Project Management: Science or a Craft?

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Abstract and background

Projects in one form or another have been undertaken for millennia, but it was only in the latter part of the 20th century people started talking about 'project management'. Project Management (PM) is becoming increasingly important in almost any kind of organization today (Kloppenborg & Opfer, 2002). Once thought applicable only to large scale projects in construction, R&D or the defence field, PM has branched out to almost all industries and is used as an essential strategic element for managing and affecting change in modern companies (Kloppenborg & Opfer, 2002; Pinto, 2002). Society has successfully delivered many of the world's wonders without calling it project management, however, the profession of project management is relatively new - it was not until 1958 that the initial steps were made to formalize project management.

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Development of Project Management thinking

Project management has been practiced since early civilization. Until 1900 civil engineering projects were generally managed by creative architects, engineers, and master builders themselves. It was in the 1950s that organizations started to systematically apply project management tools and techniques to complex engineering projects (Kwak, 2005). However, project management is a relatively new and dynamic research area. The literature on this field is growing fast and receiving wider contribution of other research fields, such as psychology, pedagogy, management, engineering, simulation, sociology, politics, linguistics. These developments make the field multi-faced and contradictory in many aspects. Moreover, as observed by Wideman (2003), much of what has been written about project management is not built on or does not carefully consider results of former research. This results in "reinventing the wheel" over and over. Thus, it is important to understand the development of the project management research and acknowledge its current state in order to properly address the organization of multi-project companies.

Human beings have undertaken project-like activities for thousands of years, e.g. the nomads had the daily but unique job: survive. As human society accumulates knowledge, creates instruments and organizes them to execute different tasks, projects perceived as complex turned to trivial activities, and new complex challenges arrived. Contradictorily, it is with the industrial revolution and the change from project to mass production that project management developed the basic tools and ideas known and used until today. In this period, H. Fayol establishes the common basis for current project management practices (Uzuegbu & Nnadozie 2015). .Taylor's job specification led to WBS (Kwak, 2003). In 1910, Henri Gantt invented the Gantt-Charts, used until today in projects. His work is the forerunner to many modern project management tools including the work breakdown structure (WBS) and resource allocation (Cleland, & Gareis, 2006).

The 50s are considered the birth of modern project management (Kwak, 2003). The role of project manager emerged as the person totally responsible for the entire project. (Stretton, 1994), and classical schedule techniques were developed. In the beginning of the 60s other practices were introduced, such as life-cycle costing, front-end concept formulation,

C/SCSC (Cost and Schedule Control System Criteria), quality assurance, value engineering and WBS (Work Breakdown Structure) (Baccarini, 1999). The 60s and 70s also witnessed a growing interest of intellectuals in the project management field and general management theories have been systematically applied to project management (Morris, 1994), such as the system approach (Shenhar, 1997).

Project management tools and methodology were applied to different types of projects and in sectors other than aerospace, construction and defence (Baccarini, 1999).

In this period two major professional bodies were established: INTERNET (Institute of Project Management Associations) in 1965 (current IPMA – International Project Management Association), and PMI (Project Management Institute), in 1969. These institutions contributed to the legitimising of project management as a discipline.

In the 70s, project management was utilized by companies as a management tool for solving special tasks (Morris, 1994). In this period, the project management field acknowledged the relevance of soft skills and environment. It was recognized that soft skills were necessary for the development of projects and behavior techniques were applied to project teams (Morris, 1994). This development followed the trend in the human resource perspective in the general organizational theory. The influence of external factors such as political and economic factors to the management of projects increased and became vital for project success and hence became a trend in the 70s (Baccarini, 1999). This development followed the development of system and contingency theory. However, the main focus remained on the tools and techniques (Baccarini, 1999).

In the 80s, an organic paradigm for project management emerged (Baccarini, 1999). Project management was recognized as a key instrument in a turbulent environment, and appropriated to almost all kinds of change processes (Fangel, 1993). This growing use of projects in organizations led to increased adoption of matrix or project organizations. At this point, project management crosses again the organization theory field, but this time, the project management field is the one to influence the general management science by proposing a new perspective of management. Different disciplines were developed/included in the project management tools/concerns, such as configuration management, simultaneous engineering, total quality management, partnership and procurement, financing (such as BOOT), risk management. (Stretton, 1994b)

With the development of IT technology in the 80s and 90s, computer-based tools, mainly for scheduling, were developed and diffused (Kwak, 2003). Up to the end of the 90s, Project Management Body of Knowledge and textbooks were published, attempting to create standards in the project management practices and theory development. Since this period, these standards are being developed and further specialized in different areas and sectors. In this period, projects gained strategic importance in companies. Analysis of success factors and consequently ways to reach them gained attention. This rehearsed the traditional understanding of project success. Challenges such as project definition, involvement of client, i.e. end-user, and an ever increased importance of external factors were closely observed and analyzed. (Morris, 1994)

Today, this project management concept has developed from different fields of application including construction, engineering, and defence with the Main Objective of Producing Maximum Productivity with Minimum Resources (Kwak, 2005).

Lack of Historical Understanding

There is a growing concern in the project management community about the lack of historical understanding of the emergence of project management and the importance of landmark projects. Both researchers in project management (Garel, 2004) and business historians (Scranton, 2008) call for the development of a history of projects and project management. Indeed with the notable exceptions of Peter Morris' work (1994) and the in depth studies of Thomas Hughes (1998) and Stephen Johnson (2002), we actually do not know of any history of project management.

History can help us to better understand the roots of project management and the evolution of current managerial practices. This could lead us to recognize innovative managerial solutions from the past that are still relevant today and contradict the dominant model of project management. Indeed there is sometimes a discrepancy between current descriptions of historical projects and their realities. For example Lenfle & Loch (2010) in a paper in the California Management Review thus demonstrate that the usual statement that the Manhattan project "exhibited the principles of organization, planning, and direction that influenced the development of standard practices for managing projects" (Shenhar & Dvir, 2007) is notoriously wrong.

On the contrary the Manhattan project exhibited managerial practices (typically parallel strategy, experimentation and concurrent engineering) that have been forgotten in favor of a more control oriented approach of project management and are regaining relevance in today's innovation based and fast paced competition (Lo H. et al, 2006). As Janik points out, the "idea that we are smarter, simply because we come later, is a scholarly form of hubris and no less self-destructive with respect to our cultural heritage" (Janik, 2006). Accordingly, a better understanding of history might create an improved understanding of the difficulties in creating, shaping and managing projects and thus add to the empirical wealth of the subject. Another role of project history would be to create a common ground among academics within this domain of knowledge. Consider the importance of the Sydney Opera House project; it makes it easier to transfer knowledge of more complex type, makes it easier for people to talk about and share experience, and could then also lead to theoretical and metaphorical developments, similar to the paradox of the Sydney Opera House project.

It is widely held that history matters in management (Kantrow, 1986; Kieser, 1994) and, therefore, in project management. However, compared to business history and management history, which has had such a profound implication for

management in general and strategic management in particular, project management has been little discussed and scrutinized in a historical light. Therefore it is critical to develop 'Project History' as an important and integral part of project management research that seeks to integrate historical research with project management research.

Engwall (2003) believes that it is necessary to link a particular project to its context and history. By so doing, we will be able to show the influence of a particular project on managerial practices, before and after it's unfolding. So far, although not completely, literature has documented such fascinating projects as the Concorde project (Morris & Hough, 1987), the Erie canal project, the Brooklyn bridge, the Empire State building (Shapiro & Berndt, 1997), the SAGE project, the Atlas project, the Central Artery/Tunnel project, the ARPANET project (Hughes, 1998), to name a few.

Kloppenborg & Opfer

For its 2000 Research Conference, the Project Management Institute supported a research effort into the "current state of project management research". Over a time period of seven months, 92 researchers analyzed "scholarly periodicals and journals, conference proceedings. The analysis spanned the time period from 1960, when modern project management started to become more wide-spread (Archibald, 1987; Fondahl, 1987) to 1999. It was the intent of the project to "learn more about trends, major issues, contributions, and the circumstances surrounding past research; to develop an understandable portrayal of how the theory and practice of project management has evolved, and to obtain recommendations about the future direction for research. Out of more than 100,000 initial sources, the research team created an annotated database of 3,554 records (Kloppenborg & Opfer, 2002).

Kloppenborg & Opfer examined 3,554 articles, papers, dissertations, and government research reports in a study of the current state of project management research in order to identify the state-of-the-art of project management research (Kloppenborg & Opfer 2002). They used the nine knowledge areas described in the PMBOK® Guide (A Guide to the Project Management Body of Knowledge) (Project Management Institute 2000) and identified, that 64% of the documents written in English deal with the typical triangle of cost, time and quality. Only 5% of the papers deal with integration and, more notably, only 8% with communication issues.

This extensive research produced a number of significant conclusions. It showed that scholarly interest in PM has increased significantly during the 1990s, supporting the growing importance of PM: Of the articles included in the annotated database, 60% were published in the 1990s, 29% in the 1980s, 7% in the 1970s and only 1% in the 1960s. The knowledge areas most frequently cited were the triple constraint areas of PM, namely cost (28%), time (24%) and quality (12%). The industries most often represented in the PM context were Construction and Information Systems (21% each), followed by Education (8%). The study found a distinct shift in topics of interest during decades: in the 1960s, most research focused on large, defence-related projects. In the 1970s, the research focused on cost and schedule control, performance measurement and WBS and life-cycle management. While cost/schedule control remained a topic of major research interest during the 1980s, research started to include team building, quality and knowledge management related topics. The 1990s saw an increase in HR related topics such as team building and leadership development, as well as a focus on risk management (Kloppenborg & Opfer, 2002; Pinto 2002).

Despite the numerous publications, an explicit theory of project management seems to be missing. Kloppenborg & Opfer state that the theory of project management research should be evaluated in more detail. Koskela & Howell argue that there is an implicit and narrow theory in project management at the present time, which has to be developed, extended and enriched (Koskela& Howell 2002b). They differentiate between the theory of project and the theory of management and identified missing aspects in both categories of the current project management theory. They claim that a paradigmatic transformation of the discipline of project management is needed. But the problem remains unsolved. They see a potential improvement through concurrent development of theory and practice.

A number of other projects have attempted to provide an overview over the field of PM (e.g. Urli & Urli 2000; Zobel & Wearne, 2000). Among those, one study refined the above quoted PMI project with a specific focus on IS/IT related literature (Tesch, Kloppenborg & Stemmer, 2003), which resulted in 784 records from 223 different journals. In a discussion of those articles with professionals in the field, one of the main conclusions reached was that "IS/IT academic research should be examined frequently for the possibility of existing successful models that may offer relevance for IS project management issues" (Tesch, Kloppenborg & Stemmer, 2003). In addition, practitioners voiced specific interest in research on factors contributing to successful project completion and risk management. Concern was voiced that some of the more advanced research was not related to everyday PM demands and problems (Tesch, Kloppenborg & Stemmer, 2003).

In addition, a number of journals were classified as proceedings, academic or practitioner Journals. Based on this classification, the majority of articles selected (60%) were published in practitioner journals, 37% of articles were found in academic journals with the remaining 3% being published in proceedings. Citation analysis was used to determine the most commonly cited PM articles in the sample journals (Katerattanakul & Hong, 2003). The articles are being classified by key words and subject areas according to the PM Body of Knowledge. Previous literature has pointed out that practitioner oriented journals and proceedings tend to focus more closely on real life problems (Tesch, Kloppenborg & Stemmer, 2003; Zobel & Wearne, 2000).

Kloppenborg & Opfer

There's a huge gap between research and practice in most disciplines. Project management is no exception. Yet, research is important because, among other things, it gives rise to new techniques and perspectives, and also confirms (or disproves!)

the often assumed utility of existing practices. The paper entitled, Project Management Research – The Challenge and Opportunity, published by Aaron Shenhar and Dov Dvir in the June 2007 issue of the Project Management Journal dealt with research in project management.

The authors began by stating that project management is one of the fastest growing disciplines. Many initiatives in organizations are managed as projects, even if they aren't labeled so. The authors observe that, "…in a paradoxical way, project failures, delays, and disappointments are much too common to be ignored…there seems to be an alarming gap between the needs of the discipline and what we know in order to fix them. From a research perspective there is a great opportunity to help close this gap…" Their stated aim is to record some observations on the challenges and opportunities in project management research, in order to stimulate discussion about the role of research in academics and industry.

As the authors point out, people have been engaged in creating things since antiquity. The creation of large monuments such as the pyramids would have required some degree of organization, planning and coordination of the efforts of a large number of people, regardless of the specifics of how that might have been done. In other words, these efforts were all projects that had to be managed somehow. The authors define a project as, "a temporary organization and process set up to achieve a specified goal under constraints of time, budget and other resources" and project management as, "the managerial activities needed to lead a project to a successful end." They claim that modern project management, as a discipline, arose from the invention of the Program Evaluation and Review Technique (PERT) in the late 1950s, and take the position that the PMI's project management standard is the premier standard of the day.

The authors admit that the paper presents their subjective view of challenges and opportunities in project management research. Given this, it is perhaps unfair to read too much into what they say. Yet, it is instructive to look at an implicit assumption they make. It is clear from some of their remarks (and to a lesser extent the references at the end of the paper) that the authors use PMI standard as the basis for their discussion. This, quite naturally, affects their arguments and conclusions: i.e. everything discussed is viewed through the lens of that standard. Perhaps this is unavoidable: one has to make some assumptions to make any progress at all! In my opinion, though, authors of research papers should highlight their assumptions and limitations thereof, so that readers are fully aware of them.

To move on with the review, it is evident that despite all our methodologies and experience, project performance is alarmingly low. The authors quote statistics from the Standish Report and other studies to emphasize this. They concede that some failures can be ascribed to neglect or lack of planning, but highlight – through examples – that even well-managed and planned projects fail. Reasons for this are varied. For example, the original Iridium Project was deemed a failure because it did not take into account future business and technology trends. The construction of Denver International Airport is another example of high-profile failure. In that case, the reason for failure was that the automated baggage-handling system which was relatively unproven (and thus high risk) was treated as a standard well-proven system. On the other hand, the Sydney Opera House is now deemed a huge success despite being a classic example of project management failure – massively over time (by 16 years) and over budget ($100 million against an original budget of $ 7 million).

Citing these examples, the authors note that the problem is not with processes, rules or tools, as project management has plenty (perhaps too many!) of these. They suggest that the problem is at a conceptual level rather than process or practice, and that what's required is a new understanding of what the discipline is about. This, they say, is the responsibility and challenge of future research.

After outlining the history of the development of project management as a discipline, the authors conclude that there is no central paradigm underlying research or practice of project management. They reckon that inspiration for new ideas may be found in other, allied areas such as: Technology and Innovation Management Research, New Product Development Research, Entrepreneurship Literature and Operations Management. Research in technology/innovation management and new product development is more mature than project management research, and hence may suggest fruitful directions for future work. This has already started to happen: many project management researchers are focusing on new product development. Operations management offers another complementary direction; Goldratt's critical chain technique is the best known example of a project management technique that emerged from operations management.

The authors believe that project management researchers have largely ignored developments in the above fields – and hence there are significant research opportunities to be exploited. This process has already begun: researchers are indeed looking to other fields for inspiration and ideas, as evidenced by the growing number of cross-disciplinary research papers in project management journals. On the flip side, most of these papers are written by researchers in project management, very few by those working in other fields. The reason for this, as the authors rightly point out, is that project management still has a low profile in management research and business schools. They comment that very little project management research is published in "prestigious" journals. This is true enough; research published in a high-profile journal is more likely to be read widely. Finally they comment that there is a disconnect between project management research and practice. It should also be noted, though, that this problem is universal – the gap between academics and practice exists in all disciplines, not just project management.

Based on the current state of project management research and the issues listed above, the authors propose a "wider research agenda to address these challenges and bring project management research to the forefront of the academic world". The authors suggest two perspectives for future research:

• The problem-driven perspective: This view focuses on solving specific project management problems such as scheduling / resource allocation and time overruns to name just two. Typically, solutions to such problems emerge from other fields. For example, solutions to scheduling and resource allocation problems have come from operations research and network theory; and solutions to time overruns have come from operations management (critical chain). The problem with the problem-driven perspective is that there is no unifying theme. Which takes us to the next perspective

• The central paradigm perspective: This refers to a central, unifying theme for the discipline – or as the authors put it, a view of what project management is about. The authors identify three views:

o Operational/process view: which views a project as a sequence of tasks to perform according to a plan.

o Team/leadership view: which considers a project as an organizational unit that has to be managed (and lead, motivated etc.).

o Strategic/business view: in which a project is considered to be a business-related activity, which (presumably) forms a part of the organization's strategy.

Each of the above perspectives is based on different assumptions, metrics of success and also a different view of what it means to "manage a project." The authors correctly recognize that, "Although each direction is a world of its own, the real challenge is to combine them all into a unified view." They go on to state that, "success in project management can only be achieved by an integrated, holistic view of the entire landscape of the project." The three perspectives are, in fact, complementary; neglecting any of them will lead to project failure. As the authors recognize, progress in these wide-ranging, diverse areas will require a multidisciplinary approach. Finally, the authors address the issue of publication of research in "leading" (aka "prestigious") journals. They believe that raising the profile of project management in the broader world of management academia can be achieved by a) improving the acceptance rate of project management papers in highly-rated management journals and b) improving the standing of project management journals in academia. In conclusion the authors make the following observations:

• Project management is still evolving as a discipline, and is yet to establish its position amongst traditional management disciplines.

• It lacks a strong theoretical framework and a coherent set of guiding principles

• It is perhaps too complex to have a single underlying theory, but the interdisciplinary nature of the field and the variety of research challenges may help attract established researchers from other fields as well as young researchers starting out on an academic career.

The authors point to significant new opportunities and a bright future for project management research.

Project Management as a Science

The development of a body of theory is typical of a well-established profession, such as law, medicine, architecture, accounting, and nursing. Mastery of theory, along with mastery of practical skills of the field, is a hallmark of professionals. Indeed, according to Fugate and Knapp, reliance on the theoretical is the single most important factor distinguishing a profession from a craft ((Fugate & Knapp 1998).

In their analysis of project management research, spanning forty years, Kloppenborg and Opfer (2000) have nothing to report on the theory of project management. This extraordinary silence on the theoretical is puzzling; it is either conceded that there is no theory of project management, or it reflects the opinion that the theoretical is not significant from the point of view of project management.

It is the poverty of current theory that explains the other problems of project management, such as frequent project failures (Kharbanda & Pinto 1996), lack of commitment towards project management methods (Forsberg & al. 1996) and slow rate of methodological renewal (Morris 1994). Thus an explicit theory is the crucial and single most important issue for the future of the project management profession.

Project Management as a Science

A theory consists primarily of concepts and causal relationships that relate these concepts (Whetten 1989). It is possible to broadly characterize a target theory of production/operations management (Koskela 2000). This characterization applies also for project management, being a special type of production/operations management. A theory of project management should be prescriptive: it should reveal how action contributes to the goals set to it.

Secondly, there are internal goals, such as cost minimization and level of utilization. Thirdly, there are external goals related to the needs of the customer, like quality, dependability and flexibility.

An explicit theory of project management would serve various functions. In prior research, the following roles of a theory have been pinpointed (Koskela 2000):

• A theory provides an explanation of observed behavior, and contributes thus to understanding.

• A theory provides a prediction of future behavior.

• On the basis of the theory, tools for analyzing, designing and controlling can be built.

• A theory, when shared, provides a common language or framework, through which the cooperation of people in collective undertakings, like project, firm, etc., is facilitated and enabled.

• A theory gives direction in pinpointing the sources of further progress.

In prior literature, it is generally seen that there is no explicit theory of project management (Shenhar 1998, Turner 1999). However, it is possible to find statements from the PMBOK Guide or the work of leading scholars on project management that approximate the definition of a theory or from which a theory can be deduced. The PMBOK Guide states that projects are composed of two kinds of processes: project management processes and product-oriented processes (which specify and create the project product). Project management processes are further divided into initiating, planning, execution, controlling and closing processes.

According to Turner (1993), scope management is the raison d'être of project management. He defines the purpose of scope management as follows: (1) an adequate or sufficient amount of work is done; (2) unnecessary work is not done; (3) the work that is done delivers the stated business purpose. The scope is defined through the work breakdown structure (WBS). Indeed, a review of the PMBOK Guide reveals that activities and tasks are the unit of analysis in the core processes of project management, like scope management, time management, and cost management, and that their management and control is centralized (Morris 1994). The transformation theory (or view) of production, which has dominated production thinking throughout the 20th century is valid in Project management. Starr (1966) in the transformation view, production is conceptualized as a transformation of inputs to outputs. There are a number of principles, by means of which production is managed (Koskela 2000).

The PMBOK Guide divides project management processes into initiating, planning, execution, controlling and closing processes. A central idea is that these processes form a closed loop: the planning processes provide a plan that is realized by the executing processes, and variances from the baseline or requests for change lead to corrections in execution or changes in further plans.

The planning of projects is thoroughly described from the point of view of different knowledge areas in the PMBOK Guide. The planning processes are structured into core processes and facilitating processes. There are ten core processes: scope planning, scope definition, activity definition, resource planning, activity sequencing, activity duration estimating, cost estimating, and schedule development, cost budgeting and project plan development. The output from these processes, the project plans, makes up an input to the executing processes.

How is the project plan executed? On this aspect, the PMBOK Guide is puzzlingly brief-worded. The only direct reference to the actual interface between plan and work is with regard to work authorization system. The underlying theory of execution turns out to be similar to the concept of job dispatching in manufacturing where it provides the interface between plan and work. The basic issue in dispatching is allocating or assignment of tasks or jobs to machines or work crews, usually by a central authority. According to a modern definition, job dispatching is a procedure that uses logical decision rules to select a job for processing on a machine that has just become available (Bhaskaran & Pinedo 1991).

The PMBOK guide divides the core process of controlling into two sub-processes: performance reporting and overall change control. Based on the former, corrections are prescribed for the executing processes, and based on the latter; changes are prescribed for the planning processes. Project management seems to be based on three theories of management: management–as planning, the dispatching model and the thermostat model. The first is evident from the structure and emphasis of the PMBOK Guide.

The third is very clearly embodied in the closed loop of planning, execution and controlling. Neither theory comes as a surprise. Management-as-planning has been the widely held – even if most often implicit - view on intentional action in organizations up to now (Johnston & Brennan 1996). The dispatching model, closely associated with management-as-planning, has been common in industrial engineering from the beginning of the 20th century. Likewise, the thermostat model has been the dominating view on management in the 20th century (Giglioni & Bedeian 1974).

Is project management based on the best available theory?

The theory of projects as transformation is not the best available; rather it has to be augmented. The flow view of production, firstly proposed by the Gilbreths (1922) in scientific terms, has provided the basis for IT and lean production. Hopp and Spearman (1996) show that by means of the queuing theory, various insights which have been used as heuristics in the framework of IT can be mathematically proven.

The major difference between the transformation view and the flow view is that the latter includes time as one attribute of production. Because time is affected by the uncertainty in the production process, as well as interdependencies between tasks, the focus is directed towards uncertainty and linkages, which are not acknowledged in the transformation view.

Regarding the goals of project management, the flow view especially addresses the goal "unnecessary work is not done". In the flow view, the basic thrust is to eliminate waste from flow processes. Such principles as lead time reduction and variability reduction are promoted. In the value generation view, the basic thrust is to reach the best possible value from the point of the customer. Axiomatic design developed by Suh (2001) advances further the principles along which requirements should be assigned to product subsystems, a significant issue of value generation.

The major difference between the transformation view and the value generation view is that the customer is included in the conceptualization of the latter. Whereas the transformation view assumes that customer requirements exist at the outset, and that they can be decomposed along with work, the value generation view admits that at the outset, customer requirements are not necessarily available or well understood, and that the allocation of requirements to different parts of the (project) product is a difficult problem.

The value generation view provides for an explanation on the third goal of project management, delivering the business purpose. Principles related to rigorous requirement analysis and systematized flow down of requirements, for example, are forwarded. Again, the prescription is very different in comparison to the transformation view, which more or less accepts the requirements as they are.

It has been argued that these three concepts of production are not alternative, competing theories of production, but rather partial and complementary (Koskela 2000). What is needed is a production theory and related tools that fully integrate the transformation, flow and value concepts.

There is another approach to management, called management-as-organizing, which has been presented as a counterpart to management-as-planning (Johnston 1995, Johnston & Brennan 1996). Here, the structured nature of the environment may contribute to purposeful acting. Another important difference to the management-as-planning model is that the agent consists of interacting sub-units, i.e. they are capable of sensing, planning and acting. Communication is non-hierarchical, based on interaction between sub-units. In this approach, management involves design, co-ordination and enabling of otherwise autonomous activities.

The proponents of the management-as-organizing model have presented several strands of critique against the management-as-planning model (Johnston & Brennan 1996). First, it has been held that it is not generally possible to maintain a complete and up-to-date representation of the current circumstances and the plan to change them. Secondly, the absolute separation of management and execution is not seen to adequately correspond to organizational reality. Thirdly, the plans push tasks to execution without taking the status of the production system into account. The last two aspects mean that this models "leaves the task of management essentially uncoupled from everyday activity" (Johnston & Brennan 1996).

It is very difficult to maintain an up-to-date plan, and thus the tasks pushed by the plan do not correspond to reality, i.e. their prerequisites in terms of predecessor tasks (or other inputs) do not necessarily exist. This leads to the situation that a major share of tasks to be commenced, when pushed by the plan, chronically lack one or more of their inputs (Johnston & Brennan 1996).

The dispatching model could be compared to starting an engine, which will run at a known rate utilizing planned resources; commitment of those responsible is implicitly presumed. This starting is achieved through communicating the authorization that is giving orders to the responsible party. However, this view has been challenged by the language/action perspective (Winograd and Flores 1986). They argue that the work in organizations is coordinated through making and keeping commitments. The commitment cycle begins with an offer or a request, followed by a promise, performance and declaration of completion. Thus action is coordinated by the commitments people make rather than by central control acting through commands.

In addition to the thermostat model, there is another theory of control, one that addresses learning and improvement. Here, the question was originally about an experiment for quality improvement, where the validity of a specific hypothesis is checked. Then, according to the outcome of the experiment, the improvement method is possibly amended (Shewhart & Deming 1939). However, this can be generalized: all operations can be treated as hypothesis testing, rather than those specified as experiments in advance. Then every operation must be specified, i.e. the hypothesis made explicit – this is exactly what is done in the Toyota Production System (Spear & Bowen 1999). In this way, the root causes for problems can be found, and performance improved.

Toward a theory of Project Management

The emergence of project management is the result from an increasing number of projects and their diversity and intricacy. Nowadays projects can be found in many organizations, and more and more organizations based on projects (consulting, software development, and service companies). The project management profession is becoming more important in corporations, governments, academia, and other organizations worldwide (Kloppenborg & Opfer 2002).

A scientific theory provides means for the understanding of a given domain or area of research. It represents the body of knowledge in that domain and serves as a general framework for practitioners and researchers alike. Thus, a theory can be regarded as a (language) standard for the discussion and verification of ideas and assumptions about a given domain. Although there are numerous publications proclaiming standards and theories about project management (Burghardt 1997, Fowler 2003, Haberfellner 1997, Jenny 1995, Kerzner 1996, Koskela& Howell 2002a, Madauss 1990, Paulk 2002, Project Management Institute 2000), the empirical investigation indicates the need for further research on project management and its foundations (Kloppenborg & Opfer 2002). It is an obvious fact that project failures are (at least partially) caused by communication deficits and misunderstandings caused by the lack of a common language (respectively standard) of project management and its concepts (PM specific terms like task, project, etc.).

From a scientific point of view, we are following the design science paradigm (Hevner, et al. 2004). Design science seeks to create new and innovative artefact (Hevner, et al. 2004). An artefact can be a construct (a vocabulary like in our case), a model (a representation of something), methods (algorithms or practices) or instantiations (prototypes). As Kamlah and Lorenzen (1984) stated, a common language is needed in order to speak about things and objects of the real or imaginary world in a scientific, meaningful and efficient manner. A native language is given to all individuals (e.g. English, German, etc.). Unfortunately, it is barely scientific and imprecise. A scientific language has to be constructed by incrementally defining core concepts precisely and non self-reflective.

There are attempts to create a conceptual model that represents our PM theory. The purposes of conceptual modeling are (1) supporting communication between developers (project

members) and users (stakeholder), (2) helping analysts understand a domain, (3) providing input for the design process, and (4) documenting the original requirements for future reference (Kung &Sølvberg 1986). A model is defined as an abstract picture of an object of the real or imaginary world with respect to a subject (Becker & Schütte 2004).

Conceptual Model of Project Management

There are attempts to build a conceptual model of project management based on the PMBOK® (Project Management Institute 2000), German Institute for Standardization (DIN) (Burghardt 1997, DIN69901 1989, DIN69902 1987, DIN69903 1987, Fowler 2003, Jenny 1995, Kerzner 1996, Madauss 1990), and practical experience in order to identify the fundamental terms of PM theory. These terms and their relations build the vocabulary of PM and represent the objects and things that have to be managed and monitored in order to successfully conduct projects. From an IS point of view, information that is exchanged within a project always refers to at least one of these terms.

The model, which is modeled using the Entity-Relationship-Method (ERM) (Chen 1976) includes min-max-cardinalities (Becker & Schütte 2004). The conceptual model is the starting point of the ontological examination of the project terms. The conceptual model consists of the fundamental terms and their relations. Each fundamental term is associated with a clear meaning. The fundamental and crucial term (concept) in literature and practice is task. The definition, planning, execution and control of tasks are the source of every activity in project management methodologies. Even the human centric methodologies, like the agile methods, use tasks as a core concept. A task is an objective for purposive human action (Kosiol 1976). Tasks are aggregated to extensive task (task structure). The project at its whole is the most extensive task. Projects are characterized by the assignment of budget, contract, group of resources, the usage of a specific project life cycle, and a well-defined deliverable (DIN69901 1989, Jenny 1995, Litke 1991, Madauss 1990). Activities are the smallest units handled within project management methods.

Tasks are structured by using different levels of abstraction and different types of relationships. This conceptualization of tasks, projects, and activities encompasses concepts like work package, scope, and sub-project that are mentioned in the literature. The usage of phase (procedure) models is a common approach in order to reduce the complexity.

A phase is a factual and logical restricted period of time that is defined by the project management method. The assignment of tasks to phases is carried out by project team members respectively by the project manager. However, the assignment is restricted due to logical constraints (e.g. implementation prior to testing). Every phase has one or more deliverables. The deliverables are the material or immaterial, tangible, and verifiable products like a feasibility study, a detailed design, or a working prototype (Project Management Institute 2000).

A risk is a possible negative deviation from the project objective(s) (Kerzner 1996). Each project is subjected to at least one risk but not to all risks that are identified. The risks that threaten the project's success are related to the project objectives.

Stakeholders are individuals or organizations, who are involved in the project or in some tasks. The stakeholders influence the result or are the users of the system. The project team members are directly involved and therefore cause costs, use budget, are integrated in the project organization and are responsible for the execution of tasks. Therefore, project members and stakeholder have to be differentiated, although there is accordance in information supply and their influence on the project objectives. The project team members are persons, which are part of the project resources. Resources represent anything needed to perform tasks. The most important resources are persons (staff), who execute tasks. Apart from staff, technical resources like computers, machines, software and tools are used to perform the project, which we subsume by using the term equipment. The resources itself have to be classified by properties, which are useful for the project. In the case of persons, properties are skills. Other resources have functions, which are needed during the project. Skills and functions have to be measured and rated with quality measures.

In contrast to the PMBOK®, the assignment of quality to tasks seems to be sensible for a detailed quality management. However, it may be difficult to obtain meaningful quality measures at the end of each task. Thus, the measurement of the quality that is actually achieved has to be measured at the end of each phase.

Time, costs and quality represent fundamental concepts, which have to be managed in projects. These concepts are usually visualized by a triangle. Time and costs are directly allocated to the tasks and can be measured easily. The expected and adequate quality depends on the deliverable and its objectives (and the customer need or guideline). Thus, quality is always related to a deliverable and an objective. The degree of quality that is actually achieved depends on efficient allocation of resources and efficient task management.

The increasing complexity of the project management task has led to debate about the way projects are currently managed and to the search for new concepts and theories through which to understand and support the project management function. One of the key recent responses to these challenges to project management in the UK was the establishment of the EPSRC Rethinking Project Management research network (Winter and Smith, 2006).

From Project Management to the Management of Projects

There are two dimensions to what has recently been termed the "mainstream" project management approach (Hodgson and Cicmil, 2006). The first approximates to what Peter Morris (1998) describes as the traditional view of project management concerned with the iron triangle (Atkinson, 1999) of time, cost and quality (Kloppenborg &Opfer, 2002) and its associated concern with project delivery as well as the tools

and techniques required. Much, although by no means all, of this understanding of project management has been encapsulated in the attempts of professional bodies to codify their knowledge base in collected bodies of knowledge (PMI, 2004; APM, 2006).

The second dimension of the project management literature defines a broader field, some of which, but by no means all, is represented in the bodies of knowledge. This literature is often critical of the first for being too much focused on the operational delivery of projects and not sufficiently concerned with defining their impact in advance, at a more strategic level. To adopt Morris's terms, this second approach emphasizes managing projects rather than being just concerned with project management. Its focus is the project. It is about accomplishing projects successfully. It is about managing change and transition. Today, as never before, it is value driven. It is about meeting and exceeding customer expectations about getting the 'best bang for their buck', creating value, and shortening implementation schedules (Morris, 1998).

In a similar vein, Lundin and Soderholm (1998) suggest that the narrowest views of project management tend to black box the context of the project. This disregards the phases before and after implementation and the possible impacts these may have on the project; for example, creating momentum in the project in the first instance or learning from the project once it is completed (Lundin and Soderholm, 1998). In the context of long-term service-led projects, project managers are increasingly being asked to deliver value to the contractor and the customer down-stream and beyond the traditional delivery point. According to Morris and Pinto (2004) what is needed is to broaden the focus to cover the management of external and front-end issues, not least technology and client issues (Morris and Pinto, 2004). We therefore need to go beyond the traditional domains of project management theory and consider new insights.

Project Management Research Streams

In general, researchers approach project management from either a social or a technical point of view and do not combine these two interdependent components into an integrated theory of project management. Project management is becoming even more complex with hundreds, sometimes thousands, of interrelated tasks requiring effective control. Additionally, project environments are becoming more difficult to handle and predict, especially with ongoing dramatic technological changes and decreasing product life cycles. Despite the rapid growth of project management it is not yet widely known as a formal and established academic discipline similar to that found in marketing, finance and operation research. This problem may be traced to the fact that there is vast literature available on many aspects of project management but only rare attempts at theory building (Shenhar & Dvir, 2007; Snider & Nissen, 2003; Belout, 1998; Pittman, 1994).

Many research studies in project management suffer from three major flaws. First, the project management literature is fragmented by many studies that focus too narrowly on certain aspects of project management at the expense of others. Lacking a precise holistic view of the project management process can result in a simplistic view of the entire process, and in some cases, generate only sub-optimal project results. The second shortcoming of the project management literature is that project management theories are still somewhat underdeveloped (Shenhar & Dvir, 2007; Shenhar, 2001; Shenhar, 1998; Shenhar & Dvir, 1996). Indeed, Packendorff (1995) asserts that research literature on the management of projects has failed to establish theoretical explanations for such problems as deviations from plans, costs overruns, and conflicts within or between projects. The third flaw is the abundance of 'inward-looking' perspectives regarding the analysis of different aspects of project management (Packendorff, 1995; Winter, Andersen, Elvin, & Levene, 2006). Researchers often build their work on previous studies in the field while ignoring potential contributions from other disciplines (Shenhar & Dvir, 2007). A significant number of theories and research with potential value for project management actually lie outside the boundaries of the field and should be examined and integrated accordingly.

The first stream of research describes project management as a set of models and techniques derived from the operation research and applied mathematics concepts (McKay & Wiers, 1999; Packendorff, 1995; Pinto, 1998; Söderlund, 2004). Project management is viewed as a set of tools used to plan, organize, monitor, control, and report projects. This approach is based on the assumption that better planning and controlling techniques will improve project management performance. In other words, the solution to project management problems is in the development of more efficient algorithms (Sculli & Wong, 1985; Woodworth, 1989). Many researchers assert that project management research is biased towards technical, quantitative, and hard system approaches (Baker & Wilemon, 1977; Belout, 1998; Turner, 2003). The dominance of the technical approach to project management may be explained by the heavy influence of the construction field (Crawford et al., 2006).

The mechanistic approach is predicated on the notion that the project manager's role is to develop and strictly adhere to a perfect plan (Dvir, Raz, & Shenhar, 2003). Pollack (2007) argues that the mechanistic view of project management assumes a strong causal connection between management actions and organizational outcomes. Thus, perfect predictions are now possible on the basis of deterministic causal laws (Ackoff, 1979; Jaafari, 2003).

Mintzberg, Quinn, & Voyer (1995) stress that organizations deal with dynamic situations in which realized (final) plans are not originally intended (initial) plans, but rather a mix of emergent and intended plans. In this way, it may not come as a surprise that "inadequate planning" is the first reason for project failures in at least 36 studies (Nikander & Eloranta, 1997). In the same way, risk management techniques fail in anticipating real future threats because risk analysis is a static one-time procedure undertaken at the beginning of the project (Nikander & Eloranta, 2001). This may explain why risk management tools are not often used in practice (White & Fortune, 2002). It follows that traditions and assumptions in project planning should be re-evaluated since it is insufficient "to prepare perfectly for an imperfectly-predicted future" (Ackoff, 1979).

Another major criticism of most quantitative techniques is that they assume a linear project management process based on the premise that activities can be ordered in the form of sequential interdependencies (Duncan, 1979; Jaafari, 2003; Packendorff, 1995; PMI, 2004; Sonawane, 2004). In reality, most projects--especially those of great complexity-- are non-linear systems with many reciprocal interdependencies (Duimering et al., 2006). Another major problem with most traditional project management techniques is in the close system representation of project management, which overlooks or underestimates the impact of the environment. White & Fortune (2002) consider that 70% of the side effects of using traditional project management techniques can be linked to a lack of awareness of the changing environment.

Project management software can be seen as a subset of the technical approach since almost all traditional techniques are incorporated in software packages. Many researchers believe that the dynamic and heterogeneous nature of project management elements, the interdependence of various participating entities, the complexity of projects, the need for flexibility, and the high degree of coordination required together suggest that information technology has a great potential for managing projects (Doloi & Jaafari, 2002; Fox & Spence, 2005; Fox, 2000; Hegazy, 2002; Hegazy & El-Zamzamy, 1998; Matthews, 1987; Thamhain, 1987). Research to date has focused on increasing the level of flexibility and improving ease of use, but little attention has been paid to the conceptual models embedded in the software (Liberatore, Pollack-Johnson, & Smith, 2001). In general, while project management software packages may differ in some advanced features, they generally share the same underlying concepts (Bobrowski, 1989; Davis & Martin, 1985; Liberatore et al., 2001).

One may argue that project management software packages are flexible tools that can cope with unexpected changes in the project management situation. However, the flexibility of any technology is limited to the predefined range of possibilities programmed in them (Duimering, Safayeni, & Purdy, 1993). These limitations in project management software may explain why project managers rank project management software as the tool with most drawbacks, especially with complex projects (White & Fortune, 2002).

Many researches assert that primary problems of project management are not merely technical, but also human (Belout & Gauvreau, 2004; Hegazy, 2002; Packendorff, 1995; Posner, 1987). Despite this view of social aspects of project management, some researchers argue that human issues are still overlooked (Belout, 1998; Laplante, 2003; Metcalfe, 1997). This shift towards a more social approach to project management is based on the premise that project outcomes can be enhanced by first changing the behaviors of people involved in the process. The main areas of interest are organizational culture, organizational support, organizational commitment, learning, leadership, decision-making, team building, knowledge building, conflict management, and communication skills (e.g. Bresnen, Edelman, Newell, Scarborough, & Swan, 2003; Brookes, Morton, Dainty, & Burns, 2006; Jackson & Klobas, 2008; Johns, 1999; Nordqvist, Hovmark, & Zika-Viktorsson, 2004; Wang & Armstrong, 2004; Wong & Cheung, 2008).

The "technical" approach to project management suffers from a myopic focus on technical components of the project system with little consideration for the social context. In the same way, many social studies of project management often lack a clear specification of the larger technical task contexts of a project, which may either constrain or facilitate both role behavior and social relations among project participants. Despite the fact that socio-technical interactions are central to the study of project management as a whole, only a few serious studies have tried to capture these complex interactions. The socio-technical approach to project management is promising because it examines the interactions among people, tasks, and technologies simultaneously (Bostrom & Heinen, 1977; Griffith & Dougherty, 2002; Pasmore & Sherwood, 1978; Shani, Grant, Krishnan, & Thompson, 1992).

At a basic level, it can be argued that whenever human and technical elements are put to work, socio-technical interactions will always occur, whether intended or not. The technical system may be defined as referring to task requirements and formal procedures and include the necessary technologies to achieve the desired results. On the other hand, the social system may be defined as having task dependencies with their coordination requirements that can lead to the development of group social norms for task performance (Palvia, Sharma, & Conrath, 2001). A similar line of thinking developed by Bavelas et al. (1983) and Scott (1987) asserts that any task dependencies will result in associated social structures since social and formal task structures do interrelate in the context of task performance. Project management can be viewed as a manifestation of a complex pattern of interrelations and interactions between individuals and groups that are pursuing different parts (i.e. subtasks) of a project.

Overall, the socio-technical approach essentially views project management as interacting subsystems in which projects are delivered by establishing a fit among various groups with different, and possibly competing, expectations and goals. Future research on socio-technical aspects of project management can shed further light on the development of project management theories as a means of understanding the process itself. Such analysis will help determine the nature of interdependent interactions and the effects these interactions have on the project management process and the outcome of the project as a whole. Additional research is needed to refine the concept of socio-technical systems, as that concept applies to project management. Currently the concept is underdeveloped and presents no clear methodology on how to capture and analyze complex interactions successfully.

Conclusion

The high number of publications in the project management discipline indicates the importance of project management as well as its immaturity. The low success rate of projects implies serious financial risks as well as missed schedules and inadequate quality, posing serious threats for organizations that are based on projects. Project failures are at least partially caused by communication deficits and understanding problems. The vast number of publications prevents a sound assessment of methods, tools and techniques in project management.

Moreover, the discipline is characterized by a huge number of methods that provide solutions for parts of the overall problem. However, integrative approaches are needed in order to reflect the complexity of the project holistically.

Management by projects plays a central role in organizations of the future where project management needs to be described in terms of the fundamentals applicable to business development. From the literature surveyed a trend developed where project management from the perspective of industrial development can be seen as the past, from the perspective of business development as the present and from social development as the future.

It is no exaggeration to claim that project management as a discipline is in crisis, and that a paradigm change, long overdue, has to be realized. Concepts and propositions from a number of areas of theoretical development in the social sciences, offer the potential to rethink project management in ways that could shed light on some of the complexities of modern major projects.

The present doctrine of project management suffers from serious deficiencies in its theoretical base. Firstly, it rests on a faulty understanding of the nature of work in projects, and deficient definitions of planning, execution and control. Secondly, the theoretical base has been implicit. It can be argued that these shortcomings have led to three classes of problem.

Firstly, project management has not achieved the goals set to it: it does not perform in a satisfactory way. In small, simple and slow projects, the theory-associated problems could be solved informally and without wider penalties. However, in the present big, complex and speedy projects, traditional project management is simply counterproductive; it creates self-inflicted problems that seriously undermine performance.

Secondly, the lack of theory has rendered education and training more difficult and has hampered effective professionalization of project management. Lacking theory, project management cannot claim, and will not be granted, a permanent and respected place in higher Education institutions. Also, the lack of an explanation of project management, to be provided by a theory, has slowed down the diffusion of project management methods in practise.

Thirdly, the renewal of project management has been hampered by the lack of theory. Anomalies, deviations from theory-predicted outcomes, have been observed long since in project management, but their cause has been misinterpreted and the project management community has not acted on them.

The important functions of a theory, regarding continual validity testing and giving direction for further progress, have neither from the viewpoint of research nor practice been realized. The present evidence is strong enough for the claim that a paradigmatic transformation of the discipline of project management is needed. The transformation required implies that a more intimate relation between theory and practice must be created in project management. Theory and practice have to be developed concurrently, similarly to other science-based fields, where theory is explicated, tested and refined in a continuous dialogue between the scientific and practitioner communities.

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