

# IMPACT OF TECHNOLOGY UTILIZATION ON PROJECT OWNER SATISFACTION

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**ABSTRACT** : Construction firms attempt to improve project performance by adopting technology. However, the advantages gained from technology utilization are still not clear. Lack of information regarding technology benefits has resulted in industry reluctance to implement new technology. Therefore, there are needs for studies that quantify the impacts of technology utilization on project performance. An industry-wide survey was used to collect project data from 70 capital facility projects on the issue of technology usage and project owner satisfaction parameter. This paper reports on integration/automation technology usage in the Taiwanese construction industry and associated impacts on project owner satisfaction. In addition, integration and automation technology findings are presented by project phase. The analyses indicate that projects with owner satisfaction have, on average, higher levels of technology utilization than projects with owner dissatisfaction for all technology usage metrics analyzed.

*Key words* : Project, Technology, Owner Satisfaction

## 1. INTRODUCTION

Technologies and innovations emerge quickly in the business world. Construction firms also attempt to improve project owner satisfaction by adopting technology. However, the advantages gained from technology utilization are still not clear. Uncertain benefits and lack of information on how technology affects overall project owner satisfaction makes some construction firms reluctant to implement technology. Therefore, there is a need for studies that quantify the impacts of technology utilization on overall project performance. Quantifying effects on project performance will assist companies in deciding whether to use certain technologies.

The primary objective of this study was to determine the extent to which Integration and Automation (IA) technologies contribute to project owner satisfaction. Integration is defined as the sharing of information between project participants or melding of information sourced from separate systems. Automation is defined as the use of an electronic or computerized tool by a human being to manipulate data or produce a product [1]. This paper presents findings pertaining to associations between project owner satisfaction and technology usage from assessment of the levels of technology employed on 58 different common project work functions (WFs) [1]. Data was collected on a total 70 capital facility projects from across Taiwan between October 2004 and June 2005.

Technology usage metrics analyzed include those at the project- and phase- levels. Phase-level technology usage metrics analyzed include technology usage in the Front-End,

Design, Procurement, Construction Management, and Construction Execution phases (technology usage in the Operation and Maintenance phase was excluded from the analysis).

## 2. RESEARCH HYPOTHESES

Research hypotheses were developed to investigate associations between project owner satisfaction and technology usage at the project and phase level. Table 1 lists the proposed research hypotheses.

## 3. SURVEY PROCESS

An industry-wide survey of technology use levels on capital facility projects was conducted to assess the level of use of IA technologies on projects and the impact of IA technologies on project owner satisfaction. A data collection tool was developed to collect project-based data through interviews. The survey was based on a study conducted by CCIS at the University of Texas at Austin [2]. Responses were collected from 70 capital facility projects in Taiwan. Steps were taken to help ensure that computed technology indices are representative of the levels of technology used on projects.

The data collection tool measured the degree of technology usage on capital facility projects and their impacts on project owner satisfaction. The survey was composed of two sections: project information and degree of technology use for work functions. The first section of the survey obtains information concerning the project, project type, and final performance of the project in terms of level

of owner satisfaction. The second section assesses level of technology used in executing the project. It addressed 58 work functions covering five project phases: Front End (Phase 1), Design (Phase 2), Procurement (Phase 3), Construction Management (Phase 4), and Construction Execution (Phase 5). The 58 work functions were divided into two categories: task automation work functions and integration link work functions. The concepts of an automation task and an integration link are defined as follows [2]:

- Automation task - a discrete task for which automation can reduce the amount of human effort required to accomplish the task's objectives
- Integration link - the means by which information is conducted from one discrete task to the next

Participants were asked to evaluate the degree of technology use for each task on the subject project. In assessing the degree of technology used in executing each work function, respondents could choose from four levels: Level 1, Level 2, Level 3, or Level 4. Each level of technology utilization was defined as follows [1]:

- Level 1- No electronic tools are used to complete the work function.
- Level 2- A few specialized electronic tools are used in completing the work function. A machine assists a human in completing the work function.
- Level 3- Several specialized electronic tools are used in completing the work function.
- Level 4- Integrated electronic tools are used in completing the work function.

The project performance variable analyzed is project owner satisfaction. Project owner satisfaction was evaluated using a Liker scale (strongly dissatisfy to strongly satisfy).

#### 4. TECHNOLOGY USAGE METRICS

Technology usage metrics analyzed include those at the phase level, at the project level, and those for task automation and integration link work functions. These indices were developed for measuring the use of Integration and Automation technologies in the industry. The technology use index values were compared with project owner satisfaction values to determine the relationships between technology usage and project owner satisfaction.

##### 4.1 Phase technology usage

Phase 1 & 2 technology usage is a measure of the level of technologies used in the Front-End and Design phases of sampled projects, which are information-intensive phases. Indices were developed to represent mean responses for the various work function assessments in the Front-End and Design phases of projects. Phase 3, 4 & 5 technology usage is a measure of the level of technologies used in the procurement and on-site phases of a project. This index represents the mean of responses associated with the work function assessments in the Procurement, Construction Management, and Construction Execution phases.

For any given work function, the assessed level of

technology on the 1-2-3-4 scale was established as the Work Function Score. The raw Phase IA Index was then computed to equally weight all Work Function Scores. The index values were converted to a 0–10 score.

##### 4.2 Project technology usage

Project IA indices are derived from mean responses associated with all the work function technology assessments on a project. The index values were converted to a 0–10 score in a similar way as used for the Phase IA Index values.

##### 4.3 Automation and integration technology usage

The Project Task Automation Index was computed to measure the level of automation used on a project. The Project Integration Link Index was computed in order to measure the level of integration used on the project [1]. As stated previously, two types of work functions are included in the survey assessment form: task automation work functions and integration link work functions. Task automation refers to the technology level used in automating a task (i.e., the use of a computerized tool to manipulate data or produce a product). Integration link refers to the level of technology used in exchanging information between tasks (i.e., the sharing of information between project participants or melding of information sourced from separate systems).

Project Task Automation Indices are the means of responses associated with the task automation work function measurements on a project. Similarly, Project Integration Link Indices are the means of responses associated with the integration link work function measurements on a project. Raw indices were computed by equally weighting all associated Work Function Scores and then converting to a 0–10 score.

#### 5. USE OF STATISTICAL TESTS

An independent-samples *t* test was conducted to determine whether the data provide evidence for significant differences in project owner satisfaction being associated with differences in technology usage. The independent-samples *t* tests were used to evaluate the difference between the means of the two independent groups. The null hypothesis was that the IA index mean for projects with owner satisfaction equals the IA index mean for projects with owner dissatisfaction. The alternative hypothesis stated that the means of the two independent groups are not equal. Also, eta square ( $\eta^2$ ) was computed for each independent-samples *t* test. This is the proportion of variance in the dependent variable that is explained by differences among groups. A value of 0 indicates that the difference in the mean scores is equal to 0, while a value of 1 indicates that the sample means differ, but the test scores do not differ within each group. Traditionally, eta square values of .01, .06, and .14 represent small, medium, and large effect sizes, respectively [3].

The independent-samples *t* test could not be performed when the assumptions underlying this test were violated. Therefore, a nonparametric alternative called a Mann-Whitney *U* test was also performed to further evaluate the

research hypotheses. The Mann-Whitney *U* tests were used to evaluate whether the medians differ significantly between two independent groups. The decision about which test should be used is based on whether the assumptions underlining the test are satisfied.

## 6. METHODS OF ANALYSIS

Project owner satisfaction is defined to have occurred when project owner strongly satisfy with the project. Project owner dissatisfaction is defined to have occurred when project owner dissatisfy with the project. The analyses focus on determining if there is a difference between projects with owner satisfaction and dissatisfaction in terms of their technology usage. Significant test results indicate that projects with owner satisfaction, on average, employ higher levels of technologies than projects with owner dissatisfaction.

## 7. ANALYSIS RESULTS

Project owner satisfaction was evaluated using a Likert scale (strongly dissatisfy to strongly satisfy). The distribution of the projects is shown in Tables 2. Project technology usage analyses focus on determining if differences between owner satisfactions are related to differences in project technology usage. Table 3 shows the results of the statistical tests. The analyses suggest that project technology usage may positively influence project owner satisfaction. Levels of technology usage for task automation work functions and integration link work functions are positively associated with project' levels of owner satisfaction. In addition, these analyses reveal significant differences in levels of technology usage in Phase 3, 4 & 5 between projects with owner satisfaction and dissatisfaction, which indicates that technology usage in the procurement and on-site phases may contribute significantly to project owner satisfaction.

## 8. CONCLUSIONS

An industry-wide survey was performed in order to quantify whether project owner satisfaction is associated with project- and phase-level technology usage. The analyses indicate that technology utilization may make a significant contribution to a project's owner satisfaction.

Specific key findings are recapped as follows:

- Project technology usage may contribute to project owner satisfaction.
- Levels of technology usage for task automation work functions and integration link work functions are positively associated with project' levels of owner satisfaction.
- Technology usage in the Procurement, Construction Management, and Construction Execution phases may contribute significantly to project owner satisfaction.

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## REFERENCES

- [1] O'Connor, J. T. and Yang L., "Project performance vs. use of technologies at the Project- and phase-levels." ASCE Journal of Construction Engineering and Management, 130(3), pp. 322-329, 2004.
- [2] Yang, L., *Influence of Technology on Project Success Measures*, PhD dissertation, The University of Texas, Austin, Texas, USA, 2003.
- [3] Green, S. B., Salkind, N. J., and Akey, T. M., *Using SPSS for windows: analyzing and understanding data*, 2nd Ed., Prentice-Hall, Upper Saddle River, New Jersey, USA, 2000.

**Table 1.** List of research hypotheses

Number	Hypothesis
H1	Levels of project technology usage are positively associated with projects' levels of owner satisfaction
H2	Levels of technology usage for task automation WFs are positively associated with projects' levels of owner satisfaction
H3	Levels of technology usage for integration link WFs are positively associated with projects' levels of owner satisfaction
H4	Levels of technology usage in Phase 1 & 2 are positively associated with projects' levels of owner satisfaction
H5	Levels of technology usage in Phase 3, 4 & 5 are positively associated with projects' levels of owner satisfaction

**Table 2.** Distribution of all projects by owner satisfaction with project

Project Owner Satisfaction									
Strongly Satisfy		Satisfy		Neutral		Dissatisfy		Strongly Dissatisfy	
N	%	N	%	N	%	N	%	N	%
5	8.06	25	40.32	19	30.65	13	20.97	0	0.00

**Table 3.** *T*-test for technology usage vs. project owner satisfaction

Technology Usage	Projects with Owner Satisfaction			Projects with Owner Dissatisfaction			Mean difference	t-statistic	Significance	Eta square
	Number	Index mean	Standard deviation	Number	Index mean	Standard deviation				
Project	5	5.76	2.59	13	3.91	2.27	1.85	1.49	0.077	0.12
Task automation	5	5.83	2.51	13	4.02	2.14	1.81	1.54	0.072	0.13
Integration link	5	5.71	2.77	13	3.80	2.45	1.91	1.43	0.086	0.11
Phase 1 & 2	5	6.36	2.66	13	5.13	1.86	1.23	--	--	--
Phase 3, 4 & 5	5	5.77	2.54	13	3.98	2.50	1.79	1.35	0.097	0.10