The Relative Importance of the PMBOK® Guide's Nine Knowledge Areas during Project Planning

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Abstract

Although *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*– Fourth Edition identifies nine Knowledge Areas that project managers should focus on while managing projects, it does not indicate the relative importance of each of these Knowledge Areas. However, such information can be of great significance in helping project managers determine how to use their available resources most effectively. This paper investigates the relative importance of the project management Knowledge Areas used during the planning phase of a project, and their impact on project success. Results presented in this paper are based on a field study which involved 783 project managers from different countries and industries. The study revealed that the Knowledge Areas with the greatest impact on project success were Time, Risk, Scope, and Human Resources., However, these results have been found to be sensitive to the industry in which projects were undertaken. Differences among industries are described and discussed in the paper.

Introduction

Many bodies of knowledge and frameworks (e.g., International Project Management Association [IPMA], 2006; OGC, 2007; Project Management Institute [PMI], 2008) support project management in practice. The most popular body of knowledge worldwide is that described in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*–Fourth Edition (PMI, 2008), which identifies nine Knowledge Areas (KAs) that the project manager should focus on during the project life (PMI, 2008). Unfortunately, most project managers often have limited time to perform all that is required by the *PMBOK® Guide*. Therefore, project managers may choose to perform only those processes that they are most familiar with or that are easier to perform. In doing so, they may give lower priority to KAs that have higher impact on project success. As the *PMBOK® Guide* itself does not identify the relative importance of each KA, the objective of this study is to empirically identify the most important of the *PMBOK® Guide's* KAs. This information may help project managers improve decision making with regard to the way that time and resources are allocated among different KAs and associated processes. For example, because a planning meeting is limited in time, the project manager may need to decide whether to include a quality planning session in this meeting's agenda or to allocate more time to discuss the scope change procedure.

As the literature identifies dissimilar characteristics in different project phases (e.g. Pinto & Slevin, 1988; Zwikael & Globerson, 2006), studies ought not to offer general advice for the whole project life, but should instead focus on only one project phase. This paper focuses on the planning phase, as this is considered a critical phase in any project (e.g., Cooper & Kleinschmidt, 1995; Fortune & White, 2006; Johnson, Karen,

Boucher, & Robinson, 2001; Pinto & Slevin, 1987). Even the best execution will fail if it follows a faulty plan. For example, recent studies have showed that when planning processes are improved, the likelihood of project success increases (e.g., Zwikael & Globerson, 2004). Further, this paper identifies the most important KAs of the planning phase.

The structure of this paper includes: (1) a review of the relevant literature in the area, (2) a description of research hypotheses, methodology, and a field study, (3) identification and analysis of the KAs that contribute most to project success, (4) a comparison between each KA's relative importance and the actual attention it receives from project managers, and finally (5) an analysis of the relative importance of KAs among different industry types.

Literature Review

Because this study focuses on the planning phase of a project, this section first introduces the relevant project planning literature. Then, the planning processes included in the *PMBOK® Guide* will be discussed.

Project Planning

The goal of the planning phase of a project is to prepare the structure for project execution and control. Planning is an important factor for project success (Cooper & Kleinschmidt, 1995; Fortune & White, 2006; Zwikael, Shimizu, & Globerson, 2005) and as such is recognized as one of the critical success factors of project management

(Johnson et al., 2001; Pinto & Slevin, 1988; Turner, 1999; Zwikael and Sadeh, 2007).

However, some criticism of project planning practices can also be found in the literature, especially as regards the ability to accurately estimate cost and schedule during planning. For example, Flyvbjerg, Holm, and Buhl (2002) investigated 258 transportation infrastructure projects, worth US$90 billion and representing different project types, geographical regions, and historical periods. The authors found overwhelming statistical significance that the cost estimates used to decide whether such projects should be built are highly and systematically misleading. They suggest that one should not trust cost estimates and cost-benefit analyses produced by project promoters and their analysts. This can lead to high cost overruns at the end of the project (e.g., Keil, Rai, Ellen, Mann, & Zhang, 2003). Bigelow (1998) criticizes the importance of planning by quoting project managers who claim that planning takes too much time and that customers do not know what they want.

Project planning involves specifying a set of decisions concerning the way in which project work should be executed in the future. The primary purpose of planning is to establish a set of directions in sufficient detail that the project team can be told what must be done, when it must be done, and what resources to use in order to successfully produce project deliverables (Meredith & Mantel, 2006). The major benefits from quality planning are: (1) to eliminate or reduce uncertainty, (2) to improve efficiency of the operation, (3) to obtain a better understanding of project objectives, and (4) to provide a basis for monitoring and controlling work (Kerzner, 2006). A project manager is responsible for completing the project to the satisfaction of all relevant stakeholders. Therefore, project managers should not only make certain that their actions are executed

according to plan, but more importantly, that the plan is reliable and properly represents stakeholders' requirements.

Project Planning in the *PMBOK® Guide*

Williams (2005) criticizes the use of project management bodies of knowledge, which he finds inappropriate for complex, uncertain, and time-limited projects. However, most scholars believe that implementing a body of knowledge increases the chance of project success. In this study, the *PMBOK® Guide* is used because of its popularity and recognition. However, one should remember some criticism related to the *PMBOK® Guide*, including lack of covered scope by the nine Knowledge Areas, missing issues (e.g., technology and design), environmental issues, and business and commercial issues (Morris, 2001).

According to the *PMBOK® Guide*–Fourth Edition (PMI, 2008), a project manager is expected to perform 42 processes, including 20 planning processes. Therefore, planning processes consist of about 48% of all processes that should be properly performed by a project manager during the project life cycle. The *PMBOK® Guide* also includes the following nine KAs: Integration, Scope, Time, Cost, Quality, Human Resources, Communications, Risk, and Procurement.

Many project managers find it disturbing that the *PMBOK® Guide* does not identify the relative importance of each of these nine KAs. Such an analysis would give project managers and executives a better understanding of how to distribute their limited time and resources. KAs have been compared in a limited number of studies. For example, in evaluating the maturity of 38 companies in the United States, Ibbs and Kwak

(2000) found that project managers pay most attention to Cost and Communications areas. Cooke-Davies (2002) argues that Risk and Human Resources KAs are critical for project success. However, no vast study has yet been conducted aimed at finding the relative importance of each of the *PMBOK® Guide's* KAs during the planning phase of projects. In summary, project managers do not always have the time, knowledge, and tools to effectively perform all project management processes included in the *PMBOK® Guide.*

Research Hypotheses

Based on the analysis of the recent literature, this paper uses a set of hypotheses, stated below, and a field study designed to investigate them.

1. **The relative importance of knowledge areas—**The Pareto principle states that 80% of the wealth of the nation is distributed among 20% of the population; this is the basis for the "80/20" rule, which states that "20% of the known variables will account for 80% of the results" (Craft and Leake, 2002). The application of this rule in project management may mean that different KAs have unequal impact on project success. Thus, the first hypothesis is phrased as follows:

H_1: Dissimilar Knowledge Areas have a different impact on project success.

H_0: All Knowledge Areas have a similar impact on project success.

Assuming that the first null hypothesis is rejected, we may state the second one on the basis of the following:

2. **Actual extent of use of KAs' processes—**Project managers are not aware of the KAs that have the greatest impact on project success. Therefore, they do not necessarily invest more effort in performing the most important KAs. For example, project managers may choose to invest their limited time in KAs that are easier to

perform or that are supported by convenient tools, rather than in those that have the greater impact on project success. Hence, the second hypothesis to be investigated is:

H_2: ***The time spent on Knowledge Areas in projects is positively correlated with the Knowledge Areas' impact on project success.***

H_0: ***The time spent on Knowledge Areas in projects is not correlated with the Knowledge Areas' impact on project success.***

3. **Moderate influence of industry type—**Most scholars agree that differences in project management exist among industry types (e.g., Ibbs & Kwak, 2000; Cooke-Davies & Arzymanow, 2002; Zwikael & Globerson, 2006). As a result, it is expected that in different industry types, each KA has different impact on project success. Thus, the last hypothesis is phrased as follows:

H_3: ***Knowledge Areas have different impact on project success in different industry types.***

H_0: ***Knowledge Areas have similar impact on project success in all industry types.***

Research Methodology

The Model

In order to find out which of the nine KAs has the greatest impact on project success, a model was designed. The model, presented in Figure 1, includes the nine KAs as the independent variables. Each of these KAs includes the relevant project management processes, as identified in the *PMBOK® Guide*.

Project success is gauged using four indexes. The first three measures (time, cost, and project performances/scope) are called in the literature the "golden/iron triangle" or "project management success" measures because they are concerned only with the

efficiency of the project management process (Atkinson, 1999; Jha & Iyer, 2007). However, because it is also important to analyze the organizational benefits of a project (Dvir, Lipovetsky, Shenhar, & Tishler, 2003; Jugdev & Müller, 2005; Kerzner 2006; Saarinen, 1990; Turner, 2006; Turner & Muller, 2003), the last project success measure (customer satisfaction) estimates the benefits to the project funder, based on the impact on the customer, business impact on the organization, opening new opportunities for the future, recurring business, the ability to use the customer's name as a reference, and other stakeholders satisfaction (Dvir et al., 2003; Kerzner, 2006; Turner & Muller, 2003). In other words, “project management success” is only a subset of project success.

A moderating variable, which describes the impact of industry type on this analysis, is also included in this model. The information collected in this research relates to the planning phase of projects.

< Figure 1 >

This study uses a model and a questionnaire that have been used, validated, and implemented in previous studies. Please refer to these previous studies to learn more about the model and its validity (Zwikael & Globerson, 2004; Zwikael & Globerson, 2006; Zwikael & Sadeh, 2007).

Data Collection

Initial data collection involved project managers who are members of the Project Management Institute (PMI) in three chapters that have supported this study (Israel,

Japan, and New Zealand). However, recognizing the danger of a “convenience sample” as a sole source, the other half of the questionnaires have been collected from organizations and project management training sessions selected and personally visited by the research team. The two groups were compared to make certain that they both led to similar conclusions.

Participants came from different industries, such as engineering, construction, software development, and services. All questionnaires were filled out anonymously. A questionnaire was included in the final analysis only if at least 80% of the questions were answered. Using the above criteria, 783 questionnaires remained for the final analysis. The number of valid questionnaires, from each industry type and country, is presented in Table 1.

< Table 1 >

Participants were requested to evaluate the extent of use of planning processes in their most recently completed project. This has been reported by using a scale ranging from 1 (lowest extent of use) to 5 (highest extent of use). While the independent variables have been collected from project managers, the dependent variables have been collected from their supervisors to avoid “same source bias.” Hence, project success results have been reported by the supervisors of the project managers, using the following four project success dimensions:

1. Schedule overrun, measured in percentages from the original plan.
2. Cost overrun, measured in percentages from the original plan.
3. Project performance, measured on a scale of 1 (lowest performance) to 10

(highest performance).

4. Customer satisfaction, measured on a scale of 1 (lowest customer satisfaction) to10 (highest customer satisfaction).

In cases of missing data, the missing values have been added using the mode of that variable calculated from the observations of the same organization. For the variables of cost overrun and schedule overrun, the missing values were added using the average of the same variable from the observations of the same organization. Project success results are reported in Table 2.

< Table 2 >

Projects results, presented in Table 2, show relatively high cost and schedule overruns. Similar overrun findings were found in previous studies (e.g., Johnson et al., 2001). Comparing success rates among industries, it has been found that construction and engineering projects achieve the best results of all selected industries, while production organizations score the lowest results. Software projects suffer mainly from low level of project performances. Government projects have the highest schedule overrun rate.

The model's reliability was calculated using a number of statistical tests, such as Cronbach alpha. Results (0.85) were considerably higher than the minimum value required by the statistical literature (Cronbach, 1951; Hair, 2006). More reliability and validity tests for the model can be found in the study of Zwikael and Globerson (2006).

Results and Analysis

The objectives of this section are: (1) to identify the KAs that appear to have the highest influence on project success, and (2) to compare KAs' relative importance with the actual extent to which they are used by project managers during the project planning phase.

The Relative Influence of Knowledge Areas on Project Success

This paper analyzes the relative importance of KAs by calculating the impact of their related planning processes on project success. A KA is important to project success when the higher extent of use of its related processes significantly improves project success. First, the extent of use of each KA was calculated as an average of its related planning processes. Then, a multivariate regression analysis was conducted with all nine KAs as independent variables and four project success measures as the dependent ones. Table 3 presents the results of this analysis, including F values, significance level, and the ranking of each KA. The ranking of each KA has been determined according to its statistical contribution to project success, as can be observed in the significance level column.

< Table 3 >

According to Table 3, seven KAs have a significant impact on project success. This means that the more frequently planning processes—which are related to these KAs—are performed, the better project success is. The KAs that most contribute to project success during planning are Time, Risk, Scope, Human Resources, and

Integration. Cost and Procurement are the KAs that contribute least to project success, maybe because they are practiced mainly during project execution. These results allow us to accept the first research hypothesis and claim that dissimilar KAs have a different impact on project success.

The time KA has the greatest impact on project success. This finding may explain the vast effort put into time management in the recent literature. Actually, project scheduling techniques, such as project evaluation and review technique (PERT) and critical path method (CPM) were the first project management tools to be developed. Ever since, new scheduling techniques have been developed, for example, critical chain analysis (Goldratt, 1997; Leach, 2005), and Resource Constrained Project Scheduling Problem (RCPSP) optimization techniques (Demeulemeester & Herroelen, 2002). Moreover, project management software packages support all time KA's related processes.

The KA that has the second highest influence on project success is Risk, which has been discussed extensively in the recent literature (Raz, Shenhar, & Dvir, 2002; Sadeh, Dvir, & Shenhar, 2000; Simon, 1997; Williams, 1995). Scope is ranked third in its impact on project success, as it is the core of project planning and considered to be "the raison d'être of project management" (Turner, 1993).

Although the Integration KA has a very high influence on project success, project managers do not receive enough support in executing its processes. During the planning phase of a project, the major output of this KA is the project plan. Despite its high importance, most organizations do not have effective tools to support their project managers in achieving this output, nor do project management software packages support

this KA or its final outputs.

The identification of the most influential KAs may be used as an aid for deciding on the most effective level of effort that should be devoted to each KA. It is therefore expected that project managers will expend more effort on more influential KAs. The next section investigates this expectation by analyzing the actual extent of use of each KA in comparison with its relative importance.

Actual Extent of Use of Knowledge Areas

This section is aimed at testing the second research hypothesis—that the time spent on KAs in projects is positively correlated with the KAs' impact on project success. As part of the questionnaire, participants were asked to report the actual extent of use by which planning processes had been achieved. The scale used ranged from one (lowest extent of use) to five (highest extent of use). The extent of use for each KA was calculated as the average extent of use of the related planning processes. Table 4 presents the average extent of use for all KAs and its standard deviations, ranked according to descending extent of use.

< Table 4 >

As shown by Table 4, planning processes from the Integration KA have the highest extent of use, followed by Time and Scope. This three-KA group has a significantly (p<0.01) higher frequency of use than any of the other six KAs. The

common denominator of these KAs is that they are strongly supported by project management tools, such as Gantt charts, work breakdown structure (WBS), project plan templates, and project management software packages. Therefore, results suggest project managers more frequently execute project processes that include well-formulated supportive tools.

The low extent of use of Communications is similar to the results found by Ibbs and Kwak (2000). Unsurprisingly, this KA has very little support of relatively simple tools and templates. This KA has a significantly (p<0.01) lower frequency of use, as compared with most other KAs. The development of more effective communications tools may increase the frequency of use of the belonging processes, and hence many improve project success. The KA with the least extent of use is Procurement. It may be that Procurement is mostly practiced in other project phases and by other team members.

These results also identify the relatively low extent of use of Risk Management processes. One explanation for this may be the high dependency on functional managers' involvement in identifying risks, an involvement which is frequently unavailable (Kwak & LaPlace, 2005; Globerson & Zwikael, 2002). Another possible explanation for this finding is that while formal risk planning is less common, informal processes are heavily used as part of other processes, such as Estimating Activities' Duration, resulting in adding safety margins to recognized high-risk activities.

Comparing the Knowledge Areas' Relative Importance with their Actual Extent of Use

In the previous sections, we have discussed the relative importance and the actual extent of use of each KA. This section compares these two results in order to identify KAs that receive low attention although they have a high influence on project success.

Major results from previous sections are summarized in a graphic presentation in Figure 2, which includes the relative importance (as measured by the significance level from Table 3), and the average extent of use of each KA (as shown in Table 4), as well as the estimated linear regression line.

< Figure 2 >

In Figure 2, the nine dots represent the nine KAs, their relative importance values, and their average extent of use. The four KAs that have the highest extent of use by project managers also have the highest impact on project success (high importance on the x-axis in Figure 2). These KAs are Integration, Time, Scope, and Human Resources. This may be because of their recognized importance and the existence of efficient tools in these areas. Quality and Communications KAs, which have moderate impact on project success, have a low extent of use. This is because most project managers lack proper knowledge and tools in communications management and lack authority in quality management (Zwikael & Globerson, 2006).

A linear regression line between the two variables was also calculated and is presented in the graph. The regression line has a negative slope, which means that project managers more frequently execute KAs that have higher impact on project success. This is done without project managers actually knowing what the importance of each KA is, but investing more time and effort in these specific KAs based on prior experience. However, the relationship between the importance of each KA and its extent of use by project managers is insignificant (*p* value for an F test equals 0.21). For example, project managers invest too much time in Cost planning, as compared to the relative impact of their efforts on project success. In addition, project managers invest too little time in Risk planning, as compared to its high contribution to improving project success. Following these results, we cannot reject the second null hypothesis. This means that the actual extent of use is not related to the KA's importance.

Industry Uniqueness

Because the results presented in previous sections of this paper may differ among industries, we further analyzed the data in six industries: (1) construction and engineering, (2) software, (3) production, (4) communications, (5) services, and (6) government. This section tests the third research hypothesis—that KAs have dissimilar impact on project success in different industry types.

A nonlinear multivariate regression has been used for this purpose. The moderate effect of industry has been investigated to analyze the relationship between each KA and project success. Table 5 summarizes the results of this analysis.

< Table 5 >

The results show that industry moderates the relationship between the importance of a KA and the level of effort invested by project managers in only two KAs—Time and Scope. In all other seven KAs, their importance for project success is similar in all industries.

In order to drill down and further investigate the special case of these two KAs in each industry, a further analysis has been conducted. A multivariate regression has been calculated for each industry to analyze the impact of each KA on project success. Results in Table 6 present the ranking of KAs in each industry, according to their contribution to project success.

< Table 6 >

These results emphasize the important role of industry in such an analysis. Although some KAs have low impact on project success in most industries (e.g., Procurement), the importance of others varies by industry. For example, in production and in construction and engineering organizations, the Time KA has low impact on project success. On the other hand, in Software, Communications, and Services organizations, Time planning is the most contributing KA to project success.

The analysis of Table 6 shows differences in the relative importance of KAs in various industries. These results support the third research hypothesis. Hence, managing projects in different industry types requires unique focus and attention. The following

paragraphs present the uniqueness of some industries.

In construction and engineering organizations, projects have a relatively low level of risk and their scope is relatively stable. Therefore, completing the project on time and within budget is extremely important. As the results presented in Table 6 indicate, Integration and Cost KAs have the highest importance in meeting schedule and cost targets. Scope planning has the lowest impact on project success. The reason for this may be the relatively clear scope of such projects.

In software organizations, Quality and Human Resources KAs were found to be relatively important. The lack of resources enforces project managers to invest more planning effort in these KAs. For this reason, much attention should be pointed toward Quality and Human Resources planning in this industry.

These findings point to some major differences among industries in managing projects. Although Grant and Pennypacker (2006) found no significant differences in project management maturity among industries, most scholars agree that such differences exist (e.g., Cooke-Davies & Arzymanow, 2002; Ibbs & Kwak, 2000; Zwikael & Globerson, 2006). Hence, tailored tools and techniques should be developed for different sectors. This should be added to the generic project management processes, tools, and techniques, which are already presented in the *PMBOK® Guide*.

Conclusion

The *PMBOK*® *Guide* identifies nine Knowledge Areas on which a project manager should focus in order to successfully manage a project. This study reveals that the nine KAs exert different levels of influence on a project's success. This finding is aligned with the Pareto principle (or, "20/80 Rule"), which claims that 20% of all possible causes impact 80% of the result (Craft & Leake, 2002). The project planning KAs that most influence project success results are Time, followed by Risk, Scope, and Human Resources. The KAs that have the lowest impact on project success are Cost and Procurement. Although these results do not suggest that some KAs are not important, still a more focused approach that prioritizes potential investment in different project management processes is required.

Results also show that, in some cases, project managers tend to invest more planning efforts in KAs that have higher influence on project success. For example, project managers pay the expected amount of effort to Time, Scope, and Human Resources KAs, which were found to have the highest influence on project success. This behavior is supported by many available project management tools and software packages. However, project managers do not invest enough effort in Communications and Quality KAs, as can be expected based on their importance.

As the most critical KAs during the planning phase of projects are Time, Risk, Scope, and Human Resources, practical implications of these findings may include:

1. Project managers may invest more effort in identifying project activities, developing Gantt charts, and identifying the critical path or the critical chain of a project, and may use these outputs to develop a formal project plan, to be

approved by key stakeholders.

2. Senior managers may make certain that project managers have enough training on these KAs instead of on less-influencing ones. In addition, senior managers should make sure that organizational procedures and templates in these KAs are in place.
3. Project management training companies may need to rethink the proportion of each KA that is used in their current project management course curriculums.
4. Scholars may decide to focus on developing new tools and techniques in the area of Quality and Communications planning.
5. PMI may decide to measure the effectiveness of each KA before the next *PMBOK® Guide* update project begins.

However, these recommendations are situational, as it has been found that KAs have different levels of importance in various industries. For example, Integration and Cost were found to be the most important KAs in construction and engineering organizations, Time the most important KA in software, services, and communications organizations, and Communications the most important KA in production organizations.

The results of this study can now be compared with those of previous studies. Time management, which was found to be the most important KAs in this research, is also considered by many scholars to be the basis for project management (e.g., Leung, 2004; Demeulemeester & Herroelen, 2002). Human Resources and Risk KAs that are considered to be critical project management factors (Cooke-Davies, 2002), have also been found to be the KA with the most influence on project performance in this study. Another similarity between this study and previous studies is the finding that high

differences exist among various industries (e.g., Müller & Turner, 2001, 2007a, 2007b).

Finally, research limitations include the fact that the majority of data was collected in three countries, which makes it difficult to generalize this study's conclusions. Future research can include data collected in additional countries and analyzed with comparison to the GLOBE study on cultural diversity among societies (House, Hanges, Javidan, Dorfman, & Gupta, 2004). This research also focused only on the planning phase of the project. Hence, all conclusions derived from this study are limited to this project phase. This study was based on the second edition of the *PMBOK® Guide* (PMI, 2000), but since only minor changes in the planning processes have been made and no KA has been changed since the time of the second edition, it can be assumed that this paper's conclusions are relevant to the fourth edition (PMI, 2008). In conclusion, this paper aims to highlight the importance of identifying the different roles that KAs play in project management, to give general guidelines, and to encourage a professional debate on this research direction.

In order to be able to generalize the results of this study, further research in different cultures, industries, and project phases must be conducted. Based on these results, effective tools in critical areas should be developed. In addition, future research can investigate the possible moderating effect of several factors, such as project novelty, technology, pace, and complexity (Dvir et al., 2006), which may impact these results.

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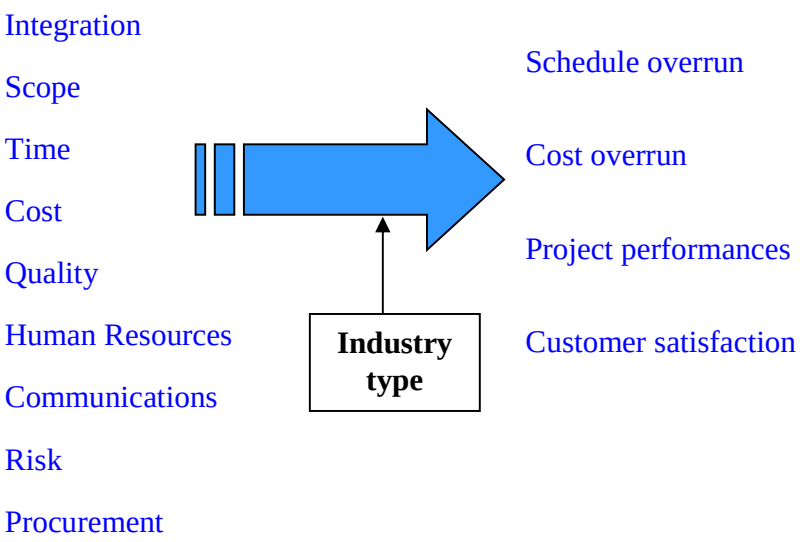

Figure 1: The research design

Industry type	Israel	Japan	New Zealand	Others	Total
Construction & engineering	49	1	60	18	**128**
Software	95	78	44	24	**241**
Production	15	33	15	5	**68**
Communications	37	1	59	4	**101**
Services	10	10	31	15	**66**
Government	69	2	91	7	**169**
Others			2	8	**10**
Total	**275**	**125**	**302**	**81**	**783**

Table 1: Distribution of industry types included in the study.

Project Success Measure	Schedule Overrun	Cost Overrun	Project Performances	Customer Satisfaction
Minimum value	−5%	−30%	1	1
Maximum Value	300%	400%	10	10
Average	18.3%	14.1%	7.6	7.8
Standard deviation	23.7%	22.6%	1.8	1.5
Construction & engineering	12.3%	11.4%	8.4	8.3
Software	19.8%	15.8%	7.1	7.6
Production	22.7%	17.1%	7.0	7.2
Communications	17.0%	11.5%	8.0	8.2
Services	12.2%	12.0%	7.8	7.7
Government	23.2%	15.3%	7.7	7.9

Table 2: Overall and industry project success results.

Knowledge Area	F Value	Significance Level	Contribution to Project Success (ranked)
Time	3.56	0.000 **	1
Risk	2.69	0.000 **	2
Scope	2.01	0.001 **	3
Human resources	1.97	0.001 **	4
Integration	2.33	0.002 **	5
Quality	2.23	0.003 **	6
Communications	1.94	0.014 *	7
Cost	1.20	0.152	8
Procurement	1.16	0.279	9

Table 3: Importance of the nine knowledge areas to project success.
**p≤0.05; ** p≤0.01*

Knowledge Area	Average Extent of Use (1–5 scale)	Standard Deviation	Ranked Extent of Use
Integration	4.18	1.06	1
Time	4.04	0.82	2
Scope	3.96	0.92	3
HR	3.74	0.96	4
Cost	3.59	0.99	5
Risk	3.33	1.32	6
Quality	3.10	1.21	7
Communications	3.09	1.32	8
Procurement	2.95	1.21	9

Table 4: The average extent of use and standard deviation of each knowledge area during the planning phase of a project.

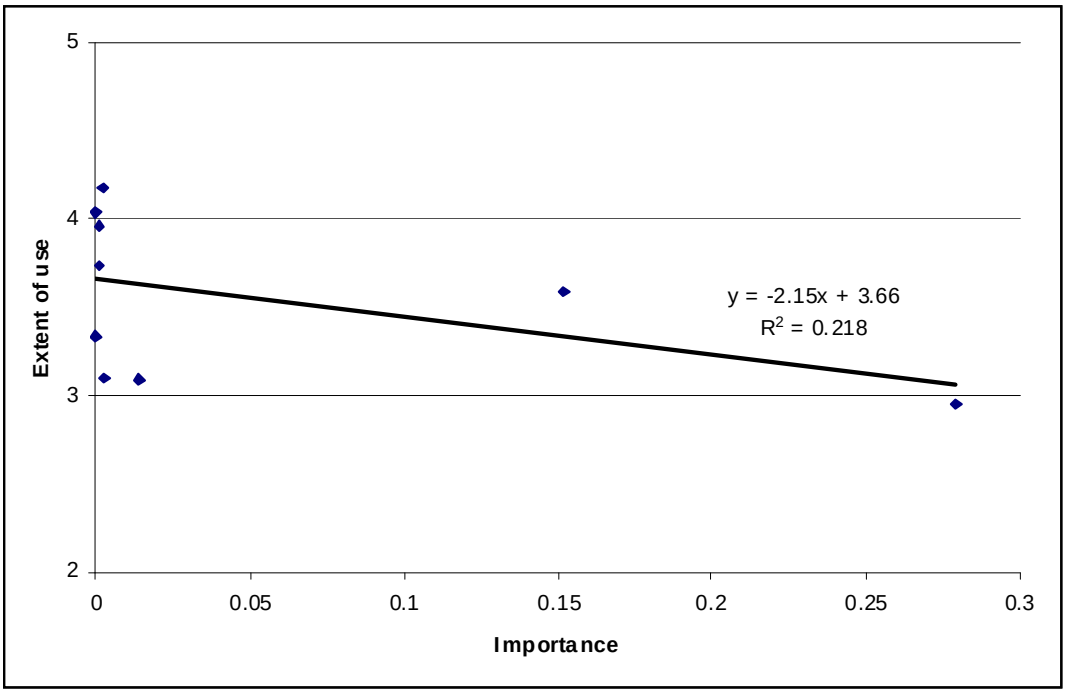

Figure 2: Relative importance and average extent of use of each knowledge area.

The Interaction Between Industry and the following KA	F Value	Significance Level	Contribution to Project Success is Impacted by Industry (Ranked)
Time	2.56	0.000 **	1
Scope	3.31	0.000 **	2
Integration	1.62	0.055	3
Human resources	1.29	0.131	4
Cost	1.19	0.178	5
Communications	0.96	0.505	6
Risk	0.92	0.543	7
Procurement	0.85	0.656	8
Quality	0.81	0.672	9

Table 5: The impact of industry on the relationship between effort invested in each knowledge areas and project success.

**p≤0.05; ** p≤0.01*

Knowledge Areas	Construction & Engineering	Software	Production	Communications	Services	Government
Integration	**1**	**6**	**3**	**3**	**7**	**8**
Scope	**9**	**9**	**8**	**8**	**8**	**9**
Time	**7**	**1**	**6**	**1**	**1**	**2**
Cost	**2**	**5**	**9**	**4**	**2**	**5**
Quality	**6**	**2**	**2**	**2**	**6**	**3**
Human resources	**3**	**3**	**7**	**9**	**5**	**6**
Communications	**5**	**7**	**1**	**6**	**9**	**4**
Risk	**4**	**4**	**5**	**7**	**4**	**1**
Procurement	**8**	**8**	**4**	**5**	**3**	**7**

Table 6: Ranking of knowledge areas' relative importance in each industry type.