder management for public private partnership', International Journal of Project Management, 24, 595-604

Q.W. Fleming, J. Koppelman, Q. W. *(2006)* Earned value project management 3rd ed., Project Management Institute, Newton Square, PA.

Flyvbjerg, B., Holm M.S. and Buhl S. *(2002)*, 'Underestimating costs in public works projects: error or lie?', Journal of the American Planning Association, 68, 3 *(Summer)*, 279-295.

Flyvberg B. *(2006)*, 'From Nobel prize to project management: getting risk right', Project management journal, 37, 5-15.

Flyvberg, B. *(2009)*, 'Survival of the un-fittest: why the worst infrastructure gets built – and what we can do about it', Oxford Review of Economic Policy, 25, 3, 344-367.

Haji-Kazemi, S., Andersen, B. and Krane,. H.P. *(2013)*, 'A review on possible approaches for detecting early warning signs in projects', Project management journal, 44*(5)*, 55-69.

Hartono, B., Sulistyo, S.R., Praftiwi, P.P., Hasmoro, D. *(2013)* 'Project risk: theoretical concepts and stakeholders' perspectives', International Journal of Project Management, to be published

Hogarth R.M. and Makridakis S. *(1981)*, 'Forecasting and planning: an evaluation', Management Science, 27, 2, 115-138

Hadaya, P. and Cassivi, L. *(2012)*, 'Joint collaborative planning as a governance mechanism to strengthen the chain of IT value co-creation', Journal of strategic information systems, 21, 182-200

Kahneman, D. and Tversky, A. *(1977)*, "Intuitive Prediction: Biases and corrective procedures", Defense Advanced Research Projects Agency.

Kahneman, D. and Tversky, A. *(1979)*, 'Intuitive prediction: biases and corrective procedures', TIMS Studies in Management Science, 12, 313–327.

Kaplan, S. *(2008)*, 'Framing contests: strategy making under uncertainty', Organization Science, 19, 5, 729-752

Kleim R., Ludin I. *(1998)*, Project Management Practitioner's Handbook, AMACOM

Kolltveit B.J. Karlsen J.T. Gronhaug K. *(2004)*, 'Exploiting opportunities in uncertainty during the early project phase', Journal of Management in Engineering, October 2004, ASCE

Lovallo D. and Kahneman D. *(2003)*, 'Delusion of Success: How optimism undermines executives' decisions', Harvard Business Review, 81, 56-63.

Makridakis S. Taleb N. *(2009)*, Living in a world of low levels of predictability, International Journal of Forecasting, 25, 840-844

Makridakis S. Hogarth R.M. Gaba A. *(2009)*, Forecasting and uncertainty in the economic and business world, International Journal of Forecasting, 25, 794-812

March, J.G. *(1978)*, 'Bounded rationality, ambiguity, and the engineering choice', The bell Journal of Economics, 9, 2, 587-608

McElroy, B and Mills, C. *(2000)* 'Managing stakeholders', in Turner J.R. *(ed)* Gower Handbook of Project Management, 4th ed, Gower Publishing, Aldershot, pp. 757-777

Merrow E.W. *(2011)*, 'Oil industry megaprojects: our recent track record', Offshore Technology Conference, Houston, Texas, 2-5 May 2011

Miller, R. and Lessard, D. *(2000)*, The strategic management of large engineering projects, shaping institutions, risks and governance, MIT

Miller, R. and Lessard, D. *(2001)*, 'Understanding and managing risks in large engineering projects', International Journal of Project Management, 19, 437-443

Mitchell, R. K., Agle, B. R. and Wood, D. J. *(1997)* 'Towards a Theory of Stakeholder Identification & Salience: Defining the Principles of Who and What Really Count', Academy of Management Review, 22-4, 853-886

Newcombe, R. *(2003)* 'From client to project stakeholders: a stakeholder mapping approach', Construction Management and Economics, 21, 841-848

Olander, S. and Landin, A. *(2005)* 'Evaluation of stakeholder influence in the implementation of construction projects', International Journal of Project Management, 23, 321-328

Olander, S. *(2007)*, 'Stakeholder impact analysis in construction project management', Construction Management and Economics, 25, 277- 287

Olander, S. and Landin, A. *(2008)* 'A comparative study of factors affecting the external stakeholder management process', Construction management and economics, 26, 553-561

Palomo J. Ruggeri F. Rios Insua D. Cagno E. Caron F. Mancini M. *(2006)*, On Bayesian forecasting of procurement delays: a case study, Applied Stochastic Models in Business and Industry, 2006, 22, 181-192

Perminova, O., Gustafsson, M. and Wikstrom, K. *(2008)*, 'Defining uncertainty in projects – a new perspective', International Journal of Project Management, 26, 73-79

Project Management Institute *(2013)* A Guide to the Project Management Body of Knowledge, Fifth Edition, Newtown Square

Rowlinson, S. and Cheung Y.K.F. *(2008)*, 'Stakeholder management through empowerment: modelling project success', Construction Management and Economics, 26, 611- 623

Shohet, I.M., Frydman, S. *(2003)* 'Communication patterns in construction at construction manager level', Journal of construction engineering and management, 129 *(5)*

Soderholm, A. *(2008)*, 'Project management of unexpected events', International Journal of Project Management, 26, 80-86

Weick K.E. *(1988)*, 'Enacted sense-making in crisis situation', Journal of management studies, 25, 4, 305-317

Weick K.E. *(1995)*, Sense-making in organizations, Thousand Oaks, SAGE

Weick K.E. Sutcliffe K.M. and Obstfeld D. *(2005)*, 'Organizing and the process of sense-making', Organization Science, 16, 4, 409-421

Williams T.M. *(1999)*, 'The need for new paradigms for complex projects', International Journal of Project Management, 17, 5, 269-273

Williams T. Samset K. and Sunnevag K.J. *(eds.) (2009)*, Making essential choices with scant information, Palgrave Macmillan

Williams T. Klakegg O.J. Andersen B. Walker D. Magnussen O.M. and Onsoyen L.E. *(2010)*, 'Early signs in complex projects', PMI Research and Education Conference, Washington, July 2010

Williams T. and Samset K. *(2010)*, 'Issues in front-end decision making on projects', Project Management Journal, 41, 2, 38-49

Williams T. Klakegg O.J. Walker D. H.T. Andersen B. and Magnussen O.M. *(2012)*, 'Identifying and Acting on Early Warning Signs in Complex Projects', Project Management Journal, 43, 2, 37-53

Zuber, L. *(2013)*, 'What in the world were we thinking, Managing stakeholder expectations and engagement through transparent and collaborative project estimation', Project Management World Journal, Vol. II, Issue X