Project Management:
From Genesis to Content to Classification

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This paper is the first of a series of six papers describing the search for a best practices linkage from project classification through management style to project success. It represent part of the research conducted between 1992 and 1998. This paper was presented to an INFORMS Conference in Washington, DC, in May, 1996, and briefly reviews the genesis of modern project management and its scope in today's business and technical environment.

Background

Change, at a seemingly ceaseless increase in pace, is recognized today as one of management's greatest challenges. Consequently, management focus is shifting from traditional routine 'enterprise' management, to one of capturing needed competitive change through establishing a project or a program of projects. Competitive change and projects are synonymous, but to be successful different projects require different management approaches. Therefore we need to establish an effective classification for both the scope of project management and for different types of project. Table 1 - A Hierarchy of Management Orientation shows the consequential implications of shifting focus from one to the other.

Enterprise		**Project**	
Direction			
Goals:	***Continuity*** defined by - sets of Objectives	Purpose:	***Change*** defined by - sets of programs
Objectives:	defined through strategies	Programs:	defined through - sets of Projects
Process			
Strategies:	achieved through - Tactics	Projects:	achieved through - sets of Tasks
Tactics:	achieved through - consistent Activities	Tasks:	achieved through - variable Effort
Activities:	result in - ***continuous*** product	Effort:	results in - ***unique*** product
Characteristic:	"In-finite"	Finite	

Table 1 - A Hierarchy of Management Orientation

Historically, projects have been associated with the construction of buildings and facilities and records tend to focus on the challenges of the construction work itself. However, even ancient history has something to tell us about the problems faced on the management side of project work.

For example, the earliest pyramid at Saqqara in Egypt was the first stone building of any size to be found in the world. It was commissioned by King Zoser of the third dynasty and while the king was clearly the 'sponsor' of the project, one of his ministers, Imhotep, was the 'project manager'.

We are told that "Although no trustworthy details of the lives of Zoser and Imhotep have come down, we can be sure that they were able men who worked long and effectively together. Probably, Imhotep was a universal genius like Archimedes and Leonardo da Vinci. Such was his repute as a physician, architect, writer, statesman, and all-round sage that in later times collections of wise sayings circulated under his name."[1]

Thus was born the reputation of the project manager, but this particular project was not without its management problems. The account goes on "[previously] ... Egyptian kings and nobles were buried in a tomb called a mastaba ... [but] ... Zoser and Imhotep ... built a stone mastaba of unusual size and shape. It was square instead of oblong like its predecessors, and was over 200 feet on side and 26 feet high.

"Not yet satisfied, Zoser and Imhotep enlarged this mastaba twice by adding stone to the sides. Before the second of these enlargements was completed, the king changed his mind again. He decided not only to enlarge the structure still further, but also to make it into a stepped pyramid, resembling four square mastabas of decreasing size piled one atop the other. Then Zoser changed his mind once more. The tomb ended as a stepped pyramid of six stages, 200 feet high on a base 358 by 411 feet ..."

This brief but age-old example demonstrates some of the classic difficulties experienced by project management in the modern world such as: controlling the scope of the project, the impact on cost and schedule, handling a difficult client, and the frustrations of the project manager. While the account suggests that Zoser and Imhotep worked well as a team, it is unlikely that Imhotep for his part was faced with the current-day need to 'gain and retain team commitment' of those working for him. No doubt he had available a powerful enticement. Those who failed to perform could be summarily executed!

Today, this form of incentive has been mostly discredited, though not entirely. Its modern-day equivalent, summary dismissal, is to be found in the corporate world, but has the attendant difficulties of extended litigation if not conducted with due care. While the remaining workers may work more intensively, morale implications suggest that they work less effectively.
The traditional techniques of project management, estimating, budgeting, scheduling and monitoring the work are relatively easy to master. The difficult areas, to which most problems can be traced, is to be found in the planning and controlling of the work, and organizing and motivating the people who do it. Moreover, the availability of 'universal geniuses' like Imhotep are few and far between, so that understanding the project management process and enabling project management learning becomes of primary importance. Major issues include: On what basis will the project be managed? How will it be controlled? And, how shall we know if it has been successful?

Genesis of Modern Project Management

We need to be sure that we have a common understanding of what a project is. Perhaps the simplest definition is that a project is "A unique set of activities with a beginning and an end, undertaken to meet some established goals, objectives and deliverables within defined constraints of scope, quality, time, cost and stakeholder or customer satisfaction." Even though the word "project" is often misused, this definition implies that a project is a process quite distinct from the product which is the output from this process. Note also that scope, quality, time and cost determine the 'boundaries' or limitations of the project (process), but that the measure of customer's satisfaction is the measure of the project's 'success'.

Intuitively, we must know that the success of a project depends on both the management process as well as the 'value' of the product upon completion. Surprisingly, the issue of project success, what it is and what management style or organizational approach can best achieve it has received only quite recent attention in the project management literature. Yet, the corner stone of modern and successful project management also derives from ancient history.

More than 2,500 years ago, the famous Chinese philosopher, Confucius, expressed this sentiment. "In all things, success depends upon previous preparation - and without such preparation there is sure to be failure." In modern parlance, this elementary observation translates into a simple two-step sequence: 'Plan before doing', or the more popular exhortation 'Plan Your Work, Work Your Plan!' This basic concept is the foundation of the project life cycle by which projects need to be managed. First plan, then produce.

Of course, the real world of project management is not quite so simple, but it helps if we can grasp the fundamentals. Interestingly, the two steps have entirely different characteristics and require quite different management approaches. This is because planning is (or should be) about 'Doing the right things' to ensure the success of the project.

It includes ensuring that the correct objectives are selected and correctly stated, selecting the best solutions, and the best way of implementing them. It also includes, and this is frequently overlooked, reaching agreement on the relevant measurable critical success indicators by which the project's management will direct or guide the project process. Planning is about maximizing the project's 'effectiveness'.

Producing, on the other hand, is about 'Doing the things right' or, in the words of the Total Quality Management enthusiasts - 'Do it right the first time!'. If the project is to be contained within its scope, quality, time and cost parameters, then the focus must be on competent administration and creating a productive environment. Producing is about maximizing the project's 'efficiency'.

Integrating the considerations just outlined above enables a project to be put through a systematic project management process consisting of the generic four-phase project life cycle shown in Figure 1.

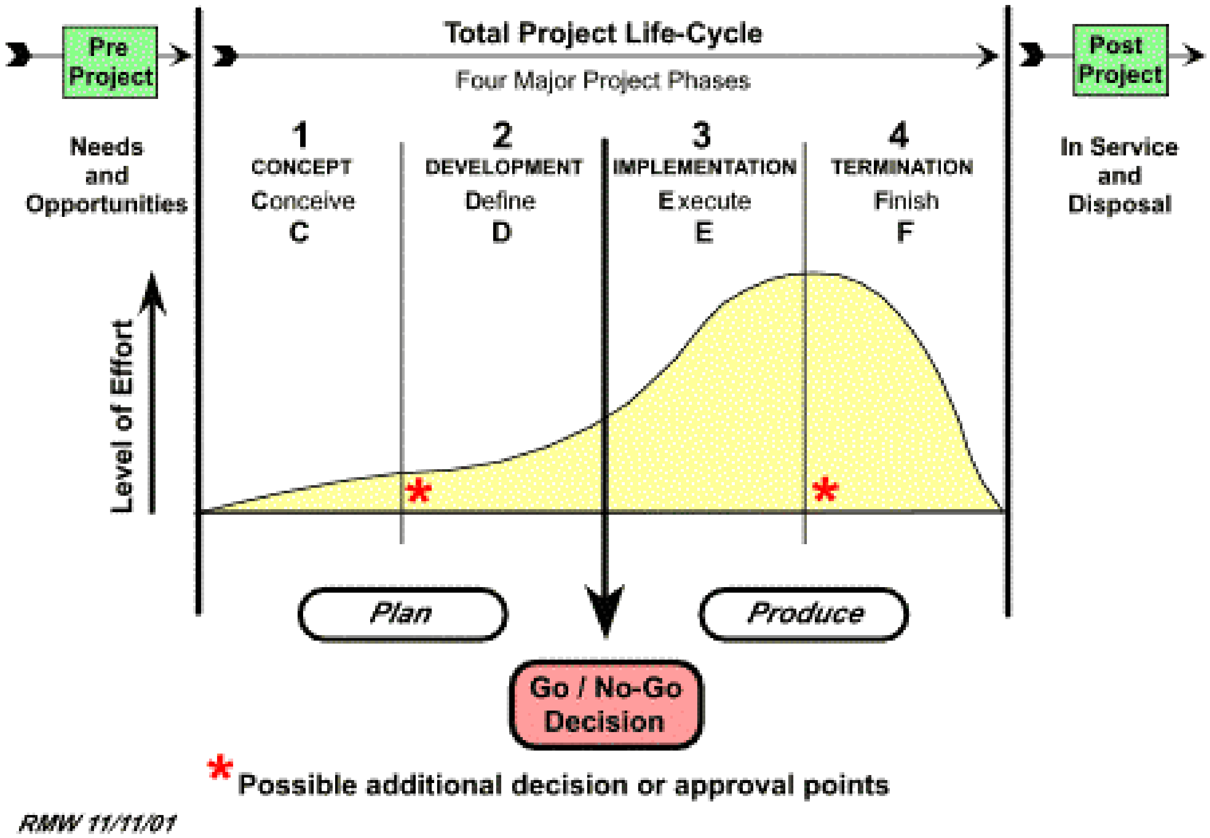

Figure 1 Four-phase Generic Project Life Cycle

Scope of Project Management in Today's Business and Technical Environment

The generic four-phase project life cycle suggests that the project management process is both linear in logic and mechanistic in application. While this may be true to some extent, the real world of project management is very different because work is accomplished by people and people respond to communication. Nothing happens without one or the other, and with today's educated work force particular attention must be paid to these elements of project leadership.

Indeed, the definition of leadership, especially project leadership, is itself an issue. Given the difference between 'Planning' and 'Producing' described earlier, and the differences generally ascribed to leaders and managers it may be deduced that project planning requires 'leadership', while project production requires 'managership', see Table 2: Differences in Style.

But this switch in style is not the only challenge. Project management is full of such paradoxes. Tom Peters, management guru, identifies seven further such paradoxes in mastering project management. These include exposing ego versus no ego; autocrat versus delegator; ambiguity versus perfection; oral versus written; complexity versus simplicity; forest versus trees; impatience versus patience[2]. He might have added internal versus external focus, and so on. However, this kind of hodge podge approach to understanding project management is not very helpful.

Leaders **focus on**	***Managers*** **focus on**
• Vision	• Goals and objectives
• Selling what and why	• Telling how and when
• Longer range	• Shorter range
• People	• Organization and structure
• Democracy	• Autocracy
• Enabling	• Restraining
• Developing	• Maintaining
• Challenging	• Conforming
• Originating	• Imitating
• Innovating	• Administrating
• Directing	• Controlling
• Policy	• Procedures
• Flexibility	• Consistency
• Risk-opportunity	• Risk-avoidance
• Top line	• Bottom line
Good leaders do the *right things*	**Good managers do the *things right***

Sources: Adapted from Warren Bennis *On Becoming a Leader*, Addison Wesley, 1989; J. W. McLean & William Weitzel *Leadership, Magic, Myth or Method?*, AMACOM, 1991; Stephen R. Covey *Principle-Centered Leadership*, Summit Books, 1991.

Table 2 Differences in Style

From the point of view of learning, a more structured compartmentalization has been suggested to describe the full scope of project management. Five primary elements have been broadly mapped as follows.[3]

The Project Environment: This sets the context of the project. It includes accommodating to the external environment into which the product of the project will be launched, whether that is simply the management culture and support services of the parent organization, or the greater environment beyond. On a large complex project the latter could require a major 'public relations' type effort. Internally, it includes accommodating to the technology vested in the project and the four constraining and interlocked project objectives of 'scope', 'quality', 'time', and 'cost'.

The Project Life Cycle: As noted earlier, a generic sequence of phases is inherent in the definition of 'project'. It, and all the intricacies associated with specific areas of project application, provides a logical and progressive basis for learning about project management.

Project Integration: This covers ministering to the people responsible for the component parts of the project and their correct interfacing. It includes 'team building' and the issues of 'temporary teamwork', 'project production and productivity', and dealing with 'uncertainty, opportunity and risk'. Above all, it relies heavily on the need for reliable 'information, data storage and retrieval'.

Project Processes: This is inherent in both 'project' and 'management' and includes the essential processes of 'justifying', 'setting direction' and 'management control'. It also provides an opportunity to describe appropriate applications of project management, its benefits and its pitfalls.

Priorities for Project Success: This flows from satisfying the project's stakeholders and constituents and provides the motivation (driver) for effective project management in the first place. It includes learning from past experience and identifying measurable project success indicators. It is also closely associated with effective communication and the total long-term value of the resulting product. These are the issues that are remembered long after the limited euphoria experienced in simply meeting objectives of time and cost.

Developing a Project Typology

Now that we have a feel for the full breadth and depth of project management, the burning question is 'How is all this related to the real world of projects?' Given a particular project to undertake, how can we decide what is important and what is not? What priorities should we pursue? What organizational structure will be most appropriate? What management style to adopt? And so on.

Since projects are essentially unique undertakings, and their range in objectives, size, complexity and technology are almost limitless, it would clearly be beneficial if projects could be brought within some manageable classification framework. In this respect we are most fortunate.

Intensive study has been conducted over the last four years on a collection of more than 120 projects for which detailed management data was available. Subsets of these have been used for more detailed examination with a view to establishing a project classification system. Up to 100 parameters have been examined for relevance and suitability. The recommendations are both enlightening and simple.[4],[5],[6],[7]

As a result of this research, a two dimensional project typology consisting of Project Management Scope versus Technological Uncertainty has been proposed. Within this typology, the primary considerations which emerged from the research can be separated into three groupings. There are those that are associated with an increase in Program/Project Management Scope, or complexity, and there are those that are associated with increasing Technological Uncertainty, according to the technology content. When projects progress along both dimensions simultaneously, a third set of considerations emerge. These are shown in Figure 2: Project Management Trends: along Scope and Uncertainty Dimensions.

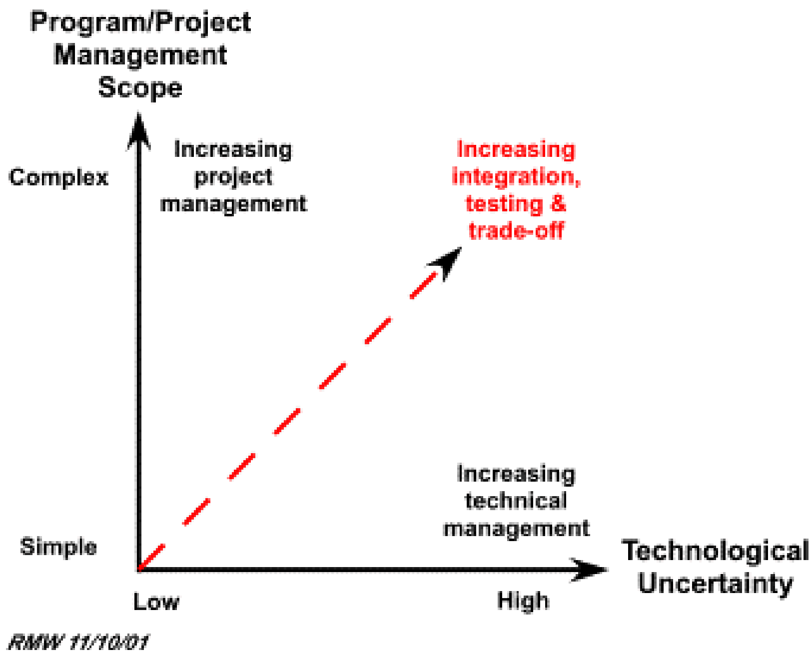

Figure 2 Project Management Trends along Scope and Uncertainty Dimensions

For practical purposes, the two continuous scales have been reduced to three levels of complexity and four levels of Technology Content. This matrix is shown in Figure 3 - Proposed Project Classification System.

Proposed Project Classification System

Understanding the descriptors along each dimension of Figure 3 is important. The three levels of complexity are as follows.

Level 1 - Assembly: This represents a project consisting of a collection of components and modules combined into a single unit. A typical assembly may perform a well defined function within a larger system, thus constituting one of its subsystems, or it can be an independent self-contained product that performs a single function of a limited scale. A computer's central processing unit, its display screen, or its printer are three separate examples of the former, while radios, washing machines or a single family home are examples of the latter.

Level 2 - System: This represents a project consisting of a complex collection of interactive elements and subsystems within a single product, jointly performing a wide range of independent functions to meet a specific operational mission or need. Examples include radar, computer work stations, any form of transportation vehicle, or multiple-use high-rise buildings.

Level 3 - Array: This represents a program, rather than a single project, where program is taken to mean a series of related projects designed to accomplish broad goals and to which the individual projects contribute. Often, arrays are dispersed over wide geographical areas, or over an extended period of time, and consist of a variety of project systems. Examples include any of a city's infrastructure, inter-airport airside control, or any of the national defense systems.

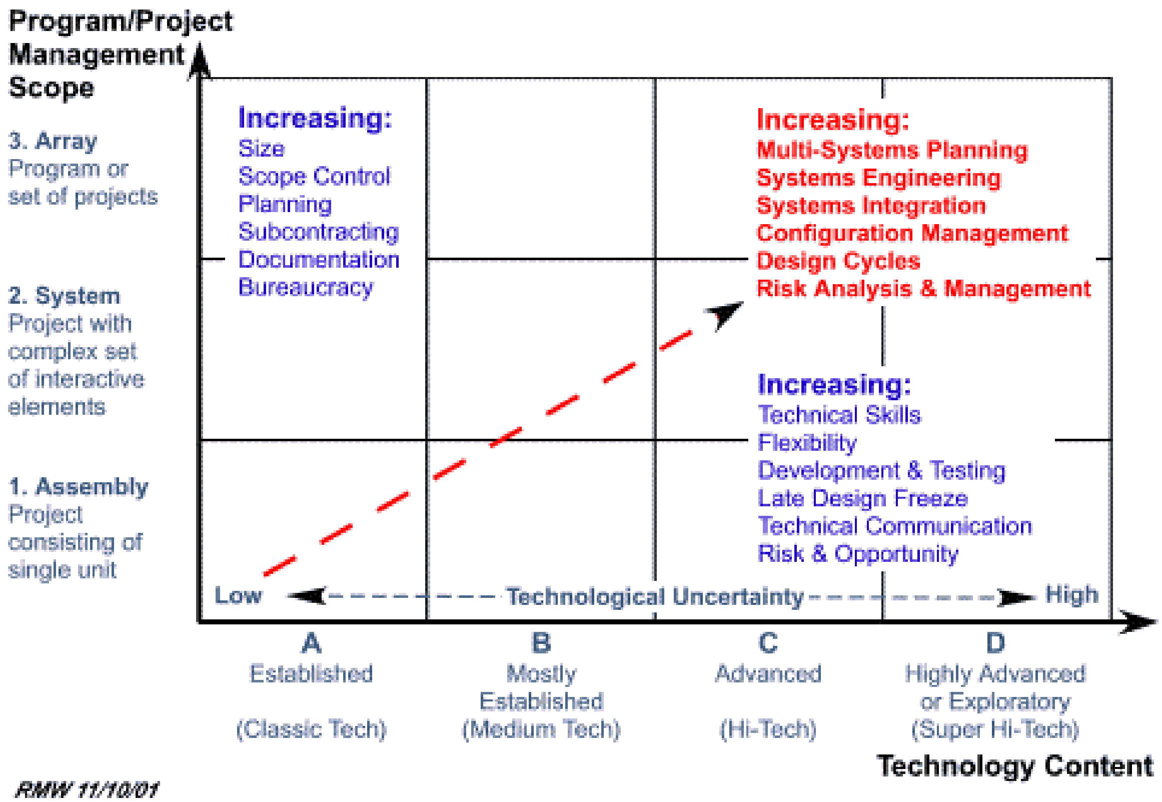

Figure 3 Proposed Project Typology

The four levels of Technological Uncertainty depend on the technology content of the project. They are as follows.

Type A - Established Technology: These projects rely on existing and well established base technologies to which all industry players have equal access. Although such projects may well be very large in scale, no new technology is employed at any stage. The majority of projects in the construction and road building industries fall into this category.

Type B - Mostly Established Technology: These are similar to Type A, but involve some new technology or feature. While the majority of the work has relatively low uncertainty, the new feature provides market advantage but also a higher degree of uncertainty. Examples include many industrial projects of incremental innovation, as well as improvements and modifications to existing products.

Type C - Advanced Technology: Often referred to as High-Tech projects, these are projects in which most of the technologies are employed together for the first time. However, the individual technologies already exist, having been developed prior to project initiation. Defense industry projects typically fall into this category.

Type D - Highly Advanced Technology: Such projects require exploratory development and may be referred to as Super High-Tech. They call for the incorporation of technologies which are not entirely existing, emerging or even unknown solutions at the time of project initiation. Project execution therefore involves technology development, testing and selection from among alternatives. Research and development projects fall into this category.

Linking Scope-Technology Classification with Project Management Processes

The research cited earlier, and illustrated conceptually in Figure 2, examined the linkage between selected projects placed in the classification system and established project management processes. Project management through the various project phases involved linking two different, but not disjointed, sets of activities. The first involved those that led to the assembly of pieces of technological knowledge to create and shape the characteristics of the final product, i.e. the project's scope and work breakdown structure. The second involved the managerial activities necessary to allocate, use and monitor resources, coordinate the various parties, manage integration through communication, and support the technical activities through decision making and data management.

The conceptualization and planning or development of a project is typically an iterative effort. Plans need to be developed, tested and re-worked On the other hand, the implementation and finishing of a project should seek to maximize productivity through logical and uninterrupted execution. However, as technology content advanced, the later that firm planning decisions were evidently taken. These were often delayed well into the implementation phases, as reflected by progressively later 'design freezes' and consequent impact on the on-going progress of work.

Similarly, as the program/project scope increased, the project management processes became more intense and more detailed. Hence the need for more and careful project management planning, more extensive coordination, closer control and attention to project configuration. The result was a tighter and more formal management form as projects progressed up the scale.

When moving along both dimensions simultaneously, new challenges and concerns arose. Higher scope higher tech projects involved producing large multi-disciplinary systems which involved many subsystems and components based on new technologies. Such projects required even more replanning activities more frequently. Similarly, systems engineering activities were also more intensive and were required to harmonize and optimize the collection of subsystems and components.

System integration was another challenge. In higher scope higher tech projects, the successful production of the separate subunits was one thing. Integrating them into one working piece was quite another. Typical problems of interfacing often required a long a tedious process of assembly, numerous testing and interface trade-offs and, in some cases, more than one design cycle for the entire system.

Configuration management, specification and documentation were also prominent problem areas, especially at the super high-tech end, and special software was required to track all the decisions and changes. Finally, there was the special need for risk management. While all projects involve some degree of risk, the higher scope higher tech projects were more sensitive to the difficulties of risk management and the need for risk analysis.

As might be expected, the studies indicated that the level of technological uncertainty was more associated with engineering and design-related variables such as design cycles, design freeze points, and systems engineering. The scope dimension, on the other hand, was more associated with administrative and managerial variables such as the number of activities, use of the work breakdown structure, planning and contracting strategies.

Conclusion

Project management is not new, although our understanding of it, and its application to a much broader range of project types may be. In fact the seeds of project management theory and practice were sown over a thousand year ago. Two simple philosophies state that success depends on preparation, and preparation must address the issues of doing the right thing, while the focus of the subsequent production is on doing the things right.

However, project management is more than just planning and doing. Modern project management encompasses managing as many as five primary areas including: the project's external and internal environments; its life cycle; integration/interfacing/configuration through reliable information; control processes; and success through effective communication.

Projects may be classified according to a two-dimensional typology of three levels of program/project scope versus four general levels of technology content. It is suggested that this form of classification provides broad guidance to the relative and respective levels of project process management and project technical management required for the project.

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[1] Sprague de Camp, L., The Ancient Engineers, Ballantine Books, New York, February 1974, p21.
[2] Peters, T., Liberation Management, Knopf, New York, NY, 1992, pp 212-214.
[3] Wideman, R. M., Criteria for a Project Management Body of Knowledge, International Journal of Project Management, Vol. 13, No. 2, 1995 Elsevier Science Ltd., UK, 1995, pp 71-75.
[4] Shenhar, A. J., From Low- to High-tech Project Management, R&D Management 23, 3, 1993, Blackwell Publishers, Oxford, UK, pp 199-214.
[5] Shenhar, A. J., Contingent Project Management: A Classical Concept in a New Arena, U. of Minnesota, Minneapolis, MN, 1994 (Working paper)
[6] Shenhar, A. J., Some Projects are More Equal: Toward a Typology of Project Management Styles, U. of Minnesota, Minneapolis, MN, 1995 (Working paper)
[7] Shenhar, A. J., & Dov Dvir, Managing Technology Projects: A Contingent Exploratory Approach, Proceedings 28th Annual Hawaii International Conference on System Sciences, 1995, pp 494-503.