IT IMPLEMENTATION PERFORMANCE AND ORGANISATIONAL CHARACTERISTICS IN TAIWANESE CONTRACTORS

Chao-Peng Ma and Graham M. Winch

The Bartlett School of Graduate Studies, University College London, Gower Street, London WC1E 6BT, UK.

Based on the innovation process and organisational change literature, this research concerns the relationship between the organisational characteristics and outcomes of IT implementation performance for business improvement in construction organisations. An analytical research framework was deployed to identify the potential organisational variables which were correlated with the outcomes of IT implementation. After interviewing a total of fifty major contractors in Taiwan, this research identified some organisational variables which were significantly correlated with the outcome of IT implementation performance in the contractors. These results can be used as guidelines for construction organisations to assess their organisational characteristics and monitor the process of IT innovation in order to achieve better IT benefits.

Keyword: information technology, implementation performance, innovation, organisational variables, organisational change, business success

INTRODUCTION

In today's increasingly competitive business climate, information technology (IT) is becoming the means for business competitiveness. The view that IT expenditures are expected to increase enormously in organisations is now widely accepted in the literature. IT innovation provides construction organisations with the opportunity to improve their business performance and gain competitiveness. According to many surveys such as CICA and KPMG (CICA 1993), IT is now widely used in the UK construction industry.

There is also much evidence to suggest that IT has had a major impact on organisations over the past decade. Technological advances provide the opportunity for organisations to change their way of working. The innovation literature has described the importance of individual and organisational characteristics as the antecedents of organisational innovation. However, what are less understood are the relationships between these characteristics and IT implementation performance in construction organisations. The challenge facing IT/IS researchers is the all-pervading nature of IT innovation. IT can permeate most or even all levels and functions in an organisation. Organisational change and learning resulting from implementing IT may improve their business performance. However, the inherent nature and characteristics within one organisation may also prevent the full success of IT implementation.

This paper presents some primary findings of a Ph.D. research project. A model was developed in this research to guide the identification of potential organisational

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variables that could influence the outcomes of IT implementation. The data acquired for this research is from interviews with 50 contractors in Taiwan analysed quantitatively. The results show that there are variables in organisational characteristics that have positive correlations with the IT implementation performance. Some significant findings from the statistical analysis are accordingly discussed.

RESEARCH PROBLEM AND METHODOLOGY

IT provides opportunities for organisational change. Managers in organisations are becoming more aware of IT potential and are keen to implement IT in their business. Business Process Re-engineering (BPR) is a good example of creating major changes in an organisation through IT. However, not all of the results of IT innovations are satisfactory. Lyytinen and Hirschheim (1987) argued that there are examples of IT systems which clearly met their design objectives, but could hardly be considered successful. These systems continued to remain in existence, yet the organisations concerned were not convinced of their value.

Much research has been undertaken to develop a better understanding of IT implementation and diffusion, such as Kwon and Zmud (1987) and Cooper and Zmud (1990). However, no research had been undertaken to investigate the relationship between organisational characteristics and IT innovation outcomes in the construction industry. Consequently, this research aims to identify why some contractors can achieve better IT implementation performance than others, as well as which factors influence the outcome of IT innovation in construction organisations.

After the identification of the research question, the development of an analytical research model is helpful for the identification of potential variables in organisational characteristics. Pettigrew and his colleagues (1985, 1990, 1991, 1992) concluded that research on organisational change should involve the interplay between the context, content, and process of change. The relations and interplay between these three elements of change can influence the outcome of the change. This theoretical conception rightly provides a sound and practical basis for developing the analytical framework required. From Pettigrew's work, the three elements representing the "why", "what" and "how" of the change can be brought into the analysis. To facilitate the investigation of the IT innovation process, an analytical research framework developed from Pettigrew's three elements of change and Winch's (1994) recursive model of innovation/implementation was deployed in this research, as shown in Figure 1. The variables involved in these three elements of change in IT innovation processes can then be identified.

According to Pettigrew, "inner context" refers to the characteristics of the organisation itself including strategy, culture, management, human resource and policy. The "outer context" refers to the industry, economy, politics, markets, and competitive environment in which the organisation operates. The "content" element refers to the particular features of change under examination (in this case, the particular choice of IT system). The "process" element refers to the implementation of the change and the reaction from the participants involved in the change. The development of this framework is based on the premise that variables inherent within the organisation's outer context and inner context may affect the content of change, as well as the process of change. The interplay between these variables can influence the performance of the IT implementation project. The evaluation stage, installation stage

and consolidation stage are the three stages of the implementation process identified in Winch's recursive mode. The successful outcomes of these three stages are adoption, technical success and business success separately. These stages are interactive and recursive with each other (Winch 1994).

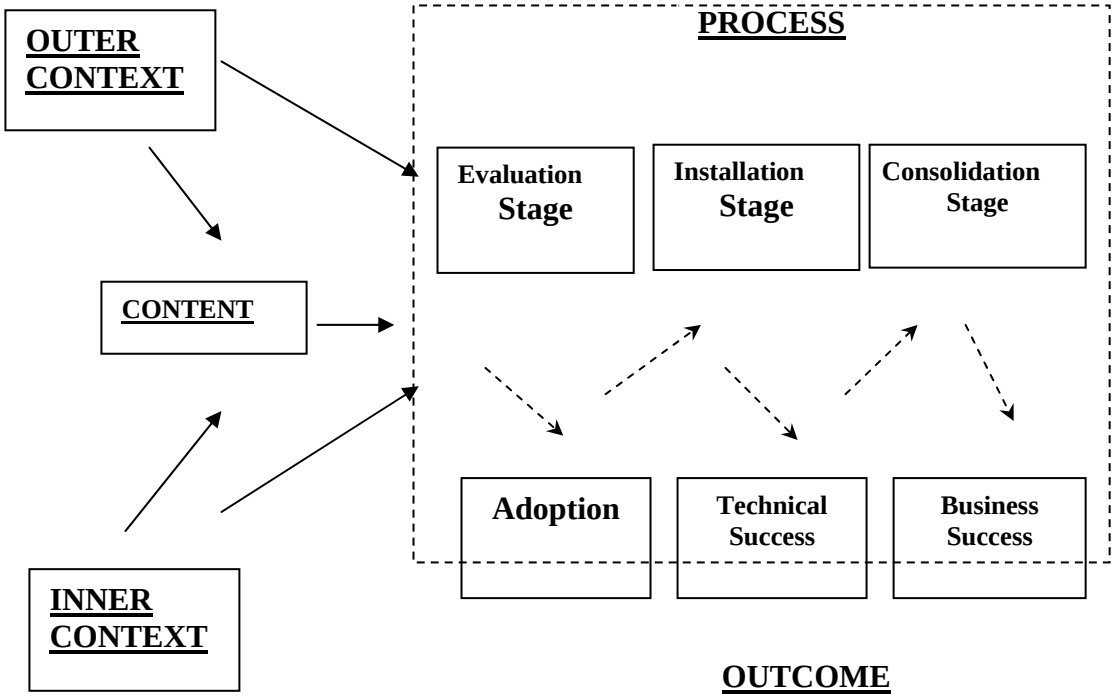

Figure 1. The Analytical Framework

The variables used to measure the IT implementation performance in terms of business success were: efficiency improvement (*doing things right*), effectiveness improvement (*doing the right things*) and competitive advantage improvement (*long-term performance*). These three variables are the same as those used by Construct IT (1998) to evaluate IT benefits in the construction industry. The contractors interviewed were asked to rank their IT systems according to their contributions in these three business success variables. Technical success was measured by two variables: expected function achievement and user satisfaction. A total of 27 variables were proposed in this research to test the relationship between IT implementation performance and organisational characteristics in construction organisations

DATA COLLECTION AND ANALYSIS

There is much literature regarding the debates between quantitative and qualitative approaches such as Bryman (1988) and Yin (1994). Both quantitative and qualitative approaches have own strengths and weaknesses. The data collection method used in this research is the interview. However, due to the requirement of quantitative data for applying statistical analysis, a structured research instrument consisting of five-point Likert scale was applied in the interviews following the organisational assessment approach developed by Van De Ven and Ferry (1980).

Fifty contractors in Taiwan were interviewed during the period June 1999 to January 2000. These contractors were selected from the top Taiwanese construction organisations list provided by the Taiwan Constructor's Union and Association in Taipei. The interviewees were mainly IT managers in the organisations. However in some cases, the IT managers did not know the answers to some questions related to

general management such as business strategies. Therefore a total of 67 people was involved in the interviews and the average time taken for each interview was one hour and forty minutes.

Among the fifty contractors in Taiwan sampled, 32 organisations are mainly building engineering contractors, 4 organisations are mainly civil engineering and the other 14 organisations are involved in both building and civil engineering works. Moreover, 5 contractors have an engineering consultancy section and 8 contractors have an architectural design section within their business. As to the geographical distribution of projects, 3 contractors have international projects, 37 organisations have projects all over Taiwan and the other 10 organisations are mainly local contractors.

Multivariate analysis was used for the statistical tests in this research. 9 variables were found to be statistically significant factors associated with achieving business success through IT implementation in the contractors, as shown in Table 1.

Table 1. Significant* variables associated with business success improvement by IT

Business Success	Variables	**Correlation Coefficient**	**P value**
Efficiency Improvement	Degree of Control	0.478	< 0.001
	Previous IT Experience	0.489	< 0.001
	IT Justification	0.416	0.003
	User's Attitude	0.559	< 0.001
	Strategic Importance	0.427	0.002
	Operational Importance	0.536	< 0.001
	Project Director/Champion	0.475	< 0.001
	User Satisfaction	0.713	< 0.001
	Expected Function Achievement	0.780	< 0.001
Effectiveness Improvement	IT Justification	0.413	0.003
	User's Attitude	0.429	0.002
	Project Director/Champion	0.393	0.005
	Operational Importance	0.465	0.001
	User Satisfaction	0.614	< 0.001
	Expected Function Achievement	0.707	< 0.001
Competitive Advantage	IT Justification	0.570	<0.001
	Strategic Importance	0.457	0.001
	User satisfaction	0.365	0.009

* All variables are significant at 0.01 level of significance (Spearman's rho 2-tailed test)
** N= 50

THE RESULTS

Table 1 shows that seven organisational variables were significantly correlated with business efficiency improvement. The two technical success variables: User Satisfaction and Expected Function Achievement, as might be expected, are also highly correlated (rho>0.7) with business efficiency improvement. This suggests that the contractors who achieved better technical success in their IT systems were more likely to obtain better business efficiency improvement by IT. The other seven organisational variables are moderately correlated (rho>0.4) with contractors' IT implementation performance in business efficiency improvement, but still at the 1 % confidence level.

Four and two organisational variables are significantly associated with business effectiveness and competitive advantage improvement respectively. All the above variables are found in the previous efficiency test but their correlation coefficients are lower. As might be expected, while operational importance was correlated with business effectiveness, strategic importance was correlated with competitive

advantage. This may be because business effectiveness and competitive advantage improvement are more difficult to realise and identify than business efficiency improvement by the contractors. While both technical success variables were correlated with effectiveness, only user satisfaction was correlated with competitive advantage.

Multiple regression analysis, as showed in Table 2, was also applied to identify the critical success factors for business performance improvement through IT implementation. The results showed that five variables: Degree of Control, IT justification method, IT development Policy, Strategic Importance of IT system and Expected Function Achievement have vital influences on the outcome of contractor's IT implementation performance in business success. On this evidence, it is suggested that a tighter control in organisational structure, a long-term strategic opportunity based assessment, a centralised IT development and control policy, focus on the IT systems with high strategy importance and a better expected function achievement in IT technical success are likely to result in a greater impact of IT implementation on business success. Thus contractors should pay much attention to these five critical variables and use them as predictors to achieve a better outcome from new IT investments.

THE RESULTS AND THE ANALYTIC FRAMEWORK

This section discusses intercorrelations between the organisational variables within the analytical framework. A summary of other significant correlations between variables in different categories of organisational change are discussed as follows:

Outer Context
The Environmental Force, as the major variable proposed at this area, mainly followed Winch's (1998) model for innovation adoption in construction organisations. It was found from the interviews that solving project problems was considered to be the factor with the strongest influence on the decision to adopt IT innovations. However, the tests also found that there were statistically significant correlations between the outer context variable and variables in the "inner context" and "process" groups.

First, the results illustrated that the contractors encountering higher environmental pressures to adopt IT were likely to find more unforeseen IT benefits after system consolidation (rho=0.563). This result is to be expected since organisations which are forced to adopt IT for problem solving or business survival are unlikely to apply detailed investment appraisals. This is also consistent with Farbey et al's (1992) argument concerning why organisations do not apply assessments for their IT investments.

Secondly, the influence of previous IT experiences on future IT strategy and plan was found to be statistically stronger (rho=0.463) among the contractors encountering higher environment pressure to adopt IT. This may be explained by the fact that solving particular project problems through IT innovation is a trial and error process (as problem solving/learning dynamics in Winch's (1994) model of IT implementation). Lessons from the trial procedure of IT innovation are certainly the source of learning for future IT development.

Inner Context
Seven variables were found to have significant correlations with variables in other categories in the framework. Top management's support for IT was found to be

associated with the appointment of project director/champion for IT development (rho=0.42). In other words, the contractors with more support from top management for IT innovation are more likely to appoint a full time project direction/champion for the development of IT. The appointment of IT project directors/champions was found to be associated with both IT technical success and business success.

Table 2. The regression model results

Business Efficiency				
	Unstandardised Coefficients		t	Sig.
Model	B	Std. Error		
(Constant)	.369	.309	1.193	.239
EXPEFUNC	.574	.069	8.270	.000
CONTROL	.246	.078	3.152	.003
JUSTIFIC	.109	.037	2.925	.005
R=0.863 R Square=0.745 F=44.754 Sig. =0.000				

Business effectiveness				
	Unstandardised Coefficients		t	Sig.
Model	B	Std. Error		
(Constant)	.991	.414	2.960	.005
EXPEFUNC	.643	.093	2.393	.021
JUSTIFIC	.153	.050	6.920	.000
ITPOLICY	-.103	.048	3.063	.004
R=0.811 R Square=0.657 F=29.408 Sig. =0.000				

Competitive Advantage				
	Unstandardised Coefficients		t	Sig.
Model	B	Std. Error		
(Constant)	1.533	.379	4.040	.000
JUSTIFIC	.247	.077	3.196	.002
STRAIMPT	.242	.102	2.367	.022
R=0.578 R Square=0.335 F=11.82 Sig. =0.000				

Top management's IT competence and knowledge was correlated with the Focus of IT implementation performance measurement after system consolidation (rho=0.481). This study found that contractors were more likely to focus on un-quantifiable benefits when they measured their IT implementation performance if their top management had greater IT competence and knowledge.

The Degree of Control in organisational structure was found to be moderately associated with User Satisfaction in IT technical success (rho=0.437) and Business Efficiency Improvement (rho=0.478) in business success. In other words, contractors with tight control in organisational structure were more likely to achieve user satisfaction and business efficiency improvement through implementing IT. Some variables in the organisation's IT strategy were also correlated with other groups of variables. The influence of previous IT experience was found to be correlated with Expected Function Achievement (rho=0.493) and Business Efficiency Improvement (rho=0.489). The contractors who learn from their previous IT implementations for future IT development are more likely to obtain expected function achievement and business efficiency improvement through implementing IT.

The justification method before the decision to adopt new IT was found to have a positive correlation with all the three business success variables. In other words, the contractors whose IT justification methods focus on long-term strategic opportunity assessment are more likely to obtain business success through implementing IT systems.

The policy for IT development and management and IT Sourcing Strategy were also found to correlate with other categories of variables. This suggests that the contractors with a centralised IT development and management policy were more likely to obtain expected IT function achievements (rho=-0.407). As to the IT sourcing strategy, the contractors who chose outsourcing to external IT suppliers were more likely to hire IT experts to assist in system installation. This reflects the finding in the interviews that IT professionals are difficult to recruit in Taiwan's construction industry. Thus, the contractors whose main IT sourcing policy is outsourcing to external suppliers usually have a contract with local computer companies for IT consultancy.

Content

The perceived strategic importance and operational importance of the IT systems installed by the contractors were found to correlate with other categories of variables. It was found that the contractors who mainly invested in IT systems which were regarded as of high strategic importance are likely to identify better user attitudes towards the new IT (rho=0.446), user satisfaction (rho=0.476), business efficiency (rho=0.427) and competitive advantage improvement (rho= 0.457) through IT. On the other hand, contractors who mainly invested in IT systems which were regarded as highly operationally important were more likely to obtain user satisfaction (rho=0.577), expected function achievement (rho=0.488), business efficiency (rho=0.536) and effectiveness improvements (rho=0.465) through IT. This suggests that the content of IT innovation does have an influence on the process and outcome of IT innovation in the contractors.

Process

Users' Attitude and the Appointment of Project Directors/Champions are the two variables with statistical correlations with variables in other categories. Users' attitude towards the new IT was found to be positively associated with the two technical success variables (rho= 0.422 and 0.485 for User Satisfaction and Expected Function Achievement respectively). It is also positively associated with Efficiency improvement (rho=0.559) and Effectiveness improvement (rho= 0.429) for business success. This result is to be expected since the cooperation and full commitment of IT users are vital for the operation and performance of IT systems. Project directors/champion also play an important role in IT innovation outcomes in this study. The results show that use of a project director/champion is positively correlated with business efficiency improvement (rho= 0.475) and User Satisfaction in technical success (rho=0.471). This finding is also consistent with the literature which emphasises the importance of champions in the innovation process (e.g. Winch 1994, Frenzel 1996 and Nam and Tatum 1997).

CONCLUSION

In order to obtain competitiveness in today's construction market, contractors are adopting information technology to improve their business processes. However, the results of IT innovation in different construction organisations were found to be different even when they had adopted the same IT systems. This can be explained by

the findings of this research that the outcomes of IT innovation were influenced by the different organisational characteristics. This also explains why some contractors achieve better IT benefits than others.

This research has identified several organisational characteristics that are correlated with the outcomes of IT implementation. The results can be used to help contractors to understand how to manage their new IT investment and get a better result in IT implementation performance. Moreover, the critical success factors identified in this research can be used as a diagnostic tool to examine contractors' existing IT systems and organisational characteristics so that the outcome of their IT systems can be improved. It is also suggested by this research that contractors should consider re-engineering their organisational structure and business processes by while adopting new IT innovation in order to obtain IT benefits and business success.

The limitation of this research is that the data are mainly collected from Taiwan's construction industry. The results may be different if the contractors investigated are in other countries such as the UK or USA due to differences in culture, environment and business behaviour. Consequently, further research conducting similar investigations in different countries is recommended. Furthermore, comparisons between contractors in different countries for their organisational characteristics and IT implementation performance are also suggested.

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