

12-31-1995

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THE IMPACT OF IT INFUSION AND DIFFUSION ON SOME CHARACTERISTICS OF IS PLANNING: A MODEL AND AN EMPIRICAL TEST

Jim Hann

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Abstract

Information systems plans traditionally have been conceived as a means of recognizing opportunities and problems where information technology might be used, identifying the resources needed to support the application of information technology, and developing strategies and procedures to allow information technology to be applied successfully. From an agency theory and transaction cost theory perspective, however, information systems plans might also be used to provide a basis for bonding and monitoring information systems managers, to help resolve how unforeseen gains and losses will be distributed among information systems managers and their superiors, and to facilitate judgments on the level of decision rights to be delegated by senior management to information systems managers. In the context of this latter view of information systems planning, an important issue is to understand the set of factors that determine whether senior management or the information systems manager controls the planning process and whether the focus of the plan primarily addresses the goals and objectives of senior management or the information systems manager. We propose a model that articulates how information technology infusion and diffusion might impact who controls the planning process and ultimately the focus of the plan. We then test this model empirically using a survey of information systems managers and their immediate superiors. We find that higher levels of infusion are associated with senior management exercising greater control over the planning process and the plan focusing more on their goals and objectives. Diffusion also has an impact on these two variables via its effects on infusion.

1. INTRODUCTION

Historically, information systems (IS) plans have been conceived as a means of (1) recognizing opportunities and problems where information technology (IT) might be applied successfully, (2) identifying the resources needed to support the application of IT, and (3) developing strategies and procedures to allow IT to be applied successfully (Boynton and Zmud 1987). Recently, however, we have argued that IS plans might be used to fulfill three other objectives: (1) providing a basis for bonding and monitoring IS managers so their actions will be more congruent with the wishes of their superiors; (2) helping resolve how unforeseen gains and losses will be distributed among IS managers and their superiors; and (3) facilitating judgments on the level of decision rights to be delegated by senior management

to IS managers (Hann and Weber, forthcoming). In short, we have conceived IS plans as mechanisms that help resolve agency problems (Jensen and Meckling 1976) and transaction cost problems (Williamson 1985) that arise between senior management and the IS manager.

In our prior work, we focused on two dimensions of IS planning: (a) whether the IS planning process was controlled primarily by senior management or the IS manager; and (b) whether the resulting IS plan reflected primarily senior management's goals or the IS manager's goals. The former dimension we called the *locus of control over the IS planning process*. We characterized it as either principal (senior management) controlled or agent (IS manager) controlled. The latter dimension we called the *focus of the IS plan*. We characterized it as either principal focused or

agent focused. If, as we have argued, IS plans provide a basis for resolving agency cost and transaction cost problems, both senior management and the IS manager have incentives to control the IS planning process and the focus of the IS plan.

In the context of this view of IS planning, an important issue is to understand the set of factors that lead to either senior management or the IS manager exercising control over the IS planning process and ultimately the focus of the resulting plan. In our prior work, we examined the effects of varying levels of environmental and task uncertainty facing senior management and the IS manager and their relative levels of dependence (co-specialization) on one another. In this paper, we investigate two other factors that might impact who exercises most control over the IS planning process and the focus of the IS plan. The first is *IT infusion*, which reflects the "the degree to which information technology has penetrated a company in terms of importance, impact, or significance" (Sullivan 1985, p. 5). The second is *IT diffusion*, which reflects "the degree to which technology has been disseminated or scattered throughout the company" (Sullivan 1985, p. 6).

2. MODEL AND PROPOSITIONS

Figure 1 shows the overall model investigated in this research. Table 1 shows the propositions derived from this model that we test empirically.

2.1 Infusion and its Relationships

We predict that higher levels of infusion will lead to senior management exercising higher levels of control over the IS planning process (Proposition 1, Table 1). As infusion increases, senior management are more likely to attend to the activities of the IS function because it becomes central to the success or failure of their organizations and ultimately to their own wealth.

We predict, also, that higher levels of infusion will lead directly to a more principal-focused IS plan. Such a plan will attend to the long-term strategic needs of the organization and to the application needs of end users rather than primarily to the operational and resource needs of the IS function (Proposition 2, Table 1).

2.2 Diffusion and its Relationships

The effect of diffusion on the locus of control over the IS planning process is not clear-cut. On the one hand, increasing diffusion might mean the overall IS plan is less significant. Instead, local IS plans become more important. On the other hand, coordination and control of IT within an organization is likely to become more difficult as diffusion increases. As a result, the overall IS plan may become more important.

Which of these tendencies dominates may depend on an organization's maturity with respect to IT and IS diffusion. It is well known, for example, that senior management often experience difficulties in planning and controlling end-user computing when it first appears in their organizations (Brancheau and Brown, 1993). Organizations that are mature users of end-user computing, however, should have had time to develop, implement, and refine planning and control mechanisms. Because the organizations we investigate in our research are large, mature users of technology, we hypothesize, therefore, that the overall IS plan will become more important to senior management as the extent of diffusion increases (Proposition 3, Table 1).

Moreover, because the IS plan becomes more important with higher levels of diffusion, other dimensions of the IS planning process besides the locus of control are likely to adjust to produce a more principal-focused plan (Proposition 4, Table 1).

2.3 Locus of Control-Focus of the IS Plan Relationship

The last relationship shown in our model is between the locus-of-control and the focus-of-the-IS-plan constructs. We predict that a plan which primarily reflects senior management's goals will be associated with a principal-controlled planning process (Proposition 5, Table 1).

3. RESEARCH METHOD

To test our five propositions, we used a subset of data collected as part of a larger survey we undertook of IS planning practices in Australian organizations.

3.1 Survey Population

The survey population comprised 945 Australian private-sector and public-sector organizations. These organizations were not chosen at random. Instead, we selected those with net annual revenues exceeding \$65 million in the hope their IS planning activities would be well-developed and relatively stable.

3.2 Survey Respondents, Instruments, and Measures

Two questionnaires were used to collect the data we needed to test our propositions. The first was completed by IS managers. It contained a five-item instrument designed to measure whether the IS planning process was superior controlled or IS manager controlled. On seven-point scales, IS managers rated the five items shown in Table 2. We deemed that high scores on the first, fourth, and fifth items reflected a superior-controlled planning process, whereas high scores on the second and third items reflected an IS manager-controlled planning process.

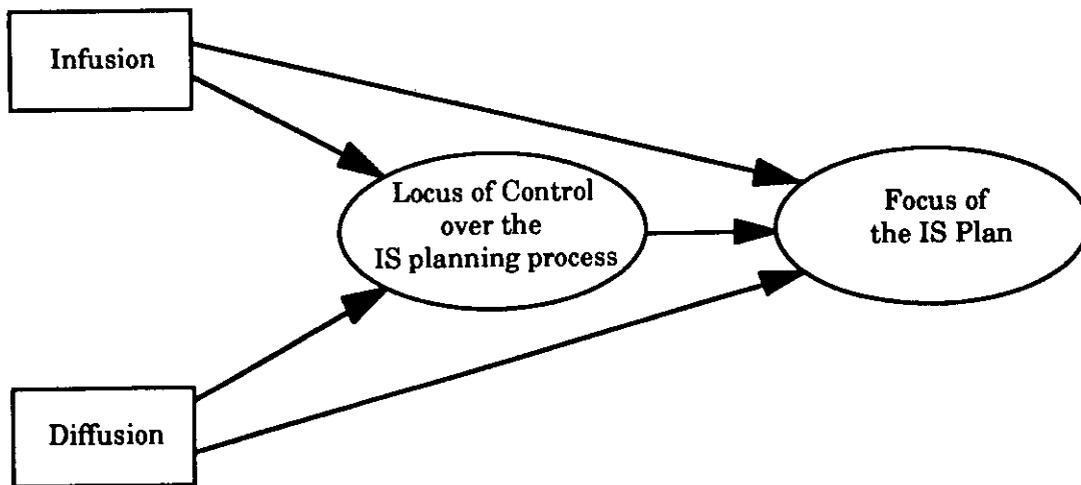


Figure 1. The Research Model

Table 1. Research Propositions

P1	Higher levels of IT infusion will lead to senior management exercising more control over the IS planning process.
P2	Higher levels of IT infusion will lead to the preparation of an IS plan that better reflects the goals and objectives of senior management.
P3	Higher levels of IT diffusion will lead to senior management exercising more control over the IS planning process.
P4	Higher levels of IT diffusion will lead to the preparation of an IS plan that better reflects the goals and objectives of senior management.
P5	Higher levels of control by senior management over the IS planning process will lead to the preparation of an IS plan that better reflects their goals and objectives.

The second questionnaire was completed by the IS manager's superior. It contained three instruments. The first was a single-item, seven-point scale instrument designed to measure the extent of IT infusion. The second was a single-item, seven-point scale instrument designed to measure the extent of IT diffusion. The third was a six-item instrument designed to measure whether the IS plan was superior focused or IS manager focused. On seven-point scales, superiors rated the six items shown in Table 2. We deemed that high scores on the second, third, fourth, and sixth items reflected a superior-focused plan, whereas high scores on the first and fifth items reflected an IS manager-focused plan.

3.3 Administration of the Survey

After pilot testing the questionnaires with four organizations, we mailed them to the CEOs of the 945 organizations in our survey population. In a covering letter, we asked them to request the IS manager and the IS manager's immediate superior to complete their questionnaires independently. We also asked them to collect the two completed questionnaires and to return them to us within two weeks in a reply-paid envelope.

Table 2. Measurement Instruments and Their Scale Items

Locus of control over IS planning process	Rate the extent to which the IS planning process:
χ_1	included representatives of departments that used the services or products provided by the IS function.
χ_2	included personnel who worked directly for the IS manager.
χ_3	used methodologies that focused on the resources (hardware, software, personnel) needed by the IS function.
χ_4	used methodologies that focused on the requirements of the services and products provided by the IS function.
χ_5	had top management communicate their overall goals and objectives for the organization.
Focus of the IS plan	Rate the extent to which the plan:
χ_6	focussed on resources needed to support the IS function.
χ_7	focussed on the requirements of end users of the services and products provided by the IS function.
χ_8	linked its goals and objectives to the overall goals and objectives of the organization.
χ_9	was likely to be implemented in practice.
χ_{10}	had a short-run, operational focus.
χ_{11}	had a long-run, strategic focus.

4. RESULTS

Of the 945 packages mailed to the survey population, 191 organizations responded (response rate 20 percent). Only 173 organizations provided complete data on all items needed to test our propositions, however. We used structural equation modeling (Long 1983) to evaluate our measures and to test our propositions.

4.1 Measurement Model Results

Figure 2 shows the initial measurement model we fitted to our data. The locus of control over the IS planning process variable and the focus of the IS plan variable are latent variables. Figure 2 also shows the results we obtained for our initial measurement model using EQS (Bentler 1992). Note that all measured variables load reasonably well on their related latent variables. The Chi-square statistic is significant ($\chi^2 = 83.4$, $df = 43$, $p <$

.001), however, indicating the model is not a good fit for the data. Nevertheless, the Chi-square test is not a good indicator of fit when the sample size is large (Bentler and Bonett 1980). Other indices of fit should be used. In this regard, the Bentler-Bonett Normed Fit Index (BBNFI) for the model is .971, the Bentler-Bonett Non-Normed Fit Index (BBNNFI) for the model is .982, and the Comparative Fit Index (CFI) for the model is .986. Providing these indices are above .9, the model is deemed to be a good fit for the data (Bentler 1990).

The factor loadings for three of the measured variables, however, do not have the expected sign. Recall, we predicted that higher scores on variables χ_2 and χ_3 would be negatively correlated with senior management exercising control over the IS planning process. Similarly, we predicted higher scores on variable χ_6 would be negatively correlated with the IS plan having a senior-management focus. Accordingly, we eliminated these variables from our measurement model and then fitted the revised model to our data.

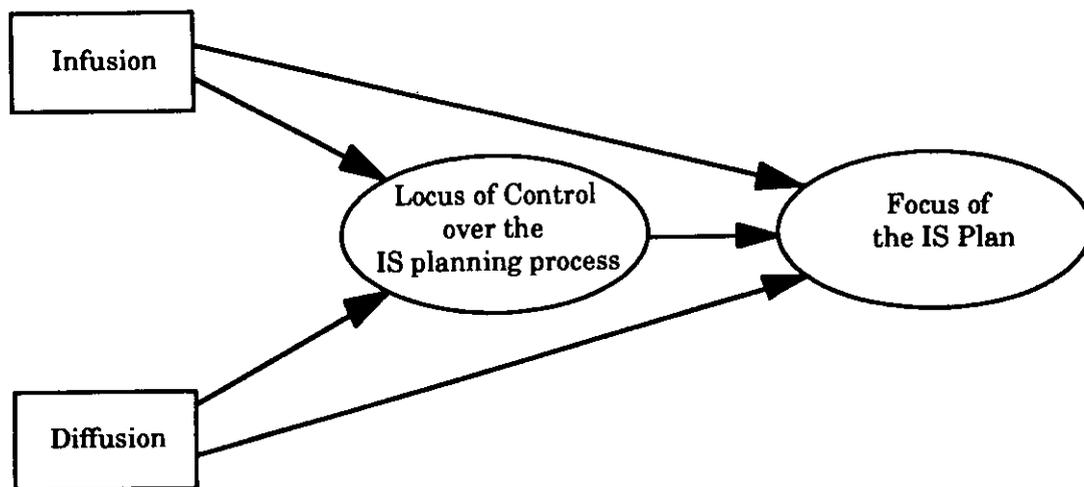


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<p>Focus of the IS plan</p>	<p>Rate the extent to which the plan:</p>
<p>χ_6</p>	<p>focussed on resources needed to support the IS function.</p>
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4. RESULTS

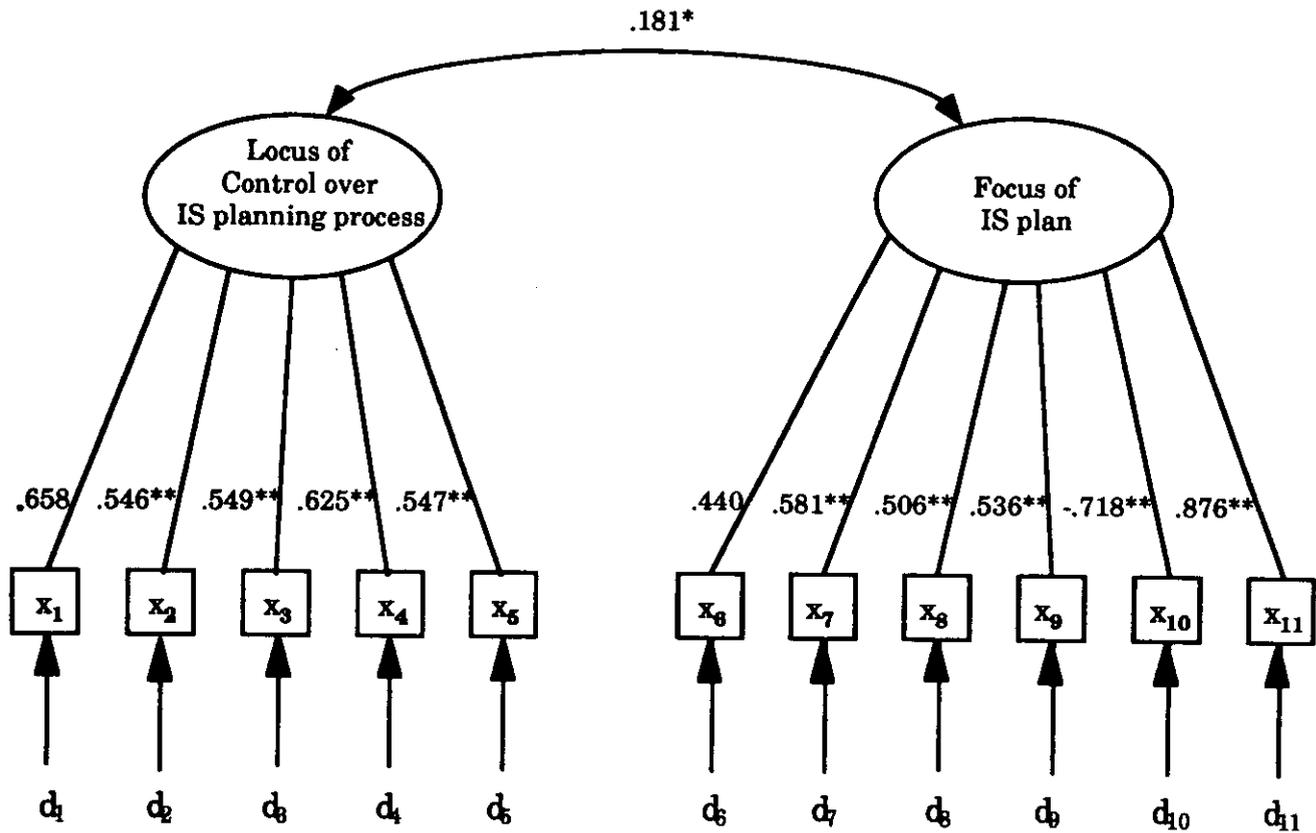
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Note: $p < .05 = *$, $p < .01 = **$, two-tailed test

Figure 2. Initial Measurement Model

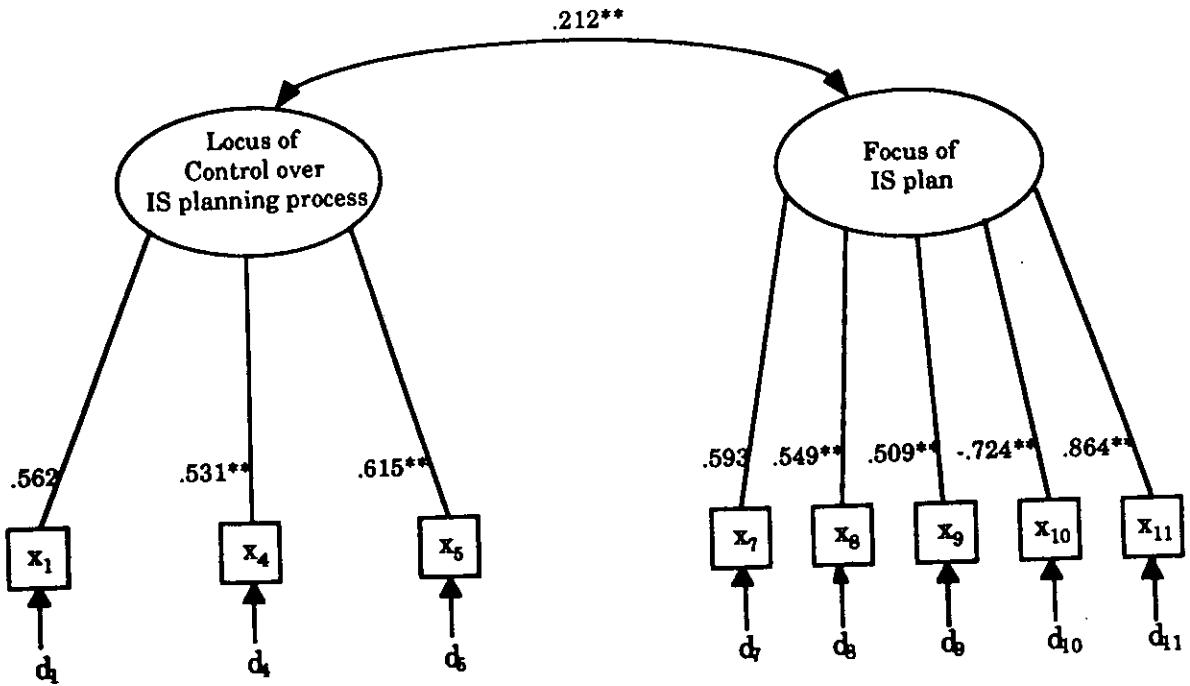
Figure 3 shows the results. Again, the Chi-square statistic is significant ($\chi^2 = 32.9$, $df = 19$, $p = .025$), indicating the model is not a good fit. On the other hand, the BBNFI, BBNNFI, and CFI indicate the model is a good fit (BBNFI = .983; BBNNFI = .989; CFI = .993).

To determine whether our measured variables were unidimensional, we examined the Lagrange multiplier and Wald statistics provided for the model. Only one statistic was significant at the .02 level — namely, for a path between measured variable x_5 and the focus of the IS plan latent variable. Ideally we would delete this variable because its unidimensionality is suspect. If we took this action, however, only two measured variables would exist for the locus of control over the IS planning process latent variable. As a result, our model would be underidentified (Bentler and Chou 1987). Thus, we retained x_5 in our model.

Using the procedures described in Segars (1994), we also calculated the composite factor reliability and the amount of variance captured by each latent construct versus the amount of variance due to measurement error (Fornell and Larcker 1981). We also tested our two multi-item measures for discriminant validity. The results indicate we have two distinct constructs that have moderate reliability.

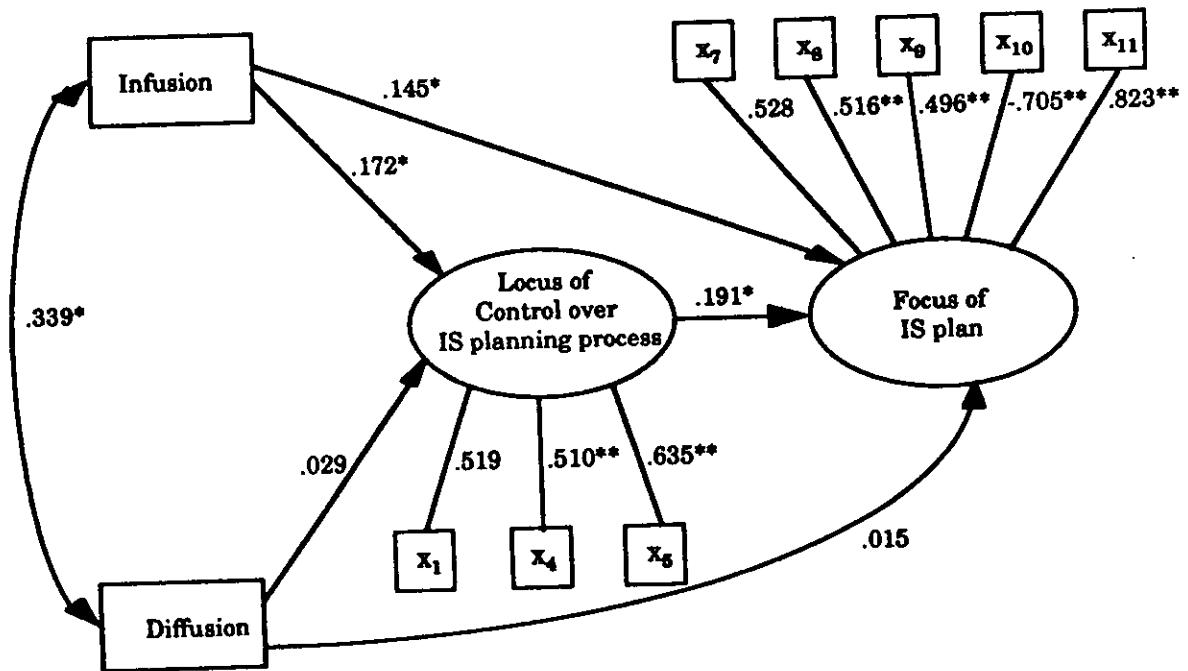
4.2 Research Model Results

To test our five propositions, we first fitted the model shown in Figure 4. The Chi-square statistic is significant ($\chi^2 = 54.7$, $df = 31$, $p = .005$), indicating the model is not a good fit. Moreover, while the CFI is greater than .9 (.915), the BBNFI and BBNNFI indices are both less than .9 (.831 and .876). Thus, the model provides only a moderate fit. The Lagrange multiplier and Wald statistics again indicate model fit can be improved by establishing



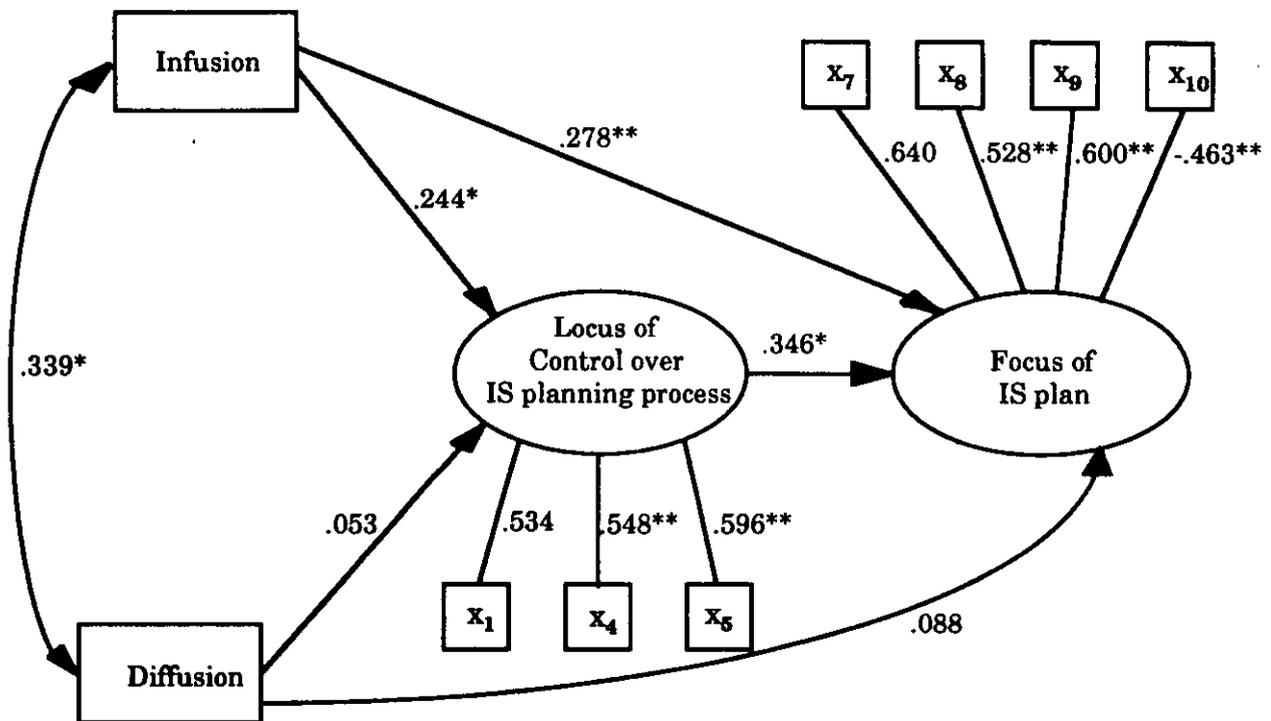
Note: $p < .05 = *$, $p < .01 = **$, two-tailed test

Figure 3. Final Measurement Model



Note: $p < .05 = *$, $p < .01 = **$, two-tailed test

Figure 4. Initial Research Model



Note: $p < .05 = *$, $p < .01 = **$, two-tailed test

Figure 5. Final Research Model

a path between measured variable χ_5 and the focus of the IS plan latent variable. In addition, they indicated model fit could be improved by establishing a path between measured variable χ_{11} and the locus of control latent variable. Because measured variable χ_{11} may not be unidimensional, therefore, we dropped it from the model.

Figure 5 shows the results for the revised research model. The Chi-square value indicates the model is a good fit ($\chi^2 = 18.4$, $df = 23$, $p = .737$). Moreover, the other three fit indices we have employed are all above .9 (BBNFI = .907; BBNNFI = 1.045; CFI = 1.000).

Note from the statistically significant path coefficients in Figure 5 that we have support for Propositions 1, 2, and 5. Contrary to our predictions, however, Hypotheses 3 and 4 were not supported.

5. LIMITATIONS OF THE RESEARCH

We see three primary limitations to our results. The first relates to the validity and reliability of our measurement instruments. Two scale items were not clearly unidimensional. The measurement scales also may have underoperationalized the constructs (Cook and Campbell 1979). In the case of the infusion

and diffusion constructs, we used only a single-item scale. Moreover, in the case of the locus-of-control and focus-of-plan constructs, ultimately we used only three and four items respectively.

The second limitation relates to the external validity of our results. We collected data from large organizations that we believed had a mature IS planning process. Our results might not hold for smaller organizations or organizations whose IS planning process is in a state of flux.

The third limitation relates to our use of cross-sectional data to test directional hypotheses. We have assumed that increases in the levels of infusion and diffusion occur before the predicted changes in the locus-of-control and focus-of-the-plan constructs. To test directionality, however, time-series data is needed.

6. IMPLICATIONS FOR RESEARCH AND PRACTICE

Our results have implications for both research and practice. For research, much work needs to be done to refine our agency theory and transaction cost theory perspective of IS planning so that rigorous and testable propositions can be articulated. Much work

also needs to be done before valid and reliable tests of such propositions can be undertaken. In particular, while our results suggest the instruments we developed in this research to measure critical constructs have moderate validity and reliability, clearly they need further development.

For practice, we believe that more effective IS plans can be produced if senior management and IS managers recognize the role that IS plans can play in resolving agency and transaction cost problems. In this regard, we see the preparation of an IS plan as a power exercise where both senior management and the IS manager try to control the negotiation process. We believe both parties will be in a better position to negotiate if they understand why senior management has incentives to exercise more control over the planning process and the content of the plan when IT infusion and diffusion increase.

7. ACKNOWLEDGMENTS

We are indebted to Neal Ashkanasy, Tony Baglioni, and Colin Ferguson for statistical advice and assistance and to Craig Hume for research assistance. We are also indebted to the reviewers for helpful comments on an earlier version of this paper. The research described in the paper was supported by a grant from GWA Ltd. and a Special Projects Grant from the University of Queensland.

9. REFERENCES

Bentler, P. M. "Comparative Fit Indexes in Structural Models." *Psychological Bulletin*, Volume 107, Number 2, 1990, pp. 238-246.

Bentler, P. M. *EQS Structural Equations Manual*. Los Angeles: BMDP Statistical Software, 1992.

Bentler, P. M., and Bonett, D. G. "Significance Tests and Goodness of Fit in the Analysis of Covariance Structures." *Psychological Bulletin*, Volume 88, Number 3, 1980, pp. 588-606.

Bentler, P. M., and Chou, C.-P. "Practical Issues in Structural Modeling." *Sociological Methods & Research*, Volume 16, Number 1, August 1987, pp. 78-117.

Boynton, A. C.; and Zmud, R. W. "Information Technology Planning in the 1990s: Directions for Practice and Research." *MIS Quarterly*, Volume 11, Number 1, March 1987, pp. 59-71.

Cook, T. D., and Campbell, D. T. *Quasi-Experimentation: Design and Analysis Issues for Field Settings*. Chicago: Rand McNally, 1979.

Fornell, C., and Larcker, D. F. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error." *Journal of Marketing Research*, Volume 18, February 1981, pp. 39-50.

Hann, J., and Weber, R. "Information Systems Planning: A Model and Empirical Tests." *Management Science*, forthcoming.

Jensen, M. C., and Meckling, W. R. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics*, Volume 3, October 1976, pp. 305-360.

Long, J. S. *Covariance Structure Models: An Introduction to LISREL*. Beverly Hills, California: Sage Publications, 1983.

Segars, A. H. "Scale Development in Information Systems Research: A Paradigm Incorporating Unidimensionality and its Assessment." In J. I. DeGross, S. L. Huff, and M. C. Munro (Editors), *Proceedings of the Fifteenth International Conference on Information Systems*, Vancouver, British Columbia, 14-17 December 1994, pp. 1-12.

Sullivan, C. Jr. "Systems Planning in the Information Age." *Sloan Management Review*, Volume 26, Number 2, Winter 1985, pp. 3-12.

Williamson, O. E. *The Economic Institutions of Capitalism*. New York: Free Press, 1985.

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