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Antecedents and Consequences of Information Technology Usage in NPD: A Comparison of Dutch and U.S. Companies*

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This study examines information technology (IT) usage for new product development (NPD) in a global context. Specifically, this research seeks to ascertain the factors that influence IT usage and the relationship between IT usage and new product performance in two different countries—the United States and the Netherlands. The interest here is in discovering if, and how, these relationships may be different depending on the country within which the NPD effort is undertaken. Employing a mail survey methodology, the present study uses data from a sample of U.S. practitioner members from the Product Development & Management Association (PDMA) and new product managers from Dutch manufacturing companies to examine the effect of IT infrastructure, IT embeddedness, NPD process formalization, colocation, outsourcing of NPD projects, and length of time on the job on the extent of IT usage. The data are also used to explore the impact of IT usage on speed to market and market performance. The results indicate that IT embeddedness and NPD process formalization positively influence IT usage in both the United States and the Netherlands. Colocation and length of time on the job are negatively associated with IT usage only in Dutch firms. Similarly, outsourcing of NPD projects is positively related to IT usage only in U.S. firms. Finally, IT usage has a positive relationship with speed to market in the Netherlands and with market performance in the United States. An important implication of the present study is that IT usage does impact speed to market and market performance, confirming anecdotal evidence. However, these relationships are not the same in each country. Moreover, the antecedents to IT usage also vary by country. Thus, the precursors and consequences of IT usage in NPD are context specific. Another implication of this research is that unless IT is embedded into the NPD process, it is unlikely that the benefits of IT will come to fruition. Finally, this study suggests that as firms use more globally dispersed teams for NPD and outsource more of their development activities, IT usage is likely to increase to facilitate communication and cooperation.

Introduction

Information technology (IT) plays an important role in supporting the strategic goals of an organization. One source of value of IT to the firm is through the creation of new business processes (or the rehabilitation of existing ones), including the innovation process (Dewitt and Jones, 2001; Farrell, 2003; Sambamurthy and Zmud, 2000; Weill, Subramani, and Broadbent, 2002). Specifically, IT can enhance the base of knowledge available to a new product development (NPD) team, can automate particular tasks, and can improve coordination, communication, and cooperation among team members (Dewitt and Jones, 2001) leading, presumably, to cost and time

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reductions and productivity gains (Farrell, 2003; Menon, Chowdhury, and Lukas, 2002).

Unfortunately, empirical evidence regarding these latter claims is confusing and contradictory. For example, though some studies find a positive relationship between the use of particular IT tools (e.g., computer-aided design/computer-aided mechanics/computer-aided engineering [CAD/CAM/CAE]) and speed to market (Carmel, 1995; Thomke, 1998), others find a negative association (Kessler and Chakrabarti, 1999). Further, research on the use of a broad number of IT tools finds no relationship between IT usage and speed to market (Barczak, Sultan, and Hultink, 2007; Durmuşoğlu, Calantone, and Sambamurthy, 2006) but a positive relationship between IT and market performance (Barczak et al., 2007).

This lack of clear evidence regarding the business value of IT may be why the usage of IT, particularly for business processes such as NPD, appears limited (Adams-Bigelow, 2004; Barczak and Sultan, 2006; Bowden, 2004). This is in spite of the proliferation of IT tools and the financial investments firms have made in their IT systems (Barczak and Sultan, 2006; Bowden, 2004).

What are the factors, then, that influence the use of IT? One factor that has been the basis of a number of studies is IT infrastructure (Broadbent, Weill, and St. Clair, 1999; Domegan, 1996). Domegan (1996) noted that IT infrastructure (i.e., number of computers, degree of network connectivity, and availability of software applications) correlates positively with IT use in marketing processes in Irish manufacturing companies. Similarly, Broadbent et al. (1999) found that IT infrastructure had an important impact on the implementation of business processes in Australian firms. Infrastructure is only one element, though, that is likely to impact IT usage (Barczak et al., 2007). However, an in-depth examination of antecedents to IT usage is lacking.

Adding to this deficiency, research on information and communication technologies (ICT) has been criticized for lacking cultural sensitivity (Stohl, 2001). This is true in spite of the evidence that ICTs are used differently from country to country, particularly in those with dissimilar national cultures (Sornes et al., 2004).

Thus, the focus of the present study is to examine the antecedents to and consequences of IT usage and ascertain if, and how, these relationships may be different depending on the country within which the NPD effort is undertaken. To pursue this research question, firms from a small, developed Western European country (i.e., the Netherlands) were targeted as well as firms from the United States. The present analyses shed light on if and how country of origin affects the antecedents and consequences of IT usage.

These two countries were selected because they share similarities and differences according to Hofstede and Hofstede's (2005) five dimensions of national culture. Specifically, the United States and the Netherlands are similar with regard to power distance, uncertainty avoidance, and individualism and are dissimilar in terms of masculinity and long-term

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Table 1. Country Culture Dimensions[a]

Dimensions	United States	The Netherlands
Power Distance	40	38
Uncertainty Avoidance	46	53
Individualism	91	80
Masculinity	62	14
Long-Term Orientation	29	44

[a] All numbers are on a 100-point scale. Numbers are taken from Hofstede and Hofstede (2005).

orientation (Hofstede and Hofstede, 2005; Table 1 shows culture scores). Power distance reflects the amount of social stratification within a country. Uncertainty avoidance measures the tendency of the culture to avoid risky situations. Individualism refers to the predominance of individual values over group values. Masculinity measures the importance placed on tough and aggressive behavior. Finally, long-term orientation reflects values oriented toward future rewards, perseverance, and thrift (Hofstede and Hofstede, 2005). These cultural similarities and differences between the two countries make it unclear as to whether they will be similar or different with regard to the antecedents and consequences of IT usage. Research on adoption/diffusion indicates that differences in adoption can be explained by country specific variables (Kumar, Ganesh, and Echambadi, 1998; Sornes et al., 2004). Yet Song et al. (2007) found no substantial differences between the United States and the Netherlands in their study of the effect of IT on knowledge dissemination. The present study seeks to clarify our understanding of country context on IT usage and new product performance.

The contributions of this research are threefold. First, as an initial cross-cultural empirical study to examine IT usage in NPD, it represents a direct response to the argument that there is a need to "learn as much as we can about the effects of culture on ... IT adoption and use" (Straub, 1994, p. 24). By so doing, it will provide insight into if and how national culture impacts IT usage and new product performance. Second, the present study explores previous antecedents as well as new, additional antecedents to IT usage to help identify factors that impact IT usage. Care has been taken to include antecedents that may be more applicable to a cross-cultural study. Finally, results from this investigation can better inform new product managers regarding actions they can take to increase the usage of IT and how these actions may need to vary from country to country.

This paper is organized as follows. First, it presents a conceptual framework and literature to support the development of the hypotheses. Next, the samples are described, and research methodology is explained. Subsequently, the paper presents the analysis and results of the study. The last section discusses the implications and limitations of the research and provides direction for future research in this area.

Conceptual Framework and Hypotheses

Figure 1 presents this study's conceptual model proposing that six antecedents are related to IT usage and that IT usage will have a direct effect on new product performance. These six antecedents were chosen as they are considered important in the literature with regard to influencing adoption/use of new products (Barczak et al., 2007; Goodman et al., 1994; Grover, 1993; Ozer, 2000; Ragatz, Handfield, and Scannell, 1999; Sharma and Rai, 2003). Moreover, IT research suggests that cultural differences can and do influence adoption (Sornes et al., 2004). However, only one dimension, uncertainty avoidance, has been found to clearly predict adoption of communication technologies (Hofstede, 2000; Maitland, 1999). Since the United States and the Netherlands score similarly (medium-low) on this dimension of national culture, and in the absence of any evidence otherwise, all hypotheses are presented as being the same for both countries.

Antecedents to IT Usage

IT infrastructure. IT infrastructure has been defined as the computer hardware, software, and people needed to support the distribution of IT tools within an organization. It also includes the extent of sophistication of the infrastructure (Sethi, Pant, and Sethi, 2003). Evidence exists that infrastructure elements such as number of computers, degree of connectivity, and availability of software applications are positively correlated with the use of IT for marketing

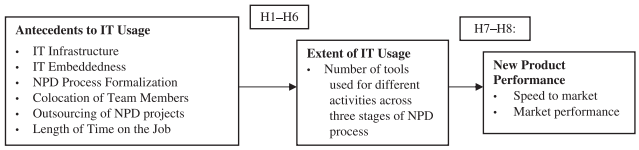

Figure 1. Conceptual Model

(Domegan, 1996). With specific regard to NPD, a strong IT infrastructure enables research and development (R&D) (Weill et al., 2002), facilitates continuous improvement of existing products (Duncan, 1995), and enhances coordination across various functional groups (Keen, 1991).

In the IT literature, national culture and lack of a technical infrastructure have been found to impede the diffusion of IT networks (Goodman et al., 1994). Moreover, the accessibility of communications infrastructure plays an important role in explaining cross-cultural differences in internet access (Bauer, Berne, and Maitland, 2002). By contrast, Barczak et al. (2007) reported that IT infrastructure had no relationship to IT usage, contradicting previous conceptual work (cf. Sethi et al., 2003). The inconsistency of these results implies the need for further examination of the role of IT infrastructure in IT usage and performance. Despite previous findings (Barczak et al., 2007), it seems logical that firms with a sophisticated IT infrastructure would provide all NPD personnel with access to the same IT tools and provide human resource support for the infrastructure. The existence of the infrastructure would facilitate quick and easy sharing of project-related information among team members. Thus, it is posited that a sophisticated IT infrastructure is necessary for high levels of IT usage for NPD efforts in both countries.

H1: The more sophisticated the IT infrastructure, the higher the IT usage in NPD projects.

IT embeddedness. Embeddedness is the degree to which IT tools play a critical role in the sharing of information among project team members and facilitate the integration of the team's activities (Sethi et al., 2003). Put another way, embeddedness reflects the level to which IT has been entrenched into business activities such as NPD and aids in improving the effectiveness of those activities (Armstrong and Sambamurthy, 1999). For IT to yield value, it must become a routinized component of people's work and a firm's business processes (Boynton, Zmud, and Jacobs, 1994; Thomke, 2006). High embeddedness implies that firms have integrated IT tools into their NPD process (Sethi et al., 2003) and thus are more likely to use those tools.

It is important to note that IT embeddedness and IT usage are not equivalent. The primary distinction between the two concepts pertains to the degree of routinization of IT tools into the NPD process. When IT tools are embedded into the NPD process, utilization of such tools is likely to be determined by the organization and the process itself. Thus, the tools are routinized into product development activities. On the other hand, individual team members or project teams may use particular IT tools for a variety of reasons including to experiment with new tools or to improve project efficiency and effectiveness. In such cases, usage of these tools is independent of what the organization requires in terms of the formal NPD process.

Previous research indicates that IT embeddedness has a positive influence on the extent of IT usage for NPD (Barczak et al., 2007). This suggests that embeddedness enables project team members to have some degree of familiarity with particular IT tools and an understanding of which tools are appropriate for specific activities. Moreover, high levels of embeddedness likely result in team members using the tools in most, if not all, projects. Thus, it is argued for both countries:

H2: The greater the embeddedness of IT in the firm, the higher the IT usage in NPD projects.

NPD process formalization. Research on the relationship between formalization and innovation adoption is mixed. Some research has found a negative relationship between well-documented procedures and adoption (Zaltman, Duncan, and Holbek, 1973); others note a positive association (Moch and Morse, 1977); and still others conclude that there is no relationship (Grover, 1993; Grover and Goslar, 1993).

Cooper, Edgett, and Kleinschmidt (2002) argued that eight activities including idea generation, concept testing, voice of the customer research, product and market testing, and business analysis have the greatest impact on new product performance, yet these are often the least well executed. IT tools such as idea generation and survey software, CAD systems, and the Internet could help firms implement these activities more proficiently. In fact, firms with a formal NPD process have been found to make greater use of NPD tools and techniques (Nijssen and Frambach, 2000). Thus, the hypothesis states,

H3: The more formal the NPD process, the higher the IT usage in NPD projects.

Colocation of team members. Colocation implies the bringing together of individuals from different functional areas into the same physical location

(Kahn and McDonough, 1997). For the complex communication involved in product development to evolve rapidly and effectively, close physical location of development team members is preferable (Moenaert and Caeldries, 1996). Pinto and Pinto (1990) found that the proximity of team members is significantly related to cooperation, perhaps as a result of the frequency and nature of interactions brought about by physically colocating them (Hershock, Cowman, and Peters, 1994). Greater interaction between members of an NPD team can enhance innovation adoption (Zaltman et al., 1973) as informal communication helps to spread information about an innovation that may positively influence the probability of adopting and using that innovation.

However, many companies today are developing products across organizational, cultural and geographic boundaries (Boutellier et al., 1998). Developing effective communication between individuals separated in such ways is quite complicated (Littler, Leverick, and Bruce, 1995). IT tools, such as the Internet, increase the communication and cooperation of team members who reside in different geographic locations and enhance coordination due to enhanced communication and information exchange capabilities (Ozer, 2000). McGrath and Iansiti (1998, p. 8) argued that IT is "progressively enabling remote collaborative development." They foresaw a time (true today) when geographically separated NPD personnel would have group conversations over linked computers, would simultaneously collaborate on documents, and would jointly view online presentations. Similarly, Ozer (2000) provided examples of companies that use IT to coordinate the NPD activities of team members who reside in different locales. Based on the above evidence, the next hypothesis is as follows:

H4: The lower the percentage of team member colocation, the higher the IT usage in NPD projects.

Outsourcing of NPD projects. Firms cannot rely simply on their own internal knowledge base when developing new products since their routines constrain departures from well-known paths (Nelson and Winter, 1982) and hinder innovation (Henderson and Clark, 1990). Suppliers' early involvement in the development process and their high level of responsibility for product design leads to faster speed to market and lower costs (Clark and Fujimoto, 1991). However, exploiting the potential of a supplier requires integration of the operations of the two companies. This involves extensive communication, coordination, and adaptation of resources (Gadde and Snehota, 2000). Common and linked information systems (e.g., e-mail, CAD/CAM, databases) have been found to be a significant differentiator between successful and less successful efforts for integrating suppliers into the NPD process (Ragatz et al., 1999). Thus, the next hypothesis states,

H5: The greater the percentage of NPD projects outsourced, the higher the IT usage in NPD projects.

Length of time on the job. Job tenure refers to the length of time an individual has been in a particular job. An individual who has been in the organization for a long period of time and has been in his or her job for a long time will have increased functional or political knowledge (Sharma and Rai, 2003). However, individuals who are older and have longer tenure tend to take fewer risks and are less innovative than those who are younger and have shorter tenure (ibid.). In the innovation literature, job tenure has generally not been found to be related to adoption (Damanpour, 1991). One exception to this is a study by Sharma and Rai (2003) that found that adopters of computer-aided software engineering had shorter job tenure (4.7 years) than those in nonadopter organizations (8 years). In concurrence with this latter research, the following hypothesis is,

H6: The shorter the job tenure, the higher the IT usage in NPD projects.

Effect of IT Usage on New Product Performance

New product performance consists of two measures: speed to market and market performance.

Speed to market. Speed to market reflects whether the new product was developed faster than similar products developed by the organization and its competitors. Prior conceptual work suggests that greater usage of IT tools increases the speed with which products are launched into the marketplace (Bowden, 2004; Menon et al., 2002; Ozer, 2000; Sethi et al., 2003). For example, it has been argued that IT can improve the speed of information processing and distribution among project team members and can facilitate the collection and analysis of various types of market data (Menon et al., 2002).

Empirical research on this issue is contradictory, however. Some NPD research based on U.S. companies and those from other countries shows that IT tools such as CAD/CAE can decrease the amount of time it takes to get a product to market (Carmel, 1995; Thomke, 1998; Sanchez and Perez, 2003). Other studies indicate that the use of such tools actually lengthens the time to market (Kessler and Chakrabarti, 1999). Still other research found that the extent of IT usage had no relationship with speed to market (Barczak et al., 2007; Durmuşoğlu et al., 2006). Given these conflicting results and the plethora of conceptual work suggesting a positive relationship between IT and speed to market, it seems plausible to hypothesize the following:

H7: Greater usage of IT tools during the development of a new product project will lead to faster speed to market.

Market performance. Market performance is defined as the degree to which the new product meets expectations with regard to sales, market share, profitability, and customer satisfaction (Sarin and Mahajan, 2001). Findings regarding investments in IT and firm performance (Osei-Bryson and Ko, 2004) are mixed. Though some studies have found a positive, direct association between IT investments and performance, others have found no direct relationship (ibid.). Evidence does exist supporting a positive, significant relationship between IT usage and financial and quality performance (Devaraj and Kohli, 2003). Recent research also maintains that IT usage is positively related to the market performance of a new product (Barczak et al., 2007). These findings intimate that IT tools can enable project teams to collect, share, and utilize important market information (Ozer, 2000; Teo and Choo, 2001), thereby enhancing the quality of the decisions made with regard to the new product (ibid.). Therefore, it is predicted that greater IT usage will result in higher market performance of the new product in both countries.

H8: Greater usage of IT tools during the development of a new product project will lead to higher market performance.

Method

In the United States, the mailing list of the Product Development & Management Association's (PDMA's) practitioner members was used to solicit the sample. The 1,371 respondents held titles such as director, manager, and project/program manager. All respondents were asked to use a new product or service launched within the past two years as the basis for completing the survey. After eliminating incomplete surveys, a total of 212 surveys were utilized, resulting in a 15.5% response rate.

In the Netherlands, a database of Dutch manufacturing companies was used as the sampling frame. Phone calls were made initially to secure companies to participate in the survey. Mail surveys were then used for data collection. The U.S. survey was translated into Dutch and then back into English to ensure consistency in the items and scales. There were 118 usable surveys from Dutch NPD managers in engineering, R&D, and marketing received. Table 2 provides some summary statistics on both country samples.

IT usage was measured by providing respondents with a table that listed numerous IT tools used for communication and collaboration, product development, project management, information and knowledge management, and market research and analysis. Different tools were presented for each activity: for example, e-mail and Web meetings for communication and collaboration; product design and NPD process tools for product development; scheduling software and tracking projects for project management; Excel/Access databases and shared drives/project rooms for information and knowledge management; and secondary data and online needs surveys for market research and analysis. For the project chosen, respondents were asked to check the tools used for each activity across each of three stages of the NPD process (i.e., fuzzy front end, development and

Table 2. Sample Characteristics (Mean Values)[a]

	United States	The Netherlands	T-test *p*-value
Speed to Market	2.56	2.90	$p < .01$
Market Performance	3.32	3.24	$p = .32$
IT Infrastructure	3.49	3.53	$p = .74$
IT Embeddedness	3.20	3.65	$p < .01$
IT Usage	26.79	20.74	$p < .01$
NPD Process Formalization	3.91	3.32	$p < .01$
%Colocation Team Members	67.94	77.00	$p < .01$
%Outsourcing NPD Projects	30.07	22.73	$p < .05$
Length of Time on Job (months)	56.64	69.44	$p < .10$

[a] Note: Speed to Market, IT Infrastructure, and IT Embeddedness were measured on a 5-point scale where 1 = strongly disagree and 5 = strongly agree; Market Performance was measured on a 5-point scale where 1 = far below expectations and 5 = far above expectations.

testing, launch). If a particular tool was not used, respondents were instructed to leave that box blank. The number of checks for each respondent was summed for all tools in all activities across each stage of the NPD process to calculate the extent of IT usage. This approach has been used in prior IT research (Grover and Goslar, 1993; Moch and Morse, 1977). The Appendix provides the items for all variables in the study.

Four variables in the study were measured with multi-item scales (i.e., IT infrastructure, IT embeddedness, speed to market, and market performance). Principal components analyses (PCAs) were conducted to obtain initial insights into the dimensionality and underlying structure of the items of each measurement scale. The scales were purified using an eigenvalue of 1.0 and factor loadings of 0.50 as the cutoff points. Next, a series of confirmatory factor analyses (CFAs) was performed to test the measurement scales on their unidimensionality. For each scale, one-factor models were fitted to the data and items that were not unidimensional were dropped until a satisfactory fit was achieved. Finally, a CFA was performed on all four constructs simultaneously using LISREL 8.8 (Scientific Software International, Lincolnwood, IL, 2008). The final CFA models containing 14 indicators in the United States and 16 items in the Netherlands revealed good fits in the United States ($\chi^2_{(71)} = 113.34$; χ^2/d.f. = 1.60; root mean square error of approximation [RMSEA] = 0.05; goodness-of-fit index [GFI] = 0.93; non-normed fit index [NNFI] = 0.96; comparative fit index [CFI] = 0.97) as well as in the Netherlands ($\chi^2_{(98)} = 123.23$; χ^2/d.f. = 1.26; RMSEA = 0.05; GFI = 0.88; NNFI = 0.95; CFI = 0.96). The significant factor loadings demonstrated convergent validity, while composite reliabilities (CRs), Cronbach's alphas, and average variance extracted (AVE) estimates exceeded the minimum thresholds for all measures. All scales demonstrated adequate discriminant validity by meeting the criterion that the square of the correlation between two constructs should be less than the AVE estimates of both constructs (Fornell and Larcker, 1981). An examination of whether a one-factor model fit the data better than the hypothesized two-factor model for each pair of constructs was also conducted. In each case, the chi-square of the constrained one-factor model was significantly greater than the chi-square of the two-factor model, also indicating discriminant validity for all constructs.

Potential concerns about common method bias were alleviated by conducting a Harman's (1967) one-factor test in which all variable items were entered into a single PCA. The results showed that neither a single factor nor a general factor accounted for the majority of the covariance in the items. Thus, the constructs were formed by averaging the responses to all remaining items in a particular scale. Table 3 reports the interconstruct correlations for all variables in both countries.

Results and Discussion

The present study's hypotheses were tested with a series of regressions. Overall, the results indicate that 4 of 6 antecedents were significantly related to IT usage in the Netherlands and 3 of 6 in the United States.

Table 3. Correlation Matrix and Descriptive Statistics of Measures[a]

Variables	1	2	3	4	5	6	7	8	9
(1) Speed to Market	N.A.	.29*	.20*	.18*	.03	.04	.08	.19*	.16*
(2) Market Performance	.21*	N.A.	.05	.15*	.27*	.15*	.14*	.09	.15*
(3) IT Infrastructure	.04	.06	N.A.	.38*	.22*	.17*	.00	.01	.11
(4) Embeddedness of IT	.13	.12	.27*	N.A.	.43*	.17*	−.03	.09	.11
(5) IT Usage	.20*	.13	.22*	.41*	N.A.	.28*	.01	.20*	−.01
(6) NPD Process Formalization	.11	.11	.26*	.17	.30*	N.A.	.05	.03	.09
(7) Colocation	−.17	−.14	.10	.09	−.20*	.07	N.A.	.05	−.02
(8) Outsourcing of NPD Projects	.03	.08	−.06	.19*	.25*	.23*	−.21*	N.A.	−.08
(9) Length of Time on Job	.02	−.16	.04	−.09	−.23	.01	−.05	−.01	N.A.
Coefficient α United States	0.74	0.76	0.89	0.86	N.A.	N.A.	N.A.	N.A.	N.A.
Coefficient α Netherlands	0.70	0.81	0.80	0.79	N.A.	N.A.	N.A.	N.A.	N.A.
Number of Items United States	3	4	4	3	N.A.	1	1	1	1
Number of Items Netherlands	4	6	3	3	N.A.	1	1	1	1

[a] Entries above the diagonal refer to the U.S. sample and those below the diagonal to the Dutch sample; number of items remaining after purification.
* $p < .05$.

Additionally, the regression models examining the effect of the antecedents on the extent of IT usage were significant for both countries.

Table 4 shows that embeddedness of IT and the formalization of the NPD process improve IT usage both in the Netherlands as well as in the United States (confirming H2 and H3). The positive relationship between IT usage and the degree to which IT is embedded in the NPD process of the organization highlights the importance of IT integration. IT integration and embeddedness, in turn, is necessary if IT is to be used to its maximum advantage (Thomke, 2006). The positive relationship between a formalized NPD process and IT usage suggests that project teams use IT tools to effectively implement their NPD process. As Cooper et al. (2002) showed, many activities important to new product performance are not executed with proficiency. It seems likely that particular IT tools can correct this gap between having a process and implementing it effectively.

Team-member colocation and length of tenure on the job were negatively associated with IT usage in the Dutch sample but not in the U.S. sample, thus partly supporting H4 and H6. The Dutch respondents had been in their jobs longer (69.4 months vs. 56.6 months), and a higher percentage of team members were colocated (77% vs. 68%) than in the United States. The finding on colocations supports previous research indicating that colocation makes communication easier and increases the chance that team members will engage in spontaneous conversations (Kraut, Egido, and Galegher, 1990). Similarly, the result on job tenure concurs with prior studies (Sharma and Rai, 2003). These results suggest that colocation of team members leads to more informal face-to-face communication whereas job tenure is associated with less risk taking by team members in terms of trying new IT tools, at least in the Netherlands.

The degree to which NPD projects are outsourced is positively related to IT usage in the U.S. sample but not in the Netherlands, partly confirming H5. A higher percentage of projects (30%) in the U.S. sample were outsourced in a given year compared with the Dutch sample (23%). Greater levels of outsourcing seem to require greater use of IT to enable communication and coordination efforts, especially in the United States.

IT infrastructure was not significantly related to IT usage, either in the Netherlands or in the United States, leading to a rejection of H1. This is surprising because recent IT literature suggests that lack of an IT infrastructure impedes diffusion (Goodman et al., 1994). One explanation may be that at least in terms of NPD, it is not the IT infrastructure but rather the NPD infrastructure (e.g., systems, processes, policies) that influences IT usage.

Next, the impact of IT on speed to market and market performance (Table 5) was investigated. Surprisingly, no relationship was found between IT usage and speed to market in the U.S. sample. A positive relationship was found in the Dutch sample, thereby partly confirming H7. One reason for these findings may be because the average size of Dutch teams was smaller than for U.S. NPD teams. This smaller size may have facilitated easier and faster communication and coordination through the use of IT tools. This study's results also show that IT usage is positively and significantly related to market performance in the United States but not in the Netherlands. Interestingly, these results hold true even though there is no significant difference in market performance between the United States and the Netherlands. There is, however, a significant difference

Table 4. Antecedents to IT Usage

	United States	The Netherlands
IT Infrastructure	.03	.09
IT Embeddedness	**.36***	**.35***
NPD Process Formalization	**.23***	**.21***
% Colocation Team Members	−.01	**−.28***
% Outsourcing NPD Projects	**.15***	.12
Length on the Job	−.05	**−.25***
R^2	.26	.41
Adjusted R^2	.24	.37
F-Value	11.24	11.62
p-Value	**.000***	**.000***
N	201	108

* $p < .01$.

Table 5. Consequences of IT Usage

	Speed to Market		Market Performance	
	United States	The Netherlands	United States	The Netherlands
IT Usage	.03	**.20***	**.27****	.13
R^2	.01	.04	.08	.02
Adjusted R^2	.00	.03	.07	.01
F-Value	.20	4.73	16.5	1.75
p-Value	.66	**.03***	**.000****	.19
N	210	112	212	112

* $p < .05$.
** $p < .01$.

between the two countries in IT usage, with the United States having a higher level of usage.

Managerial Implications

The present findings have several important implications for new product managers around the world. First, the results indicate that the degree to which IT is embedded in the organization and the NPD process positively impacts IT usage. This result supports previous arguments that unless managers take actions to routinize the usage of various IT tools, its benefits are unlikely to be realized (Thomke, 2006).

One way to embed IT and to enhance its usage in NPD efforts is to have a formal NPD process. A formal process has long been touted as being necessary for new product success; now it appears that it is also critical for increasing the use of IT tools to effectively implement the NPD process. For firms that still do not have a formal NPD process (about 26%; Cooper et al., 2002), this finding provides one more reason for them to develop and implement such a process. In fact, such firms may find that the application of specific IT tools to various activities and stages of the NPD process may actually encourage NPD personnel to use a formal NPD process. Similarly, for firms that have a process but do not use it (19%; Cooper et al., 2002), assimilation of particular IT tools into the process may facilitate more effective usage of the process itself.

Characteristics of the team also influence the extent of IT usage. Specifically, more colocation of team members and more time in the job for the project manager lead to lower IT usage, at least in the Netherlands. Recognition of these relationships may enable Dutch new product managers to manipulate these variables for a particular project, if possible, to increase the usage of IT tools. For example, a younger project leader should be selected if usage of more IT during the NPD process is a goal.

The degree of outsourcing of various NPD activities across projects also impacts the extent of IT usage, but only in U.S. teams. This suggests that as U.S. firms engage in more partnerships and outsource particular NPD activities, managers need to recognize that IT can be critical to sustaining and building these relationships as well as to ensuring effective product development. As a result, investments in specific IT tools to facilitate communication and cooperation may be required. In combination, these findings imply that as firms use more globally dispersed NPD teams and partner with other firms to develop new products, IT usage is likely to increase.

IT usage appears to impact both speed to market and market performance; however, the relationships are not the same in each country. Thus, the consequences of IT usage in NPD may be context specific. For example, in countries with smaller teams, such as the Netherlands, the impact of IT usage seems to be different than in countries with larger teams. Global firms that want to encourage the use of IT in NPD need to take these different contexts into account.

Limitations and Future Research

As with all research, this study has several inherent limitations. The first deficiency is the use of single informants in both countries. However, the respondents, on average, were in their job for about five years, which suggests that they were well qualified to report on the variables in the study.

Though this is the first empirical study to compare IT usage and new product performance in two different countries, care should be taken in generalizing the results to other countries and continents. Future research should explore these research issues by utilizing samples of firms from other countries across the globe, particularly countries that are more dissimilar on Hofstede and Hofstede's (2005) dimensions.

The antecedents selected for examination in this study represent only some of the potential precursors to IT usage in a global context. Based on adoption research (Grover, 1993), other forerunners might include size of the organization, competitive pressures, and senior management support. Future research should explore these and other antecedents to develop a more comprehensive perspective on the factors driving IT usage.

Not much research has investigated the use of specific IT tools for NPD in countries other than the United States (for an exception, see Sanchez and Perez, 2003). Insight into the usage of particular IT tools for NPD and how usage of such tools vary by country could aid developers of such tools to better target their marketing efforts.

Finally, the present parsimonious model ignores other factors that might influence IT usage as well as factors that may moderate the relationships in the model. Future research should develop a more complex model that can be tested through structural

equation modeling (SEM) to generate a more complete picture of the role of IT in NPD.

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Appendix: Items for Measures[a]

Measures and Sources	Description
Antecedents to IT Usage	
IT Infrastructure (New Scale)	This organization's computer data storage (e.g., servers, databases) is of high quality. This organization's intranet is of high quality. This organization's extranet is of high quality. The IT personnel who operate and support the IT infrastructure are well qualified to do so.[#] * In this project, we used the latest IT tools available.[#] * All product development personnel have access to the same IT tools used for new product development.[#] * The IT tools used for this project were appropriate for the NPD activities for which they were used.[#]
Embeddedness of IT (New Scale)	IT tools play a significant role in the development of new products in this organization. In this organization, IT tools play a significant role in managing the interdependence of different functions and groups during the development process. In this organization, IT tools play a significant role in the exchange and sharing of information amongst NPD project team members.
NPD Process Formalization (Griffin, 1997)	Please indicate the type of NPD process you used for product development: no process used; informal process; formal, sequential process; cross-functional, Stage-Gate®; cross-functional, facilitated Stage-Gate®; cross-functional third-generation Stage-Gate®; other.
Colocation of Team Members (Kahn and McDonough, 1997)	What percent of core team members were located in the same building?
Outsourcing of NPD Projects (new item)	What percent of projects in your organization in a given year outsource at least part of the product development process?
Length of time on job	How long have you been in this job?
New Product Performance	
Speed to Market (Olson, Walker, and Reukert 1995; Sarin and Mahajan, 2001)	* This product was developed much faster than other comparable products developed by our organization. This product was developed much faster than similar products developed by our nearest competitors. This product could have been developed in a shorter time. (R)

Appendix. (Contd.)

Measures and Sources	Description
	* The product concept formation (i.e., opportunity identification and product design) took longer than expected. (R)#
	The product development phase took longer than expected for this product. (R)
	* The product commercialization (i.e., market testing, production, distribution, promotion, sales) took longer than expected. (R)#
Market Performance	* Level of sales achieved.
(Sarin and Mahajan, 2001)	Customer satisfaction with the product.
	* Market performance of the product relative to its competition.
	Chances of the product being a success in the market.
	Level of initial market penetration (market share).
	Projected financial profits on this product.

[a] R, reverse coded. Asterisk denotes item was deleted during purification in the U.S. data. Pound symbol denotes item was deleted during purification in the Dutch data.