SUCCESSFUL EXECUTION OF PRODUCT DEVELOPMENT PROJECTS: THE EFFECTS OF PROJECT MANAGEMENT FORMALITY, AUTONOMY AND RESOURCE FLEXIBILITY

MOHAN V. TATIKONDA
Kenan-Flagler Business School
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599-3490
mohan_tatikonda@unc.edu

STEPHEN R. ROSENTHAL
Boston University School of Management

ABSTRACT

We investigate project management methods used during the execution phase of new product development projects. Hierarchical moderated regression tests on a 120-project sample show formality, autonomy and resource flexibility are singly and collectively associated with project execution success, suggesting firms can indeed "balance firmness and flexibility" in product development.

INTRODUCTION

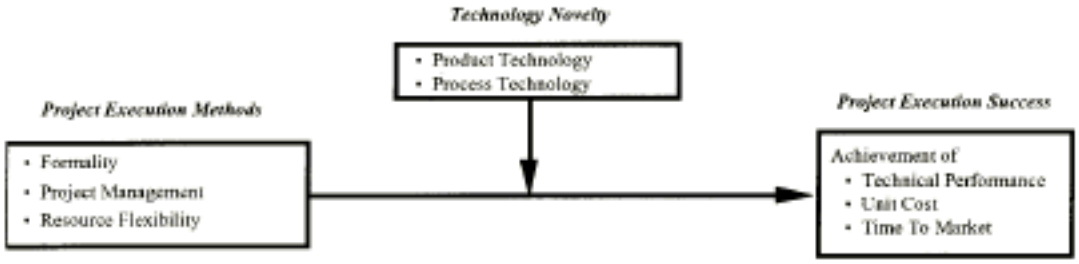
New product development is not a series of predictable steps that can be fully identified and planned in advance. For many product development projects, particularly those with some non-trivial level of technology uncertainty, the resulting capabilities of the product and the exact means to achieve the product are not known with certainty at the start of the development project. Due to the limitations inherent in project planning for product development projects, product development managers must also focus attention on managing the project during its execution to adapt to uncertainties as they arise and to assure a consistent project-oriented focus of the multiple resources. This requires a shift from thinking solely about detailed project planning to also considering the context within which the project work is accomplished, that is, project execution. In the field we observed a variety of approaches applied by project managers to manage project execution. A recurring, problematic challenge was in determining the degree to which to apply a formal process to the project, while allowing leeway to conduct project work. Practitioners really had a difficult time "balancing firmness and flexibility" in project execution.

We address two research questions. First, "how do the project execution methods of project management formality, autonomy and resource flexibility influence the execution success of product development projects?" Second, "does the newness of the technology to be developed during the project influence the strength of the relationship between project execution methods and project execution success?" Answering these questions helps us: understand whether these approaches should be adopted in practice; gain insight into the perplexing "firmness and flexibility" issue; and understand whether these project execution methods are most effective for specific project types or a variety of projects.

CONCEPTUAL FRAMEWORK

The conceptual framework (Figure 1) addresses three methods that project managers may employ, either singly or collectively, to achieve greater project execution effectiveness in new product development projects. Formality refers to existence of an overall process and structure for the project. Project management autonomy and resource flexibility refer to adaptability during the project to meet emerging circumstances, and represent the discretion available to the project management. We hypothesize that these factors have a positive, direct relationship with project execution success. We also hypothesize that the degree of product and process technology novelty incurred in the project influences the relationship between project execution methods and project execution success; that is, technology novelty has a moderating effect. Project execution success is a weighted sum of the degree of achievement of each of the three central project objectives (technical performance, product unit-cost, and time-to-market), where the weights are based on the relative importance of each objective for the given project. The hypotheses are grounded in our prior field observations and literature on project management, organizational information processing theory, organizational design and product development.

Figure 1. Conceptual Framework of Execution Effectiveness in Development Projects



Formality represents the use of rules, policies and procedures to administer organizational activity. A work process with controls and reviews provides a sense of structure and sequence to the work, reducing ambiguity for project personnel regarding what to work on and when. Rules and reviews can provide both motivation and a sense of accomplishment. These procedures allow earlier surfacing and resolution of potential problems, and so reduce overall elapsed time and work effort. Formality can cause personnel to adopt a project-focus (a "collective orientation") rather than solely a departmental focus. One complaint against formality is that too much time can be spent preparing for the reviews, conducting reviews and following rules, detracting from accomplishment of "real" work. It is argued that excessive formality may reduce flexibility by forcing project execution in one pre-determined manner, rather than allowing the adaptability necessary to cope with uncertainties that arise in development projects as new market information becomes available, or as unanticipated technological problems arise.

> **Hypothesis 1**: Projects having a greater degree of project formality have higher levels of project execution success.

Autonomy is the degree to which an organization is responsible for and has discretion regarding work activities and job-related decisions. Autonomy facilitates creativity in solving problems. Autonomy supports during-project learning and adaptation to problems as they emerge, allowing refocus of resources and energy to the uncertainties. This reduces wasteful effort and time delays, helping achieve technical objectives and a speedier development. Due to the uncertainty inherent in product development projects, project management needs some flexibility during project execution to adjust to emerging needs of the project and to take advantage of increasing knowledge about the nature of the project. Project management must also have the discretion to make resource adjustments to cope with emerging and unexpected problem areas, and to reduce the resources allocated to areas that no longer need attention. Such resource flexibility cuts across functional boundaries and is a means of dynamic matching of available resources to necessary work requirements.

> **Hypothesis 2:** Projects having a greater degree of project management autonomy have higher levels of project execution success.

> **Hypothesis 3:** Projects having a greater degree of resource flexibility have higher levels of project execution success.

Organizational information processing theory explains that organizational "tasks," such as product development projects, vary in their level of uncertainty. Uncertainty represents lack of knowledge about the exact means to accomplish the task. Tasks having higher uncertainty require greater information processing during the execution of the task than tasks having lower uncertainty. "Organic" organizational approaches provide greater information processing capacity to the organization, while "mechanistic" approaches provide less. Therefore, in order to be successful, tasks with high uncertainty should be executed using organic organizational approaches, while tasks with low uncertainty are accomplished most efficiently with mechanistic organizational approaches. Technology novelty is a major contributor to task uncertainty. Per theory, formality is a mechanistic approach, and project management autonomy and resource flexibility are organic approaches. Therefore, projects having lower technology novelty (lower task uncertainty) should benefit more from formality, and projects having higher technology novelty (higher task uncertainty) should benefit more from project management autonomy and resource flexibility.

> **Hypothesis 4:** The positive relationship between project formality and project execution success is weaker in projects having higher technology novelty than in projects having lower technology novelty.

> **Hypotheses 5, 6:** The positive relationship between project management autonomy/resource flexibility and project execution success is stronger in projects having higher technology novelty than in projects having lower technology novelty.

METHODS

A cross-sectional, stratified-sample, mail survey methodology was employed. The unit of analysis is a development project for an assembled product. We received 120 usable surveys (from 57 companies) representing 23% participation. The questionnaire was completed by a project man-

ager who was with the project from beginning to end, had interacted with both upper management and project personnel, and had a significant technical understanding of the product. The average respondent had 15 years of product development experience.

We adapted existing organizational survey scales to the product development project context and also developed some new scales due to a lack of existing scales for the phenomena of interest. Scales underwent three waves of field pilot tests before full-scale survey administration to assure scale content and construct reliability and validity. All scales are multiple-item Likert-type. A simple average of the scale items was used as the scale measure. Factor analysis of the scale items showed that the predicted factors (variables) emerged. Principal components extraction with varimax rotation was employed. The Kaiser criterion was employed in conjunction with evaluation of scree plots. All multi-item scales are internally reliable per the Cronbach's alpha statistic. Studies of product development routinely employ retrospective methods due to research feasibility reasons. Concerns about retrospective bias and common methods variance were in part ameliorated through careful instrument development in terms of question wording and sequence.

RESULTS

We employed hierarchical moderated regression analysis, following variance partitioning procedures outlined by methodologists. Three "separate" and one "composite" hierarchical regressions were created. The separate regressions each addressed one project execution method and its two technology novelty interactions, while the composite regression addressed all three project execution methods and their six technology novelty interactions. For space purposes here we present only the composite regression results (see Table 1), which are fully consistent with the results of the separate regressions. The hierarchical procedure first entered the control variable, then entered project execution methods variables as a block, then entered the two technology novelty variables as a block, and then the six interaction terms as a block. To mitigate any potential multicollinearity we employed deviation scores for each predictor variable and for calculation of cross-products (the value of the moderator variable is the product of the centered component variables). Acceptable variance inflation factors were found.

The three project execution main effects are highly positively significant (see the step 2 regression of Table 1). This strongly supports hypotheses 1, 2 and 3 that use of the project execution methods is associated with project execution success. The interaction terms have non-significant betas, and the incremental F for the block of interaction terms is also not significant (see the step 4 regression). There is no evidence of moderation. Accordingly, hypotheses 4,5 and 6 are not supported, suggesting that technology novelty does not influence the strength of the relationship between given project execution methods and project execution success.

DISCUSSION AND IMPLICATIONS

In responding to the uncertainty posed by new product development projects, a key issue project managers face is that of balancing "firmness and flexibility" in the execution of product development projects. Based on the results, and in contradiction to traditional organizational information processing theory, we believe that firmness and flexibility are different roles that are compatible together. Firmness is achieved through project management formality which provides an overall

Table 1. Hierarchical Regression with Execution Methods and Technology Interactions

Variables Entered	Step 1	Step 2	Step 3	Step 4
Project Priority	-.077	-.205**	-.182*	-.185*
Formality		.240***	.245***	.250***
Project Management Autonomy		.192**	.200**	.214**
Resource Flexibility		.179*	.185*	.179*
Product Technology Novelty			.026	.008
Process Technology Novelty			-.137	-.124
Formality x Product Technology Novelty				-.046
Formality x Process Technology Novelty				.052
Project Management Autonomy x Product Technology Novelty				.044
Project Management Autonomy x Process Technology Novelty				.048
Resource Flexibility x Product Technology Novelty				-.006
Resource Flexibility x Process Technology Novelty				-.014
Intercept	4.759****	5.209****	5.129****	5.135****
F for the step	.702	6.809****	1.043	.177
F for the regression	.702	5.308****	3.889****	1.948**
R^2	.01	.16	.17	.18

1. dependent variable is Project Execution Success
2. n = 120
3. main table contains standardized coefficient betas
4. **** p <= .001; *** p <= .01; ** p <= .05; * p <= .1

control and review structure for the project. Flexibility is achieved by project management autonomy and resource flexibility which allow somewhat unfettered means to get work done and respond to emerging project problems. Effective product development execution requires organizational flexibility within a structure; that is, firmness in the sense of having a predetermined structure, and flexibility in the nature of work within that structure.

The finding that the project execution effectiveness of formality, project management autonomy and resource flexibility is not significantly influenced by technology novelty is counter-intuitive. The findings suggest that the project execution methods are equally effective for product development projects of high or low technology novelty. Prior studies have empirically confirmed contingent relationships between organizational factors and innovative tasks; however, these studies considered a wide range of innovative activity from maintenance tasks and engineering-change orders (highly certain tasks) to pure "breakthrough" scientific research projects (highly uncertain tasks). In contrast, the present study conducts contingent tests of project execution methods specifically for product development projects. We now see that product development projects take up a narrower range in the center of that full innovative spectrum, and have limited variation in task uncertainty relative to the variation inherent in the broad spectrum of innovative tasks. Organizational information processing theory requires broad variation in the task uncertainty dimension for contingent effects to be shown. That is, different product development projects are "not different enough" in their task uncertainty to gain benefits from different project execution methods. Practically, this suggests firms can manage many product development projects in a broadly similar fashion: project execution could be straightforward, using similar project execution methods in all projects. This also suggests that the application of organizational information processing theory in the product development project context has limited explanatory value.

Future research should determine how firms can efficiently adopt, utilize, evaluate, and continuously improve the project execution methods. Future investigation should address the contingent results findings through replication studies, and through studies to confirm whether, from the perspective of information processing theory, product development projects are in fact largely similar.

CONCLUSIONS

This paper aimed to contribute to both the new product development and project management literatures by providing a large sample, cross-sectional, confirmatory test of the effectiveness of selected project execution approaches in achieving product development project execution success. We found that there are ways to better manage product development projects through both formality and flexibility. In addition, we hope this study contributes to motivating a renewed research emphasis, including theory development, on project execution.