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THE ROLE OF MANNING LEVEL IN INFORMATION SYSTEMS PROJECTS

Adel M. Aladwani

Awad M. Al-Zufairi

Abdullah Kh. Al-Owaihan

Rashed Sh. Al-Ajmi

Kuwait University, Kuwait

Key Words

Management of IS Projects, manning level; Open Communication; Participation; IS Project Performance.

Abstract

The present paper investigates the role of manning level in information systems projects. We used data collected via a questionnaire to shed light on the nature of this role. We found that the nature of the effect of manning levels on within-project interaction--participation and open communication--and performance in large projects is different from the nature of the same effect in small projects. More specifically, the findings suggest that the increase in project manning exert a negative influence on within-project interaction and performance in small projects. In large projects, however, manning levels did not show any significant relationship with information systems project outcomes. We discuss the implications of these findings for managerial practice and future research.

Introduction

Project manning continues to be a major concern for information systems managers. This is particularly true because of the significant role project manning plays in shaping the outcome of the system development effort (Conte *et al*, 1986; Kraut and Streeter, 1995). Despite its importance for the performance of the information systems project, project-manning level received inadequate attention from information systems scholars. With the lack of empirical evidence highlighting the nature of this role, information systems managers have no guidelines to follow but their intuition.

From our experience, increasing manning level to boost project output is a widely followed strategy within organizations especially when pressure increases to deliver the system before the deadline. However, increasing project-manning level to increase output may not always be the best strategy to follow.

The overall evidence from systems development research suggests that the relationship between manning level and performance

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is to a great extent negative (see for example, Kraut and Streeter, 1995). Information systems researchers contend that the increase in project manning leads to recognizable within-project interaction difficulties, e.g., increase of communication paths, which may lead to a reduction in performance. Nonetheless, it is not clear yet: 1) whether manning level, within-project interaction, and performance are changed given the change in project size, and 2) how manning level would influence other internal interaction variables such as participation and open communication in small and large information systems projects.

The purpose of this study is to examine the relationship between manning level, within-project interaction--participation and open communication--and the performance of information systems projects. This study is a pioneering attempt to compare the nature of the effect of manning level on within-project interaction--participation and open communication--and performance in small and large information systems projects. By clarifying the impact of project manning on within-project interaction and performance, information systems managers will be better informed about design issues related to information systems projects.

After introducing the manuscript, we organize the rest of the paper as follows. Section 2 presents the theoretical background of the study. Section 3 discusses the proposed relationships. Section 4 outlines research methodology. Section 5 describes research findings. The sixth and last section presents the conclusion and implications of the findings for managerial practice.

Theoretical Background

IS projects and their performance

According to Marshall (1986:90) an information system project is "a small or large job that can be subdivided into a sequence of subactivities or tasks. The tasks take time, consume resources, need people, and cost money". King (1992:2) defines an IS project as "a set of activities that starts and ends at identifiable points in time and that produces quantifiable and qualifiable software deliverables".

These conceptualizations closely follow the definition of a project as reported in the project management literature. For example, Archibald (1976:18) considers a project as a one that is "A complex effort, usually less than 3 years in duration, made up of interrelated tasks performed by various organizations, with a well-defined objective, schedule, and budget". Cleland and Kerzner (1985:199) define a project as one that has "a combination of human and nonhuman resources pulled together in a temporary organization to achieve a specified purpose".

Information systems scholars also followed the steps of the project management scholars in defining project performance. For example, Schultz and Slevin (1975) defined project success in terms of technical validity and organizational validity. The former refers to the project meeting minimum technical criteria while the later denotes to the acceptance of the project by the ultimate clients. In the same vein, Slevin and Pinto (1986) defined project success in terms of meeting budget, schedule, quality standards, etc. Information

systems scholars (Powers and Dickson, 1973; Saarinen, 1990; Henderson and Lee, 1992; Nidumolu, 1996; Robey *et al*, 1993) also operationalized information system projects performance in terms of: process efficiency (as measured, for example, by cost and schedule overruns) and project effectiveness (as measured, for example, by quality of outcome). Consequently, we will try to measure information system project performance according to project efficiency and effectiveness.

Previous research

Early examinations into the manning-performance relationship were largely non-experimental. Nearly three decades ago, Weinberg's (1971) analysis, for example, led him to believe that a project team consisting of three individuals can only do as much as one individual because the project team will spend more time on coordination. A few years later, Brooks (1975) provided a detailed comparison of small (10 members) and large (1000 members) project teams. The result of this comparison clearly showed that small teams were more productive. Yourden (1975) has the same conclusion as Brooks's (1975) regarding the relative performance of small and large projects.

In more recent years, some experimental investigations, which examine the effect of manning level on project performance, were attempted. Schroeder (1991), for example, identified project size as one of the factors that need to be taken into account when empirically estimating IS project performance. Conte *et al* (1986) provided empirical evidence showing why performance decreases as the manning level increases. The authors suggest that this can be attributed to the increase in the number of communication paths in larger projects. Banker and Slaughter (1997) explained how reducing project size (line of code) through batching smaller projects into larger planned releases would reduce maintenance costs considerably. Kraut and Streeter's (1995) study demonstrated a positive link between manning level and formal communication, which could adversely affect project outcomes. To some extent, this finding is consistent with the propositions of Conte *et al* (1986). In addition, Koushik and Mookerjee (1995), in an analytical study, showed that marginal productive outcome of the information systems project is a diminishing function of manning level. Banker and Kaufman (1991) concluded that in order to be able to improve IS project outcome development team characteristics (such as size) should be well understood.

Although the contributions of previous studies are significant, they suffer from at least three drawbacks. First, these studies, for the most part, are unsettled (The studies by Kraut and Streeter (1995) and Conte *et al* (1986) are noticeable exceptions) in that they relied on theoretical discussions or simulated experiments to reach their conclusions. Second, these studies overlooked the nature of the relationship between manning level and within-project interaction and performance in large and small IS projects. Third, these studies ignored the relationship between manning level and a wide array of important project processes in the systems development literature such as participation in the development effort and open communication.

In the context of systems development, it is possible that within project interaction, e.g., participation and open communication will be adversely affected if manning level of the information systems project is radically increased. Consequently, the overall performance of the information systems project may be reduced. Participation in system development refers to the extent to which organizational members are engaged in system development activities (Robey *et al*, 1989). Open communication refers to the extent to which members of the information systems project engage in open and free dialog (Trent, 1993). The relationship between manning level, participation and open communication, and information systems project performance has never been explicitly examined in systems development research.

Project manning level can have important implications for successful participation in system development. Shaw (1981) asserts that manning level strongly influences the amount and distribution of participation within the working unit. Some researchers suggest that this influence is mostly, negative (Steiner, 1972). This is largely because it is much harder to control intragroup behavior in larger workgroups. In a large information systems project it is quite possible for an individual to come, for example, to system design meetings without adequate preparation. Consequently, the same individual may offer almost no input to the total system development effort. This in turn may lead to a lower chance of an increased information systems project performance (e.g., Hartwick and Barki, 1994; Robey *et al*, 1989; Tait and Vessey, 1988; McKeen *et al*, 1994):

Project manning level may also have a profound influence on how open communication relates to project performance. According to Shaw (1981), a notably crowded project causes many processual problems among which are coordination problems. Moreover, the evidence from the information systems literature supports the premise that a higher project manning level leads indeed to formalizing within project communication, which can adversely influence coordination outcomes (Kraut and Streeter, 1995).

Research Objectives

The present paper has the following objectives:

1. To examine whether manning level, participation in activities, open communication among project members, and performance are changed given the change in project size.

2. To examine the nature of the relationship between manning level and participation in large and small IS projects.

3. To examine the nature of the relationship between manning level and open communication in large and small IS projects.

4. To examine the nature of the relationship between manning level and performance in large and small IS projects.

5. To examine the nature of the relationship between participation, open communication, and performance in large and small IS projects.

Research Hypotheses

In order to meet the above objectives, we propose the following omnibus null hypothesis for testing:

H1: Large and small information systems projects will not differ in terms of project manning, participation, open communication, and performance.

If this hypothesis is not supported, then we propose the following two sets of corollaries (stated in null terms) for large and small projects:

For small projects:

H2a: project-manning level will have no relationship with participation in information systems project.

H2b: project-manning level will have no relationship with open communication among members of the information systems project.

H2c: project-manning level will have no relationship with the performance of the information systems project.

H2d: open communication will have no relationship with the performance of the information systems project.

H2e: participation will have no relationship with the performance of the information systems project.

For large projects:

H3a: project-manning level will have no relationship with participation in information systems project.

H3b: project-manning level will have no relationship with open communication among members of the information systems project.

H3c: project-manning level will have no relationship with the performance of the information systems project.

H3d: open communication will have no relationship with the performance of the information systems project.

H3e: participation will have no relationship with the performance of the information systems project.

Research Methodology

Sample

The data for this study was collected by means of a questionnaire using a convenience sample of information systems project leaders. We used the convenience sample approach because there was not a complete list of all information systems project leaders in Kuwait. The research assistants distributed questionnaires to seventy-nine information systems project leaders working in thirty-two Kuwaiti organizations and collected usable responses from sixty-one information systems project leaders or a 77 percent response rate.

Most of the information systems project leaders in our sample are less than 40 years old. They have on average approximately seven years of field experience. The majority, or close to 87 percent, of these leaders have a bachelor degree; those holding a high school degree rank next representing approximately 8 percent of the respondents. Only a few (close to 5 percent) of the leaders have a master's degree. None, however, has a doctorate degree.

Approximately 23 percent of the projects in our sample were completed within 3 months, 28 percent were completed within 4-6 months, 26 percent were completed within 7-12 months, 5 percent were completed within 13-24 months, and 2 percent were completed

after more than 24 months. The time duration for approximately 16 percent of the projects was unknown. Table 1a summarizes the profile of respondents.

Moreover, the responding firms cover a wide spectrum of industrial sectors in Kuwait. Nine organizations, or twenty-eight percent of our sample, are government ministries. Five organizations, or sixteen percent of the data set, represent public agencies. Three organizations, or nine percent of our sample, belong to the banking sector. The other sectors that are represented by the participating organizations are the oil, insurance, financial services, electronics, scientific institutions, real state, food, and construction sectors. Table 1b summarizes the profile of responding firms by sector.

Table 1a
Profile of Respondents

Characteristic	Value	Frequency	Approximate Percentage
Age	Less than 30 years old	26	43
	30 years and above	34	55
	Unknown	1	2
Education	Bachelor	53	87
	Non-bachelor	8	13
Field experience	Mean = 5.98		
experience	SD = 4.16		
	Range = 1-16		

Table 1b
Participating Organizations by Sector

Sector	Number of Organizations	Approximate Percentage
Ministries	9	28
Public Agencies	5	16
Banking	3	9
Trading	2	6
Oil	2	6
Insurance	2	6
Financial Services	2	6
Electronics	2	6
Scientific Institutions	2	6
Real State	1	3
Food	1	3
Construction	1	3

Study Measures

Information systems project performance. We operationalized performance using efficiency and effectiveness measures described in (Henderson and Lee, 1992). The efficiency scale had four items that tap amount of work produced, adherence to schedules, adherence to budgets, and overall efficiency of operations. The effectiveness scale reflected the quality of work, the effectiveness of interaction with non-members, and ability to meet goals. A factor analysis on the seven items representing the information systems project performance resulted in a single factor with item loadings that ranged from 0.724 to 0.882. The unidimensional scale had a reliability level of 0.92.

Participation. Participation was measured using a scale borrowed from (Robey *et al.*, 1989). The three items reflected the extent to which project members were consulted for their opinion during meetings, came prepared for the meetings, and were asking questions during meetings. When we factor analyzed the data on the three variables constituting the participation construct, they loaded on the same factor (item loadings ranged from 0.811 to 0.902). The Cronbach alpha for the scale was 0.83.

Open communication. A three-item scale was borrowed from Trent (1993) and used to measure the extent to which project members were communicating freely, openly, and enjoy talking to each other. When we factor analyzed the data on the three variables constituting the open communication construct, they loaded on the same factor (item loadings ranged from 0.680 to 0.885). The Cronbach alpha for the scale was 0.73.

Project manning level. A single-item scale was used to measure this construct. We requested that the leader indicate the number of individuals involved in the project.

Participation and open communication were measured using a seven-point scale that ranges from (1) strongly disagree to (7) strongly agree, while performance was measured using a seven point likert-like scale that ranged from (1) extremely low to (7) extremely high. Table 2 summarizes the characteristics of the variables in our study.

Research Procedures and Findings

The first objective of this paper is to investigate whether manning level, within-project interaction, and performance are changed given the size of the information systems project. Hence, Multivariate Analysis of Variance (MANOVA) was chosen as the analysis method to test the first research hypothesis (H1). Moreover, a set of corollary objectives to the first goal focuses on the nature of the links between manning level, within-project interaction, and performance in small and large projects. We selected linear regression analysis to test the rest of the hypotheses (H2a to H3e).

Table 2
Summary Statistics of Study Variables

	Number of Items	Mean	SD	Scale Range	Cronbach Alpha
Project Performance	7	4.41	1.20	1-7	.92
Participation	3	4.68	1.24	1-7	.83
Open Communication	3	4.80	1.22	1-7	.73
Project Manning Level	1	5.00	1.94	---	---

Assuring the appropriateness of the data was necessary before running MANOVA and reporting results. Nine observations were deleted due to outliers (belong to project manning) and missing data, which reduced the total observations to fifty-two. The small projects group has twenty-three observations, while the large projects group has twenty-nine observations. Both groups exceed the minimum sample size in the smallest cell, which is twenty observations. The sample has no problems regarding the normality of the dependent variables and within-set multicollinearity.

Multivariate Analysis of Variance was carried out using SPSS MANOVA procedure. To obtain the small and large project size samples, we divided the manning level variable at the median to create a dummy variable and named it project size (1 = small and 2 = large) to test the size effect in our MANOVA research model. The results of our analysis (Table 3) show that at alpha = .05 the combined dependent variables were significantly affected by information systems project size ($F_{4,47} = 17.538$ for Hotelling's Trace test, which represents the pooled ratio of effect variance to error variance). Therefore, the first hypothesis (H1), which postulates, in null terms, that there are no differences between large and small projects can not be accepted.

To test the rest of the proposed relationships--ten of them--we ran two separate sets of regression analyses--one using the small projects sample and the other using the large projects sample. Table 4 and Table 5 summarize the series of linear regression analyses that we ran to test the remaining ten research hypotheses. Table 6 summarizes regression results for the combined sample.

Table 4 shows that in small information systems projects there are significant and negative relationship between manning level and participation (B = -.685, p < .05), manning level and open communication (B = -.680, p < .05), and manning level and performance (B = -.580, p < .05). Moreover, Table 4 shows that open communication has a significant and positive relationship with performance (B = .511, p < .01), while participation has only marginally significant relationship with information systems project performance (B = .304, p < .056).

Table 5 reveals that, in large information systems projects, the relationship between manning level and participation (B = -.04), manning level and open communication (B = -.184), and manning level and performance (B = -.185) are not significant at alpha = 0.05. Table 5 also reveals that open communication has a significant and positive relationship with performance (B = .688, p < .01), while the relationship between participation and information systems project performance is only marginally significant (B = .286, p < .080).

Table 3
MANOVA Results for Small Versus Large Size Effect

Test	Value	F	Hypothesis df	Error df	Sig
Pillai's Trace	.599	17.538	4	47	.000
Wilks' Lambda	.401	17.538	4	47	.000
Hotelling's T	1.493	17.538	4	47	.000
Roy's Largest Root	1.493	17.538	4	47	.000

Table 4
Regression Results for Small Size Projects

	Open Communication			Participation			Performance		
	B@	T-value	P*	B@	T-value	P*	B@	T-value	P*
ML	-.680	-1.999	.029	-.685	-1.988	.030	-.580	-1.866	.038
OC				.110	.511	.307	.511	3.148	.002
Pa							.304	1.660	.056

ML = Manning Level
OC = Open Communication
Pa = Participation
@ Unstandardized coefficient
* 1-tailed

Table 5
Regression Results for Large Size Projects

	Open Communication			Participation			Performance		
	B@	T-value	P*	B@	T-value	P*	B@	T-value	P*
ML	-.184	-1.502	.072	-.040	-.308	.380	-.185	-1.346	.095
OC				.256	1.322	.099	.688	4.100	.000
Pa							.286	1.443	.080

ML = Manning Level
OC = Open Communication
Pa = Participation
@ Unstandardized coefficient
* 1-tailed

Table 6
Regression Results for the Combined Sample

	Open Communication			Participation			Performance		
	B@	T-value	P*	B@	T-value	P*	B@	T-value	P*
ML	.003	.040	.484	-.085	-.998	.161	-.048	-.564	.287
OC				.078	.619	.269	.608	6.056	.000
Pa							.246	2.023	.024

ML = Manning Level
OC = Open Communication
Pa = Participation
@ Unstandardized coefficient
* 1-tailed

Based on the results that are reported in Table 4 and Table 5, we cannot accept H2a, H2b, H2c, H2d, H2e, H3d, or H3e; and we cannot reject H3a, H3b, and H3c. The most notable finding of all is the fact that in small projects the increase in manning level will have an adverse effect on project outcomes--within project interaction and performance. In large information systems projects, however, the increase in project manning level does not have the same serious adverse effects on outcomes as in small projects.

Discussion and Conclusions

The present investigation is pioneering in that it tried to compare the nature of the effect of manning level on within-project interaction--participation and open communication--and performance in small and large information systems projects. We used MANOVA and regression analyses to shed light on the nature of this role and test eleven research hypotheses. Our analyses reveal that the nature of the effect of manning level on within-project interaction and performance in large projects is different from the nature of the same effect in small projects. More specifically, our findings suggest that the increase in project manning exert a negative influence on open communication, participation, and performance in small projects. In large information systems projects, however, manning level did not show any significant relationship with information systems project outcomes.

Only in small projects, project-manning level showed a negative impact on the interaction within information systems projects. In large projects, project-manning level showed no relationship with project outcomes. Why? We believe one answer could be the result of what we call the "observablility" effect. Previous research argue that manning level strongly influences the amount and distribution of effort within the working unit (Shaw, 1981). Latane, Williams, and Harkins (1979) convincingly explain that this is so because as the number of individuals involved in a group increases, pressure on any individual to perform well is diffused. Consequently, it becomes easier for any individual in the group to become a "free-rider." It is harder to take log of intragroup behavior in larger workgroups. In smaller projects this is not the case, however. In a project with a limited number of individuals, it is much easier for members to monitor each other's behavior and to evaluate the outcome of each other's level of interaction.

Another interpretation to our findings could be found in what we also call the "sensitivity" effect. Previous research indicates that, in a working unit, performance gain is a diminishing function of manning level (Koushik and Mookerjee, 1995; Shaw, 1981). As the project grows bigger, the proportion of increase in performance due to increase in manning level decreases. Our data set did not show a clear relationship between manning level and outcomes in the large projects sample. In larger projects, the increase in manning level could have marginal positive effects on outcome. Or, the increase in manning level could have marginal negative effects on the outcomes of a larger project. In either case, a slight increase (or decrease) in project outcomes could go unnoticed because larger projects, unlike smaller projects, are less sensitive to changes in interaction and performance levels.

What implications do these results suggest for practicing managers? First, it is quite evident from our data that project-manning level should be kept relatively low especially in small information systems projects. This will offer a greater chance for information systems managers to cultivate open communication and participation within, and ultimately the performance of information systems projects.

Second, information systems managers are strongly encouraged to exert additional effort to cultivate open communication within information systems projects. Open communication is proved conducive of project performance. Management may want to benefit from some special training programs designed to foster open and free exchange of ideas and feelings within information systems projects.

Finally, our results find marginal support for the widely agreed upon recommendation by the IS community regarding the importance of participation in system development for the success of IS projects. Management should find ways to promote participation during system design meetings. For example, management may try to show its concern for the contribution behavior of individual members in project activities (through rewards, etc.) in order to encourage participation.

The present study makes it clear that project-manning level is an important issue in the management of IS projects and that additional effort to understand the role project manning plays in systems development may still be needed. There is a need to continue examining this relationship in a variety of settings before formulating a conclusion on the issue. Moreover, in this study we limited our attention to two internal interaction variables--open communication and participation. In the future, we suggest that other interaction variables such as vertical and/or horizontal coordination within IS projects be examined. Further, the type of IS platform is important for understanding project success. Thus, in future studies, there is a need to collect platform data and examine its role in IS projects. Finally, in our study we used scales tested in an environment different from Kuwait's. Hence, we recommend that future studies develop and test instruments specifically designed for the Kuwaiti environment.

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الملخص

دور مستوى العمالة في مشاريع نظم المعلومات

عادل محمد العدواني **عبدالله خالد العويهان**
عواد محمد الظفيري **راشد شبيب العجمي**
جامعة الكويت

يسلط هذا البحث الضوء على طبيعة الدور الذي يلعبه مستوى العمالة في مشاريع نظم المعلومات. نتائج الدراسية تشير إلى أن طبيعة أثر مستوى العمالة على التبادل الاجتماعي داخل المشروع وعلى الأداء العام للمشروع تختلف في المشاريع الكبيرة عنها في المشاريع الصغيرة. بصورة أكثر تحديداً، وجد أن زيادة مستوى العمالة تؤدي إلى آثار سلبية على التبادل الاجتماعي والأداء في المشاريع الصغيرة، بينما وجد أن متسوى العمالة لم يكن له أثر واضح على مخرجات مشاريع نظم المعلومات في المشاريع الكبيرة.

Adel M. Aladwani (DBA. in Information Systems, Southern Illinios University, U.S.A., 1996), Assistant Professor, Department of Quantitative Methods & Information Systems, Kuwait University. His Current Research Interests Focus on the System Development Process and Individual and Organizational Impacts of Information Technology.

Awad M. Al-Zufairi (Ph.D. in Business Administration, Saint Louis University, U.S.A., 1996), Assistant Professor, Department of Management and Marketing, Kuwait University. His Current Research Interests Focus on the Areas of Human Resources Management, Organizational Behavior, Organizational Development, and Small Business Management.

Abdullah Kh. Al-Owaihan (Ph.D. in Business Administration, Saint Louis University, U.S.A., 1996) Assistant Professor, Department of Management and Marketing, Kuwait University. His Current Research Interests Focus on the Areas of Enterpreneurship, Technology Management in Small Organizations, Human Resources Management, Organizational Behavior, and Organizational Development.

Rashed Sh. Al-Ajmi (Ph.D. in Business Administration, Kent State University, U.S.A., 1995), Assistant Professor at the Department of Management and Marketing, Kuwait University. His Current Research Interests Focus on the Areas of Organizational Behavior, Human Resources Management, Enterpre-Neurship, Organizational Development, and the Role of Information in Contemporary Management.

المجلة التربوية

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* تنشر لأساتذة التربية والمختصين فيها.

رئيس التحرير

أ. د. عبدالله محمد الشيخ

الاشتراكات

* في الكويت:	* في الدول العربية:	* في الدول الأجنبية:
٣ د.ك للأفراد	٤ د.ك للأفراد	١٥ دولارا للأفراد
١٥ د.ك للمؤسسات	١٥ د.ك للمؤسسات	٦٠ دولارا للمؤسسات.

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ص.ب. ١٣٤١١ كيفان - الرمز البريدي 71955 الكويت
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