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An empirical analysis of the relationship between project planning and project success

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Abstract

This paper examines the relationship between project planning efforts and project success. Three planning aspects are considered (requirements definition, development of technical specifications, and project management processes and procedures), along with three perspectives on project success (end-user, project manager, and contracting office). The study is based on data from more than a hundred defense research and development projects (aimed at the development of weapon systems and support equipment) performed in Israel and includes an analysis of the statistical correlation between the two sets of variables. The findings suggest that project success is insensitive to the level of implementation of management processes and procedures, which are readily supported by modern computerized tools and project management training. On the other hand, project success is positively correlated with the investment in requirements' definition and development of technical specifications.

Keywords: Project planning; Requirements capture; Project success

1. Introduction

A typical description of the project manager goal is "...to bring a project to completion on time, within the budget cost, and to meet the planned performance or end-product goals" [1]. This commonly held view of the project manager task is based on the assumption that the performance or end product goals are always clear and well defined in advance. All the project manager has to do is to prepare a solid project plan and follow this plan all the way to success. Although there are some that claim that too much planning can curtail the creativity of the project team, there is no argument that at least a minimum level of planning is required. In fact, although planning does not guarantee project success, lack of planning will probably guarantee failure. However, there are many cases where projects are executed as planned, on time, on budget and achieve the planned performance goals, but turn out to be complete failures because they failed to produce actual benefits to the customer or adequate revenue and profit for the performing organization.

This paper examines the relationship between different aspects of project planning and project success as perceived from various perspectives. Our objective is to analyze the relationship between the amounts of effort invested in project planning, and the degree of success achieved, as seen from different viewpoints. The analysis is based on data collected from more than a hundred defense R&D projects performed in Israel and includes three planning aspects (requirements definition, development of technical specifications, and project management processes and procedures) and three perspectives on project success (end-user, project manager, and the contracting office). The paper is organized as follows. We begin with a review of the pertinent literature, followed by a description of the research methodology. Next, we present the questionnaire data and show how it relates to the planning and success variables. The following section contains the analysis of the statistical correlations between planning variables and success variables. We conclude with a discussion of the findings and their implications for the practice of project management.

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2. Literature review

2.1. Project planning

Most authors agree that a project is a unique endeavor, a special task that has not been done before. Consequently, it is very difficult or even impossible to know precisely at the initial planning stage what are all the activities that need to be carried out in order to complete the project, and what their cost and duration parameters are [2]. The issue is even more severe when the kind of activities that should be undertaken depends on the outcome of earlier activities. For that reason some might even jump to a conclusion that planning is not necessarily helpful or even desirable [2]. Andersen proposes to replace the standard planning approach with milestone planning [3,4], where a milestone is defined as a result to be achieved. Since a milestone describes what is to be done, but not the way it should be done, milestone planning promotes result-oriented thinking rather than activity-oriented thinking.

Bart [5] points out that the traditional approach of planning and controlling of R&D projects tend to fail mainly because of too much formal control which curtails creativity from playing a crucial role in execution of the project. Bart proposes to reduce the formal control and keep only a minimum required level.

Even if we agree with Bart and keep planning to a minimum level, there is no argument as to the contribution of complete and accurate capture of end-user requirements to successful project completion [6]. This is because the output of the requirements analysis stage will most likely determine the output of the entire development process. Posten [7,8] has found that 55% of all defects in R&D projects occur during requirement analysis and specification whereas 43% of all defects are not found until after the testing stage.

The importance of the initiation phase stands out relative to other phases in the project life cycle [9,10]. Dvir et al. [11] in a recent study of development projects in Israel indicate that the origination and initiation phase, in which major decisions are made, such as deciding the project's objectives and planning the project's execution, has the most influence on the project's success. They also found that although the preparation of formal design and planning documents has a strong positive effect on meeting the project's time and budget objectives, it also contributes significantly to the customer's benefits from the end-product.

The discussion above led us to distinguish between three levels of planning. The first is at the end-user level, where planning focuses mainly on the functional characteristics of the project end product. Next is the technical level, where the team that has to create the product focuses on the technical specifications of the project deliverables that are needed to support the functional requirements. Finally, at the project management level, the focus is on planning the activities and processes that need to be carried out in order to allow the technical work to proceed effectively.

2.2. Success measures

Although studies of organizational effectiveness and organizational success have been at the heart of organization theory for many years, research into project success has not converged to a standard approach. One widely used approach searches for a simple formula that is unequivocal and easy to apply. Measures of this type have typically equated success with meeting the project's budget and schedule and achieving an acceptable level of performance [12]. However, these measures, even when taken together, are at most partial. They may count as successful projects that met the planning objectives (schedule, budget and performance objectives), but may not have met end-user needs and requirements or there may have been difficulty in commercializing the final product [13].

The success rating of a project may also differ according to subjective, individual judgment. Freeman and Beale [14] point out that success means different things to different people. Comprehensive success criteria must therefore reflect different interests and views, which lead to a multi-dimensional, multi-criteria approach [14–16]. Pinto and Mantel [16] identified three aspects of project performance as benchmarks for measuring the success or failure of a project: the implementation process, the perceived value of the project, and client satisfaction with the delivered project.

Shenhar, Dvir and Levy [17] used 13 success measures adapted from previous research and showed that these measures could be grouped into four dimensions: (1) *Meeting design goals*, (2) *Benefit to the customer*, (3) *Commercial success*, and (4) *Future potential*. Clearly, not all four-success dimensions are of the same importance. Lipovetsky et al. [18], who analyzed defense projects, concluded that the success dimensions *meeting design goals* and *benefit to the customer* are the most important ones to all stakeholders in the projects (customer, developer or purchasing organization). In this research we followed a similar approach and looked at success through the eyes of the main stakeholders involved in the project: the end-user, the project manager, and the contracting office.

3. Research methodology

Our research is based on the analysis of the correlation between the extent of effort invested at the three planning levels (functional specifications, technical specifications and project management processes) and the success of the project as perceived by the three main stakeholders (end-user, project manager, and the contracting office). The data for the analysis was drawn from a survey of 110 defense-related research and development projects carried out in Israel. The characteristics of the projects in the sample as well as the questionnaire that was used to collect data are described in detail in Section 4.

Each of the planning and success variables was measured using several questionnaire items. In order to simplify the analysis, we first applied factor analysis (principal component analysis) to reduce the large number of questionnaire items into a small number of factors (see, for example, Timm [19] and Harman [20]). The resulting factors served as the basis for the correlation analysis.

4. Data

The data came from 110 defense R&D projects performed in Israel over the last 20 years and was gathered using structured questionnaires and interviews. This kind of project is usually intended to provide the Israeli Defense Forces (IDF) with weapon systems and various types of support equipment. The procurement process involves three main entities: the end-user, the contracting office and the contractor.

The end-user represents the personnel who will be using the systems and equipment that the project is intended to develop and produce. The need for the project originates with the end-user, who is significantly involved in defining the functional requirements. The contracting office is a unit of the Ministry of Defense. Its role is to manage the procurement process on behalf of the end-user, and includes, among other responsibilities, monitoring the performance of the contractor selected for carrying out the project. The contractor is a commercial firm or a government R&D facility that has been awarded the contract for carrying out the project that will develop and produce the system that will fulfill the end-user need. The project manager is an employee of the contractor who has full responsibility for successful execution of the project.

The projects in the sample were performed by a variety of contractors in the areas of electronics, computers, aerospace, mechanics and others. The respondent population included many types of defense projects: new weapon systems, communication, command and control systems, electronic warfare equipment, and other support equipment development projects, they all were completed by the time of the survey. The questionnaires were filled out within not more than 3 years after the completion of the projects by at least three key personnel related to the project and representing the various stakeholders (the end-user, the project manager within the contractor organization and the contracting office).

The questions solicited subjective evaluations on a seven-point scale. For example, the level of improvement of the end-user capabilities by using the new product was determined by asking the respondent the following question: "According to your assessment, were the end-user capabilities significantly improved?" The answer was given on the scale: 1 (not at all) to 7 (extremely improved). The questionnaire was administered in a face-to-face session by specially trained interviewers, all of whom had been previously involved with this type of projects in various capacities. For each project there were three respondents: the project manager (or a senior representative from the project office); a representative from the end-user community; and a representative from the contracting office. Later, the interviewer completed a separate questionnaire that integrated the three sets of responses while accounting for the relative weight given by the interviewer to the three interviewees. This method was used since not in all cases the most informed respondent was tracked and interviewed. In such cases a greater weight was given to the answers of the respondents who were better informed than the others. The analysis presented here is based on the integrative responses compiled by the trained interviewers.

The questionnaire addressed numerous aspects of the research and development process. In this research our analysis is limited to the items pertaining to project success and the project planning. All the questionnaire items included in this analysis appear on the tables that follow, as described next. The analysis of other aspects has been reported elsewhere (see, for example [17,18,21,22]).

5. Measures

5.1. Success criteria

Project success was measured along three criteria that were applied and validated in previous research by Shenhar, Dvir and Levy [17]. These criteria are:

1. Meeting planning goals (success at the project manager level)
2. End-user benefits (success from the end-user point of view)
3. Contractor benefits (success at the contractor's level, and includes their last two criteria: commercial success of the project and potential for future revenues)

Tables 1–3 below describe the responses to the questionnaire items that addressed the three measures of

Table 1
Descriptive statistics for the "Meeting planning goals" items

Success measures	*N*	Min	Max	Mean	S.D.
Meeting Functional Requirement as defined during the design phase	103	1	7	5.82	1.23
Meeting Technical Specifications as defined during the design phase	101	1	7	5.69	1.31
Meeting Schedule	103	1	7	3.89	1.78
Meeting Budget goals	102	1	7	4.22	1.74
Meeting Procurement goals (number of items supplied compared to plan)	82	1	7	4.62	2.30

Table 2
Descriptive statistics for the "End-user benefits" items

Success measures	*N*	Min	Max	Mean	S.D.
Satisfying end-user operational need	93	1	7	5.56	1.66
Project end-product is in use	90	1	7	4.83	2.45
Systems delivered to end-user on time	83	1	7	4.24	2.16
System has significant usable life expectancy	86	1	7	5.24	1.99
Performance level superior to previous release	75	1	7	6.08	1.47
End-user capabilities significantly improved	74	1	7	4.96	2.01
End-user satisfied from project end-product	75	1	7	4.79	2.03

Table 3
Descriptive statistics for the "Contractor benefits" items

Success measures	*N*	Min	Max	Mean	S.D.
Profit exceeded plans	101	1	7	2.55	1.95
Profit exceeded similar projects	97	1	7	2.79	1.90
New market penetration	102	1	7	3.46	2.42
Created new market	100	1	7	3.54	2.35
Created new product line	102	1	7	4.34	2.23
Developed new technologies and infrastructures	107	1	7	5.56	1.44
Developed new knowledge and expertise	107	2	7	5.81	1.20
Generated positive reputation	104	1	7	5.20	1.43
Responded to business or competitive threat	95	1	7	3.52	2.34

success used in this study. The results of the principal component analysis performed to establish their validity are given below.

In Table 1 there are 81 observations with valid responses to all five items. The factor analysis carried out on these observations yielded a single factor that explains 61% of the variance. Consequently, for the correlation analysis we used the average of the response to these five items.

In Table 2 there are 60 observations with valid responses to all seven items. The factor analysis carried out on these observations yielded a single factor explaining 66% of the variance. Here again, in the rest of the analysis we used the average response to these items.

In Table 3 there are 87 observations with valid responses to all nine items. Principal Component Analysis yielded two factors. However, one factor accounted for 50% of the sample variance and included also the only two items that had high loadings on the second factor. Consequently, here again we decided to proceed to the correlation analysis with the average response to these nine items.

6. Overall success measure

In addition to the three sets of success measures described above, the questionnaire included an item dealing with overall success of the project. The *overall success* was also measured on a 1–7 scale, where 1 represents a complete failure and 7 represents full success. There were 108 responses, ranging from 1 to 7, with an average of 4.85 and a standard deviation of 1.54.

7. Project planning

The amount of effort invested in project planning was considered along the following three dimensions:

Table 4
Descriptive statistics for the "Development of functional requirements" items

Measures	N	Min	Max	Mean	S.D.
End-user requirements properly defined	100	1	7	5.09	1.50
Concept well defined	101	1	7	5.66	1.27
Operational requirements properly documented	97	1	7	5.02	1.93
Defined operational effectiveness criteria	99	1	7	4.75	1.77
End-user representatives involved in need definition	100	1	7	5.80	1.42
System Use characteristics defined	95	1	7	4.38	1.82

Table 5
Descriptive statistics for the "Development of technical specifications" items

Measures	N	Min	Max	Mean	S.D.
Operational requirements and specifications well defined	95	1	7	5.18	1.34
Technical specifications well defined	97	1	7	5.52	1.29
Acceptance criteria well defined	93	1	7	5.11	1.70
Logistic support well defined	87	1	7	3.99	1.85
Reliability specifications defined	89	1	7	4.29	1.93
Coexistence specifications defined	88	1	7	4.76	1.93
Human engineering specifications	87	1	7	4.34	1.89
Target cost for batch production	84	1	7	4.64	1.92
Life cycle cost defined	86	1	7	2.64	1.72

1. Development of functional requirements
2. Development of technical specifications
3. Implementation of project management processes and procedures.

Each dimension consists of several questionnaire items (variables) that measure its various aspects. The items used here were taken from previous work of Shenhar et al. [17].

Descriptive statistics for the items comprising each dimension are shown in Tables 4–6. As before, we carried out a principal component analysis on each set of items in order to examine the internal consistency. Here again, in all cases a single factor was found to account for most of the sample variance, justifying the use of the average score for the subsequent correlation analysis. The number of observations used for the factor analysis and the percentage of variance explained were as follows: Development of functional requirements: 93 observations, 51%; Development of technical specifications: 76 observations, 61%; and Implementation of project management processes and procedures: 49 observations, 60%.

From the pure statistics methodology perspective, one should be aware of the risk of overfitting when fewer than five observations per variable are used. In the case of the last dimension (Implementation of project management processes and procedures) there were 49 observations and 17 variables. However, keeping in mind that the number of degrees of freedom is still greater than 30, and that the purpose of this part of the analysis was to ascertain the validity of the underlying concept rather than to test hypotheses regarding the existence of additional factors, we feel that the result is acceptable.

Table 6
Descriptive statistics for the "Implementation of project management processes and procedures" items

Measures	N	Min	Max	Mean	S.D.
Systems engineering	84	1	7	4.82	1.76
Engineering design	84	1	7	5.20	1.50
Risk management	86	1	7	3.63	1.89
Resource and schedule planning	91	1	7	4.75	1.44
Financial management	91	1	7	4.69	1.43
Contract management	80	1	7	4.57	1.50
Procurement management	82	1	7	4.88	1.50
ILS management	68	1	7	3.60	1.93
Quality and reliability assurance	81	1	7	4.69	1.55
Test and inspection management	91	1	7	5.38	1.17
End-user relationship management	93	1	7	5.61	1.27
Configuration management	82	1	7	4.71	1.66
Change management	74	1	7	4.16	1.94
Team management	90	1	7	4.79	1.60
Meeting and decision making management	95	1	7	5.06	1.31
Reporting and communications	95	1	7	5.12	1.35
Transfer to production	68	1	7	4.57	1.75
Valid N (list-wise)	49				

8. Data analysis and results

The central part of the data analysis consists of examining the correlations between the three composite measures of planning (Development of functional requirements; Development of technical specifications;

Table 7
Correlation between average planning scores and average success scores

		Tech. Spec.	Management Infrastructure	Planning Goals	End-user Benefits	Contractor Benefits	Overall Success
Functional Requirement	Correlation	0.572	0.098	0.128	0.217	0.062	0.297
	Significance	0.000	0.358	0.205	0.038	0.539	0.003
	N	98	90	100	92	101	100
Technical Specification	Correlation		0.127	0.159	0.344	0.051	0.256
	Significance		0.241	0.117	0.001	0.621	0.011
	N		87	98	89	98	98
Management Infrastructure	Correlation			−0.020	−0.098	−0.171	−0.039
	Significance			0.849	0.378	0.102	0.708
	N			92	83	93	94
Planning Goals	Correlation				0.621	0.317	0.570
	Significance				0.000	0.001	0.000
	N				94	104	105
End-user Benefits	Correlation					0.418	0.706
	Significance					0.000	0.000
	N					95	95
Contractor Benefits	Correlation						0.454
	Significance						0.000
	N						105

and Implementation of project management processes and procedures) and the four measures of project success: three composites (Meeting planning goals; End-user benefits; and Contractor benefits) and the single item "Overall project success". The results of the correlation analysis appear on Table 7.

There are 21 correlation coefficients, and it is possible that some will appear to be statistically significant due to the compounded effect of Type I error. Consequently, we have adjusted the critical significance level to the rather conservative value of 0.001. This means that the compounded Type I error, i.e. the probability that one of the 21 correlations will appear to be statistically significant while in fact it is not, is about 0.021, well below the commonly applied threshold of 0.05.

Several interesting results emerge from the results in Table 7. First, not surprisingly, there is a high correlation between the capturing and developing of the functional specifications of the end product and the definition of the technical specifications. But, there is no correlation at all between the implementation of planning procedures in the project and the quality of the functional and technical specifications of the end product.

Second, there is no correlation between the implementation of planning procedures in the project and the various success dimensions.

Third, there is a positive (but not statistically significant) correlation between the development of functional and technical specifications on one hand, and meeting planning goals and achieving contractor benefits on the other hand. In contrast to that, the correlation of these two planning variables and end-user benefits and overall success is quite high and significant.

Finally, all four success-measures (Meeting planning goals; End-user benefits; Contractor benefits; and Overall project success) are highly inter-correlated, implying that projects perceived to be successful are successful for all their stakeholders.

9. Discussion and conclusion

Although there are some that claim that too much planning can curtail the creativity of the project workers [5] and others that propose to do milestone planning instead of activity planning, there is no argument that at least a minimum level of planning is required. In fact, planning is considered a central element of modern project management. Commonly accepted professional standards, such as the PMI Guide to the Project Management Body of Knowledge, emphasize heavily the need to invest in project management processes and procedures to support planning. The assumption behind this position is that planning reduces uncertainty and increases the likelihood of project success. Furthermore, the PMBOK encourages project managers to believe that although planning does not guarantee project success, lack of planning will probably guarantee failure. Now days with the advancement in computerized planning tools and the blooming in project management training, a certain level of planning is done in all projects, even in those that eventually turn out to be unsuccessful projects. Hence, when a certain level of planning is done in all types of projects, a significant statistical correlation cannot be found in the data.

On the other hand, this study strengthens previous research findings related to requirements and specifications capture. There is a significant positive relationship between the amount of effort invested in defining the goals of the project and the functional requirements and technical specifications of the product on one hand, and project success on the other, especially in the eyes of the end-user.

Not surprisingly, the relationship with overall success is also positive and significant. Previous research by Lipovetzky et al. [18] has shown that the most important dimension of project success is the end-user benefit. The overall success measure mainly reflects the end-user point of view and that is the reason for the similarity in correlation with the end-user benefit dimension and the overall success.

The main conclusion from our results is that no effort should be spared in the initial stage of a project to properly define the project goals and its deliverables requirements. This task cannot be achieved without the customer or end-user involvement in the process. End-user involvement should start at the first stage of the project and continue until its successful end. Of special importance is end-user involvement until the freezing of all end-product specifications. A minimum level of planning tools and procedure use is also important but what kind of tools is of no importance. Furthermore, formal planning is in the hands of the project manager while the development of requirements and specification is dependent on tight cooperation with the end-user.

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