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Cross-Functional Integration and New Product Performance: An Empirical Analysis and Findings

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Cross-Functional Integration and New Product Success: An Empirical Investigation of the Findings

Although cross-functional integration is often considered an important element in a successful new product development program, a great deal of variance exists in extant literature regarding how integration is defined and implemented and how relevant studies are conducted. The authors attempt to bring clarity to a diverse set of 25 studies that investigate cross-functional integration by empirically analyzing 146 correlations between integration and aspects of new product success. The authors examine the impact of 12 potential moderators that affect the integration–success link using meta-analysis techniques. The findings indicate that though cross-functional integration may indeed have a direct impact on success, the combination of integration with other variables may be of greater importance. Furthermore, because most of the nine variables that significantly affect the integration–success relationship are either managerially controlled or industry specific, the findings imply that firms should design cross-functional structures to maximize their effectiveness. Other variables that affect the integration–success relationship reflect researchers' methodological decisions, suggesting that care should be taken when designing and interpreting the results of such studies. The authors discuss the implications of these findings and directions for further research.

Keywords: cross-functional integration, new product success, new product development, meta-analysis

Because of the strategic importance of new product development to the firm, it is not surprising that outcomes of the new product development process are heavily researched across many disciplines. For example, a large body of literature has identified drivers of new product success, including industry (e.g., levels of competitive rivalry, environmental turbulence), product (e.g., quality, features, benefits), and organizational (e.g., strategy, skills, structure, culture) factors (see reviews in Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994). Of the organizational factors studied, cross-functional integration (i.e., the degree of interaction, communication, information sharing, or coordination across functions) has been identified as a key driver of new product success (e.g., Griffin and Hauser 1992, 1996; Gupta, Raj, and Wilemon 1986; Olson, Walker, and Ruekert 1995). There seems to be general agreement that some form of cross-functional integration is important for successful new product development. Indeed, the Product Development and Management Association's best-practice survey indicates that approximately 60% of U.S. firms employ cross-functional integration to develop new products (Griffin 1997).

However, close scrutiny of the field reveals significant diversity in terms of how cross-functional studies are conducted (e.g., variance in construct identification and measurement, sampling methods, research settings, analysis). There is also considerable variance in terms of what constitutes new product success. For example, some studies consider new product outcomes, such as competitive advantage, quality, or uniqueness, (e.g., Li and Calantone 1998; Song and Montoya-Weiss 2001), as dependent variables in cross-functional models; some examine market-based outcomes of integration, such as market share or profit (e.g., Atuahene-Gima 1996b; Gatignon and Xuereb 1997; Millson 1993); and still others investigate productivity-related outcomes, such as cycle time or production superiority (e.g., Sherman, Souder, and Jenssen 2000). Finally, there are many different ways cross-functional integration is implemented in the firm and, thus, many ways it has been studied. For example, integration can occur at either the team (project) level or the organizational (functional) level. Regardless of level, integration has been studied in terms of cross-functional communication or interaction frequency, amount and type of information shared, mutually agreed-on approaches, goal congruence, trust and relationships, physical processes in place, levels of conflict resolution, coordination, collaboration, and so forth. The existence of such diversity raises important questions about cross-functional integration and new product development, including the following: Which forms of integration are more effective?

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Which type of new product success (e.g., marketplace, product, productivity) is most strongly influenced by cross-functional integration? Which firms or products (e.g., industries, nationalities) are more positively affected by cross-functional integration? and Which research design decisions can result in higher or lower cross-functional integration effects? Against this backdrop, the purpose of our research is to bring clarity to a diverse set of studies that examine what is commonly considered a key driver of new product success. Our primary objective is to determine specific product, firm, and environmental conditions that might moderate the cross-functional integration–new product success relationship. In other words, we investigate the conditions under which cross-functional integration may be more or less effective for various forms (e.g., product effectiveness characteristics, marketplace performance, productivity measures) of new product success.

To accomplish this objective, we employ a meta-analysis of the existing research on cross-functional integration and new product success. Compared with a primary study on the subject, this research technique enables us to identify a more complete set of potential moderating variables, which can help answer questions such as *who* or *what* should be integrated or *how* or *when* integration should occur. A meta-analysis provides a systematic procedure, can document whether the observed variance in effect sizes is real, and can enable estimation of the central tendency of the net relationship between the two constructs. We proceed with an overview of the conceptual background for the study, followed by discussion of the research methodology and identification of the potential moderating design elements. Then, we describe the findings, discuss their implications, and note directions for further research.

Background on Cross-Functional Integration

Cross-functional integration typically involves facilitating communication among different functions (Gatignon and Xuereb 1997; Moenaert et al. 1994; Song, Montoya-Weiss, and Schmidt 1997). Song and Montoya-Weiss (2001, p. 65) describe cross-functional integration in the new product development context as "the magnitude of interaction and communication, the level of information sharing, the degree of coordination, and the extent of joint involvement across functions in specific new product development tasks." Cross-functional integration can have significant advantages for the development of new products by increasing both communication frequency and the amount of information flow in the organization (Randolph and Posner 1992). For example, Pinto and Pinto (1991) find that hospitals with a high level of cooperation across functions are characterized by a high level of informal communication and successful project teams. Information integration in the cross-functional structure helps employees achieve a common understanding about the product and enhances consistency among decisions made throughout the new product development process, both of which are considered critical for success (Sethi 2000). Finally, cross-functional integration pools resources and skills from different functions, providing flexibility in workforce and capital resources and enhancing the utilization of organizational resources (e.g., Ford and Randolph 1992).

There are many important advantages of cross-functional integration, but this type of organic management structure also has some disadvantages. Although the integration of different functions may increase the success of new products through effective communication, functional diversity can also increase decision complexity and confusion (Sethi 2000). The informal communication patterns, participative decision making, and consensual conflict resolution in cross-functional integration can be more time consuming and less efficient than more centralized and bureaucratic processes (Olson, Walker, and Ruekert 1995). Employee satisfaction and success can suffer if workloads increase because of new interfunctional tasks along with existing home function duties (e.g., Karlsson and Åhlström 1996). Working with other employees who have different backgrounds and perspectives on work and goals can generate conflict over resources, technical issues, pay, and personnel assignments (e.g., Olson, Walker, and Ruekert 1995). The resultant increased costs to the organization (e.g., overhead, staff, efforts, delayed decisions) can combine to reduce the success of new products.

Despite the potential disadvantages, cross-functional integration is largely considered a positive factor in effective new product development. Indeed, firms identified as having "best practices" in new product development tend to employ cross-functional integration more extensively than other firms, especially for less innovative projects (Griffin 1997). Yet our understanding of the true impact of cross-functional integration on new product success remains clouded by the diversity that exists in how cross-functional integration is implemented in the firm and how researchers study it. As we mentioned previously, the primary goal of our research is to investigate the key conditions under which cross-functional integration can be more or less effective for new product success. We pursue these insights next in the design and analysis stages of our research.

Research Design

To begin the meta-analysis process, we searched for relevant studies (i.e., those focusing on the link between cross-functional integration and new product success) in several electronic databases (e.g., ABI/INFORM, Business Source Premier, Digital Dissertation, Emerald Fulltext, Electronic Collections Online, INFORMS PubOnLine, ScienceDirect) using keywords such as "cross-function integration," "functional integration," "interdepartment cooperation," "collaboration," "interfunctional teams," "integrated teams/functions," "interfunctional climate," "intraorganizational team/cooperation/collaboration," "new products," "new product performance/success," and "innovation." Next, we hand-searched appropriate marketing and management journals (e.g., *Journal of Marketing*, *Journal of Marketing Research*, *Journal of the Academy of Marketing Science*, *Journal of Product Innovation Management*, *Journal of Business Research*, *Marketing Science*, *Academy of Management Journal*, *Management Science*) for articles pertinent to our study. We also reviewed the references of these studies for additional leads. Finally, to avoid bias from including only published studies, we posted a request for unpublished papers on a major electronic listserv (ELMAR) and wrote to key authors in this field requesting unpublished or working papers. We concluded our search in November 2007 when it became apparent that additional search efforts would not yield additional studies. We identified 37 empirical studies (34 published articles, 2 dissertations, and 1 unpublished manuscript).

Unit and Level of Analysis

The next step in our research process was to identify the appropriate (unitless) measure of association and level of analysis (i.e., model or study) for our research. A review of the studies included in our database indicated that correlations were the most common measures reported in the literature and therefore would allow for the greatest number of studies in our research. Indeed, 25 of the studies in our database reported correlations. This 68% inclusion rate is comparable to other meta-analyses in marketing, including those of Henard and Szymanski (2001: 68%), Szymanski, Troy, and Bharadwaj (1995: 70%), and Szymanski, Bharadwaj, and Varadarajan (1993: 63%).

Furthermore, we determined that a model-level analysis (i.e., analyzing each of the 146 correlations individually) rather than a study-level analysis (i.e., averaging the correlations across multiple models within a study) was more appropriate. This decision was based in part on the Q-test for homogeneity of correlations within studies. The Q-test was rejected at $p < .01$(χ^2 = 1196.96, d.f. = 145), implying that there is significant heterogeneity within studies in the database (Hedges and Olkin 1985). In addition, because models within the studies varied in terms of design variables (e.g., measurement and contextual factors), a model-level analysis is necessary to capture the influence of these variables. Finally, no single study contributes an excessive number of correlations (maximum number of correlations in a single study accounted for less than 21% of the total). Therefore, we remain consistent with previous meta-analyses in marketing that analyze correlations at the model level rather than at the study level (e.g., Geyskens, Steenkamp, and Kumar 1998; Henard and Szymanski 2001; Sultan, Farley, and Lehmann 1990). The 25 empirical studies yield a database with 146 correlations between cross-functional integration and new product success, with the correlations ranging from –.330 to .740. The studies represent data from more than 13 countries spanning four continents.

The number of studies included (25) is consistent with several published meta-analyses in marketing, including those of Sultan, Farley, and Lehmann (1990: 15 studies), Szymanski and Busch (1987: 24 studies), and Szymanski, Troy, and Bharadwaj (1995: 22 studies). Furthermore, the 25 studies represent more than 5000 individual observations, with study sample sizes ranging from 44 to 553. The number of correlations in our study (n = 146) also exceeds those in previous meta-analyses in marketing (e.g., Rao and Monroe 1989: 85 effects; Szymanski, Kroff, and Troy 2007: 93 effects; Szymanski, Troy, and Bharadwaj 1995: 64 effects). Finally, we are able to achieve a more in-depth analysis of the link between cross-functional integration and new product success than Henard and Szymanski's (2001) meta-analysis because we include more than three times the number of correlations examining the relationship between cross-functional integration and new product success (i.e., 146 correlations versus 41).

To develop the database for our study, two researchers independently coded half the studies and cross-checked each other's work. A third researcher verified the final coding worksheet. The few inconsistencies were resolved by discussions to ensure that conceptually similar items would be combined appropriately and that conceptually dissimilar items would not be combined. In addition to coding effect sizes, we also identified and coded the key variables that might influence the conditions under which cross-functional integration affects new product success.

Identification of Moderating Design Elements

Because meta-analysis is a tool for summarizing and estimating effects from previously conducted research, the identification of moderators is necessarily restricted to factors that can be coded from the set of studies in that body of literature. Inclusion of potential moderators is also restricted to those that theory or logic indicate should have an impact on the relationship of interest (in this case, cross-functional integration and new product success) (Henard and Szymanski 2001). We categorized these moderators as management controlled (i.e., managerial decisions regarding how new product development or cross-functional integration is implemented in the firm), researcher controlled (i.e., researchers' decisions regarding how constructs are defined and measured), and contextual (variables related to the environment in which the cross-functional integration takes place). The final set of moderators included was further restricted to variables for which sufficient power existed to detect differences in the integration–success correlations and that were compatible with the multilevel modeling technique we employed.[1] To this end, we identified 12 factors as potentially affecting the relationship between cross-functional integration and new product success, including 7 management-controlled factors, 2 researcher-controlled factors, and 3 contextual factors.

[1]We originally identified and coded 16 potential moderators of the cross-functional integration–new product success relationship. However, because of specification issues, we were able to retain only 12 of these moderators in our final model. Because of its ability to control for possible dependencies among the correlations, we believe that the hierarchical linear modeling method is superior to other multiple regression models, despite the reduction in the number of moderators we could examine. Moderators were retained based on a multilevel modeling technique that examines the change in deviance between a hypothesized model and an intercept-only model. After specifying the best-fitting models, we examined the excluded moderators for their potential theoretical impact and selected the most theoretically robust ones. This approach helps avoid model misspecification and can prevent bias associated with selecting only significant moderators for inclusion.

Management-Controlled Moderators

Level of integration. In some firms, integration occurs at the team or project level. In this case, the separate functions continue to perform their duties, and representatives from each function are assigned to the integrated new product team. In another form, integration occurs at the organizational level, including integration of the functions themselves. Although O'Reilly and Tushmann (2004) find that new products developed by ambidextrous organizations (i.e., functions integrated at the organizational level) outperform those developed by teams integrated at the project level, we believe that, in general, organization-level integration may be more difficult to implement successfully. For example, difficulties in encouraging or even enforcing cross-functional cooperation can arise, especially when there is resource competition at a higher level. Successful organizational integration requires senior managers who understand and are sensitive to the needs of this different type of organization. Conversely, members integrated at the team level can get to know one another better and work more closely to solve problems and communicate more quickly and effectively. Thus:

> H_1: The relationship between cross-functional integration and new product success is stronger when integration occurs at the team level than when it occurs at the organizational level (i.e., H_1+: team level > organization level).

Type of integration. Regardless of the level at which integration occurs in a firm (e.g., team or organizational), cross-functional integration is often viewed simply as communication or interaction frequency. Studies analyzing this type of integration do not take into account what type of information is shared or how it is shared (e.g., Lievens and Moenaert 2000). In other studies, however (e.g., Moenaert et al. 1994), cross-functional integration reflects an environment of trust and cooperation among different functions in the product development process. This perspective involves how cohesively the interfunctional team works and has more bearing on the climate of the organization. When there is a more positive organizational climate, important information is likely to be shared more freely rather than hoarded, and the information is more likely to be trusted and used by others. Thus:

> H_2: The relationship between cross-functional integration and new product success is stronger when integration is implemented as a climate of cooperation than when it is implemented as information sharing alone (i.e., H_2+: cooperation > information sharing only).

Type of information shared. A key premise underlying effective cross-functional integration is the enhanced ability to share key information across functional boundaries. As we mentioned previously, some studies focus on the amount of information shared or frequency of team member interaction without considering how the information is shared (i.e., in a climate of cooperation) or what type of information is shared. Yet previous research has indicated that the type of information disseminated throughout an organization can have a positive impact on new product outcomes. For example, research on market orientation (e.g., Narver and Slater 1990) indicates that information on customers, competitors, and technologies is key to developing successful new products. Moorman and Rust (1999) find that marketing's value to the organization increases when customer knowledge is developed. Finally, Gatignon and Xuereb (1997) indicate that the possibility of new product success is commensurate with a firm's customer, competitor, and technology orientation. Therefore, in addition to expecting a higher level of success when cross-functional integration involves a climate of cooperation rather than mere information sharing, we expect that the actual type of information shared across functions makes a significant difference in the integration–success relationship. Although research suggests that three primary types of information (customer, competitor, and technology) are most effective for new product success (e.g., Narver and Slater 1990), the information most often studied with respect to integration and new product success (and, thus, the only type with enough data points to include in our analysis) is information about customers. Thus:

> H_3: The relationship between cross-functional integration and new product success is stronger when specific customer information is shared among team members than when it is not (i.e., H_3+: customer information shared > customer information not shared).

Inclusion of the marketing function. The marketing department remains in closest contact with the customers of the firm, and this is where the demand for new products is recognized (Hunt and Lambe 2000). Furthermore, marketing plays important roles in the market research, prototype development, and launch stages and therefore is a vital function to be integrated into a cross-functional team (Moorman and Rust 1999). We expect that inclusion of the marketing function results in a more positive outcome for the new product, regardless of the stage of development. Formally,

> H_4: The relationship between cross-functional integration and new product success is stronger when marketing is included in the product development process than when it is not (i.e., H_4+: marketing included > marketing not included).

Inclusion of the research-and-development function. The involvement of research-and-development (R&D) functions in the new product development process is also crucial to new product success. Research-and-development departments are often incorporated into new product teams to come up with innovations and to contribute to the technological success, production efficiencies, and marketplace success of new products. Thus:

> H_5: The relationship between cross-functional integration and new product success is stronger when the R&D function is included in the new product development process than when it is not (i.e., H_5+: R&D included > R&D not included).

Number of functions integrated. Regardless of which specific functions are included in the new product process, an overall greater number of functions can lead to more divergent insights, thus contributing to more new product ideas (Troy, Szymanski, and Varadarajan 2001). However, a greater number of functions can cause confusion and make it increasingly difficult to achieve goal congruity (Moorman and Rust 1999) or a collaborative climate (Moenaert et al. 1994). In other words, although greater insights into products and markets can emerge with more functions participating in the process, it is likely that decision making and implementation will become more difficult. Therefore, we investigate the possibility that though some diversity can enhance the new product process, too much diversity can hinder it. Our data set enables us to compare integration of two functions with multiple functions. Formally,

> H_6: The relationship between cross-functional integration and new product success is stronger when two, rather than more than two, functions are integrated (i.e., H_6+: two functions > multiple functions).

Stage of new product development process. The product development process can be broadly categorized in terms of innovation initiation (e.g., planning, idea generation) and implementation (e.g., product development, testing, launch). Organizational characteristics that foster success at one stage of the process may differ from those that foster success at another stage. Although cross-functional integration is effective for idea generation (Troy, Szymanksi, and Varadarajan 2001), it can actually have a negative impact at certain stages of the new product process (Song, Thieme, and Xie 1998); the divergent perspectives that contribute to the cross-fertilization of new product ideas hinder decisions when specialized knowledge may be needed. Because of sample size, we are unable to test the relationship between any two specific stages, such as idea generation, product planning and design, product development, and launch. However, if we collapse the available data, we can code whether integration occurring at earlier stages (e.g., planning through development) varies significantly from that at later stages (e.g., launch). Because the earlier stages of development tend to involve more creative thinking (e.g., idea generation, product design), theory suggests that integration can have a more positive impact at these stages than at later stages when the tasks are more function specific. Thus:

> H_7: The relationship between cross-functional integration and new product success is stronger when integration occurs at earlier stages than when it occurs at later stages of development (i.e., H_7+: earlier stages > later stages).

Researcher-Controlled Moderators

Dimensions of success. Studies in our database used marketing performance (e.g., market share, financial), product effectiveness (e.g., product quality, advantage, uniqueness), and production outcome (e.g., cycle time, production superiority) dimensions to measure the success of new product development efforts. Although production superiority measures are important to the bottom line of the firm, they are more likely to be influenced by levels of specialized expertise in production systems than by the implementation of a functionally integrated team. Furthermore, marketing performance outcomes can be mitigated by external forces, such as competitive rivalry, environmental turbulence, and other marketplace factors. Conversely, cross-functional integration is more likely to result in new products that are more innovative or superior because members can draw on divergent perspectives to generate new and better products (Troy, Szymanski, and Varadarajan 1995). Thus:

> H_8: The relationship between cross-functional integration and new product success is stronger when success is measured as product effectiveness outcomes than when it is measured as productivity or marketplace performance (i.e., H_8+: product effectiveness > productivity and marketplace performance).

Measures of success. New product studies typically capture success as either an objective assessment (e.g., documented return on investment, sales, market share, profits) or a subjective assessment (e.g., managers' perceptions of how well the new product performed relative to expectations). The measure of success used in a study could influence the magnitude of the integration effect. In general, objective measures, such as financial data, should be relatively free of bias and more accurate than subjective measures (Ford, Smith, and Swasy 1990). Subjective measures may have greater error as a result of demand artifacts (e.g., intentionally or unintentionally inflating performance to look good) or because respondents may not accurately know how well the new product performed (e.g., Starbuck and Mezias 1996). However, because objective measures are often global in nature (e.g., sales, market share), they also capture the effects of uncontrollable market factors, such as competitive response or economic conditions. The inclusion of such noise in objective measures could serve either to inflate or to deflate true effect sizes. Although we are not able to anticipate the direction of existing noise in objective data, we believe that inconsistencies in subjective measures are more generally inflated (i.e., products are described as more successful than they actually are). Thus:

> H_9: The relationship between cross-functional integration and new product success is stronger when success is measured subjectively than when it is measured objectively (i.e., H_9+: subjective > objective measures of success).

Contextual Moderators

Country of operation. Although there is rapid globalization, some distinct cultural differences still remain between Western and non-Western countries. With respect to culture, Western countries are considered more individualist, and non-Western countries are typically considered collectivist (Nakata and Sivakumar 1996). A collectivist culture typically involves living and working as a group, with mutual responsibilities and group accountability as an active norm in the society. The more distinct the collectivist traits of team members, the higher is the chance that team members will embrace cross-functional integration; the more individualist their traits, the more members may resist. Therefore, we expect that cross-functional integration has a greater impact on product success in collectivist cultures (i.e., observed in samples from non-Western countries). Thus:

> H_{10}: The relationship between cross-functional integration and new product success is stronger in samples from non-Western countries than in samples of Western countries (i.e., H_{10}+: non-Western > Western).

Industry: high- versus low-tech. High-tech markets are characterized by complexity, instability, intensity, and uncertainty compared with low-tech markets (Glazer 1991). Functional integration may be more important in such volatile, rapidly changing situations because information dissemination and cooperation among functions can be achieved more quickly when cross-functional integration is employed. When markets change more slowly, the efficiencies of cross-functional integration may not be as important and therefore may not have as dramatic an impact on success. Thus:

> H_{11}: The relationship between cross-functional integration and new product success is stronger in high-tech markets than in low-tech markets (i.e., H_{11}+: high tech > low tech).

Product: services versus goods. Services are typically distinct from goods in that they are intangible, less consistently delivered, and produced simultaneously with consumption (Zeithaml, Parasuraman, and Berry 1985). Because services are produced at the same time they are consumed, consumers may easily notice a lack of collaboration among different functional departments and may experience lower satisfaction levels. Conversely, consumers of goods are typically exposed only to the final product itself and are less directly affected by a lack of cooperation among producing functions. Therefore, we expect that cross-functional integration is more directly related to success in services than to goods. Thus:

> H_{12}: The relationship between cross-functional integration and new product success is stronger for services than for goods (H_{12}+: services > goods).

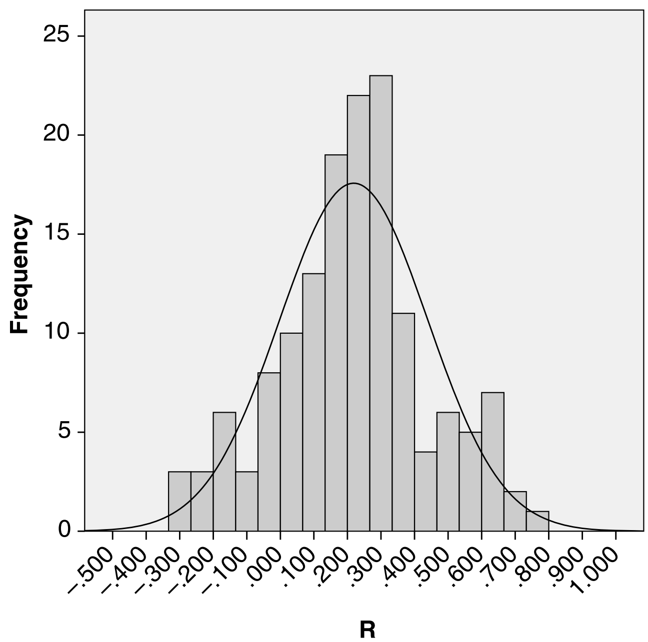
Analysis Procedure

This study followed the procedures that are common to many meta-analyses in marketing (e.g., Bijmolt, Van Heerde, and Pieters 2005; Henard and Szymanski 2001; Szymanski, Kroff, and Troy 2007) and are suggested by authors in quantitative meta-analysis techniques (e.g., Bijmolt and Pieters 2001; Hedges and Olkin 1985; Hunter and Schmidt 1990; Lipsey and Wilson 2001). We conduct a preliminary analysis that provides initial insights into the central tendency of the effects, including the size and direction of the relationship between cross-functional integration and new product success, all else being equal. We then investigate the specific conditions under which the relationship might vary (i.e., the management-controlled, researcher-controlled, and contextual variables) by conducting a moderator analysis using hierarchical linear modeling (HLM) estimation (Bijmolt and Pieters 2001; Hox 2002; Singer and Willett 2003).

Preliminary Analysis

As Figure 1 illustrates, a frequency distribution of the 146 correlations between cross-functional integration and new product success indicates that the correlations range from –.330 to .740. The correlation frequency is normally distributed ($Z_{Skewness}$ = –.171, p > .05; $Z_{Kurtosis}$ = –.280, p > .05; M = .219).

FIGURE 1
Frequency Distribution of Correlations



Notes: M = .219, SE = .018, SD = .221; $Z_{Skewness}$ = –.171, p > .05; $Z_{Kurtosis}$ = –.280, p > .05.

Although one correlation is reported as zero and many of the correlations are negative (23 of 146), most of the correlations in the database are positive (122 of 146). Therefore, it is not surprising that we find that the weighted estimator of the common correlation ($\bar{r}$ = .295, p < .01) is positive and significantly different from zero.[2] Note that this positive, statistically significant (p < .01) reliability-corrected mean compares with a nonsignificant correlation of .23 (p > .05) in Henard and Szymanski's (2001) meta-analysis of the drivers of new product success. However, although the preliminary analysis supports a positive relationship between cross-functional integration and new product success, all else being equal, our goal is to investigate

[2]In general, the weighted estimator of the common correlation is considered a superior approach to linear combinations of correlations (Hedges and Olkin 1985). We followed Hunter and Schmidt's (1990) recommendation in calculating the weighted estimator. This approach of correcting for error may increase the variance of the estimator by inflating r_i, especially when low reliability measures are used. However, both p_x and p_y are fairly distributed around a high value (means [standard deviations] of p_x and p_y are .81 [.11] and .83 [.14], respectively, and are above .70, as recommended by Nunnally [1978]). Inflated correlation caused by low reliability is unlikely. Moreover, because we use the square root of the product of the reliability coefficients, the effects of inflating variance is minimal (Hedges and Olkin 1985). Next, we calculate the interval estimation of the correlation using an approximate procedure based on a transformation (Neter et al. 1996). We converted each r_i by Fisher's z-transformation and then calculated the weighted average z (Hedges and Olkin 1985). Finally, we reconverted z into the weighted estimator of common correlation.

the specific conditions under which this positive relationship might be augmented or mitigated. Therefore, we turn to the examination of the conditions under which cross-functional integration may have a positive or negative impact on success (i.e., the moderator analysis) before we draw any conclusions.

Moderator Analysis

Before investigating the impact of the potential moderators on the integration–success relationship, we first used a homogeneity test (Q-statistic) to detect the systematic variance associated with each effect size (the reliability-corrected correlations) due to moderators (Overton 1998). The homogeneity test of the correlations between cross-functional integration and new product success relationship was significant at $p < .01$ ($\chi^2 = 1808.40$, d.f. = 145), confirming that the distribution of effect size is heterogeneous (Lipsey and Wilson 2001, p. 117). The remaining variance of the effect sizes (after we corrected for sampling error) was 86.31%, indicating that meaningful variance in effect sizes exists across studies (Hunter and Schmidt 1990).[3]

Consistent with several meta-analyses in marketing, we used the reliability-corrected correlations in the moderator analysis (e.g., Geyskens, Steenkamp, and Kumar 1998; Henard and Szymanski 2001; Kirca, Jayachandran, and Bearden 2005; Szymanski, Kroff, and Troy 2007). Because of the potential for significant bias in effect size, we adjust the reliability-corrected correlations for measurement artifacts, and thus they more accurately represent effect size than uncorrected correlations (Hunter and Schmidt 1990). We converted each reliability-corrected correlation using Fisher's transformation to yield "z," which is generally considered a superior approach to linear combinations of correlations (Hedges and Olkin 1985: Neter et al. 1996). We modeled the reliability-corrected correlations (z) between cross-functional integration and new product success as a linear function of the determinants (Sultan, Farley, and Lehmann 1990). Finally, as Bijmolt and Pieters (2001) suggest, we performed the meta-analysis with HLM to account for within-study error correlation between effect sizes (see also Hox 2002; Singer and Willett 2003).[4] We specified the estimated model as the following form:

$$Y_{ij} = \gamma_0 + \sum_{k=1}^{12} \gamma_k X_{k,ij} + u_j + e_{ij},$$

where Y_{ij} are z-transformations of the reliability-corrected correlations (z_i) in study j, γ_0 is a constant, γ_k are parameter estimates of the determinants, $X_{k,ij}$ are dummy variable matrices (absence or presence) of the determinants (moderators), u_j is the study-level residual error term, and e_{ij} is the measurement-level residual error term.

Before running the HLM, we examined the correlations among the main effects (moderators) and found that the maximum value is .587 (Table 1). We further investigated the potential confounds between the moderators by regressing z_i on all 12 moderators. Both tolerance (minimum tolerance = .609) and variance inflation factor (maximum variance inflation factor = 1.642) confirm that multicollinearity did not unduly influence the findings. Therefore, we kept all the determinants in the model. In addition, we performed model diagnostics by exploring the model residuals for normality, linearity, and homoskedasticity (Hox 2002; Singer and Willett 2003). The residual plot did not indicate significant violations of the assumptions.[5] The resultant model accounts for a reasonable proportion of the variance between cross-functional integration and new product success (R^2 = .468).[6] The results of the hierarchical linear regression appear in Table 2.

Findings

The results of the regression analysis indicate that 9 of the 12 hypothesized main effects (H_1, H_2, H_3, H_6, H_8, H_9, H_{10}, H_{11}, and H_{12}) were significant. Of the 9 significant main effects, 7 were in the direction specified a priori (H_1, H_3, H_6, H_8, H_{10}, H_{11}, and H_{12}), and 2 were in the opposite direction (H_2 and H_9). These findings suggest that there are indeed conditions under which cross-functional integration can be more strongly or weakly related to success. Of the seven management-controlled moderators, three influenced the integration–success relationship, as we hypothesized, and one was counter to our supposition. Three moderators (i.e., marketing function included versus not included, R&D function included versus not included, and integration in earlier stages versus later stages) did not have a significant effect on the integration–success relationship. As we expected, the cross-functional integration–new product success relationship was stronger when integration occurred at the team level than when it occurred at the organizational level ($\beta = .157$, $p < .05$), when customer information was shared ($\beta = .212$, $p < .05$), and when only two functions (versus more than two functions) were integrated (β =.138,

[3]Hunter and Schmidt (1990) maintain that examining the true variance in effect size across studies is warranted if the statistical artifacts (e.g., sampling and measurement error) account for less than 75% of total between-study variance.

[4]We estimate the model using the maximum likelihood method, which is the most common estimation method in multilevel modeling because "it is generally robust, and produces estimates that are asymptotically efficient and consistent" (Hox 2002, p. 37; see also Singer and Willet 2003, pp. 91–92). To run the HLM model, we used an imputation method of replacing missing values (moderators) with series means.

[5]Plots of standardized residuals (at Levels 1 and 2) by studies show that most fall within two standard deviations of the center, suggesting that the residuals are normally distributed (Singer and Willett 2003, pp. 128–32). We also used a plot of Level 1 standardized residuals by predicted values using a fixed part of multilevel regression (Hox 2002). The plot shows a large majority of residuals evenly divided below and above their mean with a mild structure.

[6]We used three fit statistics to verify model fit. First, we followed Snijders and Bosker's (1994) recommendation for calculating R-square for the HLM (R^2 = .468). Second, we used Akaike information criterion (AIC) statistics to compare the final model (model with moderators, AIC = .40) with the base model (intercept-only model, AIC = 18.30). Our final model's deviance indicates better fit with the effects (deviance = 41.90, d.f. = 12, $p <$ .01).

TABLE 1
Correlations Between Moderators

	1	2	3	4	5	6	7	8	9	10	11	12
1. Team/project_org	1.000											
2. Cooperation_info only	.041	1.000										
3. Customer info_not	–.063	.230**	1.000									
4. Marketing_not	–.046	.026	.186*	1.000								
5. R&D_not	–.066	.036	.032	.587**	1.000							
6. Two functions_more	.160	.008	.015	–.056	.000	1.000						
7. Early_late	.000	–.006	.012	–.091	–.119	–.335**	1.00					
8. Effective_other	–.072	–.044	–.009	.010	–.008	–.018	–.058	1.000				
9. Subjective_objective	–.155	.055	.000	–.024	–.035	.136	–.050	.166*	1.000			
10. Non-West_West	.014	–.033	–.146	.049	.071	–.233**	.093	.019	–.519**	1.000		
11. High_low tech	–.248**	.162*	–.008	–.127	–.150	–.224**	.302**	–.152	.171*	–.082	1.000	
12. Service_good	.136	–.398**	–.303**	.088	.063	–.246**	.127	–.060	.070	–.068	–.045	1.000

*$p \le .05$ (two-tailed).
**$p \le .01$ (two-tailed).

TABLE 2
Coefficients: Moderating Impact on the Relationship Between Cross-Functional Integration and New Product Success

Description	Hypotheses	Estimates	SE
Constant/intercept		–.083	.216
Management-Controlled Moderators			
Integration at team/project versus organization levels	H_1 (+)	.157*	.061
Integration as cooperative climate versus information sharing only	H_2 (+)	–.146*	.059
Customer information shared versus not shared	H_3 (+)	.212*	.102
Marketing function included in integration versus not included	H_4 (+)	–.054	.141
R&D function included in integration versus not included	H_5 (+)	.140	.133
Two functions integrated versus more than two	H_6 (+)	.138*	.069
Integration in earlier stages versus later stages	H_7 (+)	.130	.103
Researcher-Controlled Moderators			
Product effectiveness versus productivity/market performance	H_8 (+)	.185**	.048
Subjective versus objective measures of success	H_9 (+)	–.381**	.086
Contextual Moderator			
Non-Western countries versus Western countries	H_{10} (+)	.214**	.075
High-tech products versus low-tech products	H_{11} (+)	.268**	.068
Services versus goods	H_{12} (+)	.183*	.074

*$p \leq .05$ (two-tailed).
**$p \leq .01$ (two-tailed).

$p < .05$). However, contrary to our expectation, the cross-functional integration–new product success relationship was stronger when integration involved only information sharing than when it involved a cooperative climate ($\beta = –.146$, $p < .05$). Of the two researcher-controlled variables, one affected the integration–success relationship, as we hypothesized, and the other was counter to our supposition. The integration–success link was stronger when researchers examined product effectiveness outcomes (e.g., innovativeness or superiority of products) than either productivity outcomes or marketplace performance measures, such as sales, market share, and profitability ($\beta = .185$, $p < .01$). However, the integration–success relationship was stronger when objective measures of success were used than when subjective measures were used ($\beta = –.381$, $p < .01$). With respect to the contextual moderators, the relationship between integration and success was stronger in non-Western countries ($\beta = .214$, $p < .01$) and in high-tech and service-based industries (high- versus low-tech: $\beta = .268$, $p < .01$; services versus goods: $\beta = .183$, $p < .05$).

Discussion

Findings from our study provide evidence that the relationship between cross-functional integration and new product success is indeed complicated. The presence of significant moderators suggests that integration alone is not the key to new product success but rather that integration in combination with other management-controlled, researcher-controlled, and context-specific factors can enhance or mitigate new product success. We discuss each of these factors in turn along with their implications and suggest directions for further research.

Impact of Management-Controlled Variables: How to Integrate Effectively

A key finding of our research is that decisions regarding how to integrate various functions for new product development should not be taken lightly. Because integration can be difficult to implement, care should be taken to ensure that the most effective form of integration is achieved in the firm. Managers must make decisions regarding the level at which integration should occur (e.g., team versus organizational level); how integration should occur (e.g., cooperative climate versus information sharing only); which types of information should be shared, how many, and which functions should be integrated (e.g., marketing, R&D, multiple functions); and in which stages of the process integration should occur. We discuss each of these in turn.

Level of integration. The results from our study indicate that when integration occurs at the organizational level rather than at the team level, the impact of the integration is diminished. In other words, the findings imply that integrating teams (e.g., bringing together members from different functions to work on a project) is more effective in terms of new product success than integrating higher up within the organization. This finding is important because few empirical studies have directly tested whether one organizational structure is better than another in terms of new product development success. It is also counter to findings from O'Reilly and Tushmann's (2004) case study, which suggests that organizational integration is superior to team-level integration with respect to new product success.

A possible explanation for this finding is that though integration can enhance new product success by increasing communication in the organization, too much organizational complexity can be dysfunctional (Randolph and Posner 1992). Without complete support from top management and the ability of senior managers to move beyond power struggles, turf battles, and resource disputes, a greater degree of integration can disrupt the team's ability to develop new products effectively by causing greater conflict and confusion. Our finding is also important because organizational structures are relatively difficult to change in the short run and may be closely tied to organizational culture. Firms that want to employ cross-functional new product development should consider integrating at the project level rather than expending the additional cost and energy on a possibly less effective integration of the whole firm, at least without a thorough examination and understanding of the challenges required to effect long-term changes in a firm's corporate culture.

However, further research is needed to understand more fully the nuances associated with team versus full integration. Because of model constraints, we were unable to test for possible interaction effects among firm-level integration and other managerial decision variables, such as stages of the process, functions integrated, or environmental conditions (e.g., industry, products, countries served). For example, it is possible that volatile industries benefit more from the flexibility of team-level integration, whereas more mature or stable industries more successfully implement organizationwide integration. It is also possible that organizational integration is more successful when fewer rather than more functions are integrated. Further research into this area could provide a greater understanding of whether there are certain conditions under which organizational integration affects the integration–success link more positively.

Type of integration. In addition to the level of integration (e.g., team versus organizational), our review of research in the field suggested that variance exists in the type of integration employed in the firm. Our model investigated whether integration involving a cooperative climate versus integration reflecting only information sharing has a greater impact on the cross-functional–new product success link. Because we hypothesized that key information is more likely to be shared, trusted, and used in a positive organizational climate, we were surprised that the results were counter to our supposition. Instead, the findings indicate that when integration involves only information sharing, the cross-functional–new product success link is stronger than when integration involves a climate of cooperation.

A potential explanation for this finding reflects the importance of information to the new product process. Cooperation alone may not be enough to ensure that the most appropriate information regarding new product development is disseminated. Rather, teams operating in a more cooperative environment may socialize more during work time or may share information that is less relevant to the new product process. Teams operating in more formal (less social) environments may share information that is more relevant to developing successful new products. The information shared in a more formal environment may also be subject to greater questioning and analysis, whereas information shared in a more cohesive environment may be accepted without verification. Finally, social identity theory suggests that when cross-functional teams operate more cohesively, team members are more likely to reject outside information (Van Knippenberg, De Dreu, and Homan 2004); thus, important information coming from outside the team may be ignored.

The implication of this finding is that managers operating in organizations that use cross-functional integration should take care to ensure that appropriate market information is being shared by team members. Note that we do not suggest that managers should discourage team member cooperation and collaboration. Indeed, the findings do not indicate that team member cooperation is detrimental to new product success, only that information sharing enhances the effectiveness of cross-functional teams to a greater extent. It is likely that cross-functional teams that operate in an environment that is cohesive and involves a great deal of relevant information sharing contribute even more to new product success than either cooperation or information sharing alone. Further research could explore this possibility in more detail.

Type of information shared. Our findings indicate that both level and type of integration can affect the success of cross-functional teams in new product development activities. Another finding regarding how to integrate effectively involves the kind of information that is shared by team members. Although researchers in marketing agree that information about customers, competitors, and technologies is key to new product success, we were only able to extract enough information from our database to test the importance of customer information to the cross-functional integration–new product success linkage. Consistent with our hypothesis, we found that teams that share specific customer information resulted in a stronger integration–success linkage than teams that did not. Although this result is not surprising, it underscores the importance of ensuring that relevant information is being shared among cross-functional team members, especially in light of the previously discussed finding that information sharing itself enhances the integration–success link more than a cooperative climate. Because we were unable to test the effects of other types of information, further research could investigate which of the three primary types (customer, competitor, or technology) enhances the integration–success linkage the most and under which conditions. Regardless, managers are encouraged to provide cross-functional team members with training and incentives focused on the importance of sharing key market information (especially information about customers) during product development activities.

How many and which functions to integrate. Another managerial decision regarding how to integrate involves which specific functions and how many different functions should be included. Our meta-analysis indicates that the impact of integration on new product success is stronger when fewer functions are included in the cross-functional team than when more functions are included. However, we found that the integration–success linkage is not significantly affected when either R&D or marketing is specifically included. The nonsignificant results of including R&D and marketing were surprising at first. However, further reflection suggests that R&D and marketing could constitute a necessary condition rather than a key for a successful team. Because R&D and marketing are typically the primary functions involved in the new product process, little variance may exist in terms of their impact on success. Instead of examining these primary functions, further research could consider the impact of including fewer common functions (e.g., finance, manufacturing, industrial designers) and external constituents (e.g., consultants, suppliers, industry analysts) in the cross-functional team to determine whether more diverse viewpoints make a significant contribution to the team success.

In addition, it is possible that the inclusion of marketing or R&D is more critical to the success of new product teams during specific stages of the new product process or in different industries. Sample size precluded us from testing any interaction terms between the functions included and other variables. Further research could investigate this possibility in greater detail to determine when in the new product development process and under what conditions the integration of marketing, R&D, and other potential functions has the greatest impact.

The finding regarding number of functions to integrate was consistent with the rationale that though more functions can contribute to greater creativity and ideas for new products, increased confusion and conflict can also result as more divergent viewpoints come together. The implication is that managers should consider forming teams with a smaller number of key functions rather than larger, more diverse teams. However, diversity can also have a differential effect on cross-functional team success. More fluid environments in which different functions move in and out of the team during different stages of the product development process may prove even more effective than limiting team members to a few functions. In addition to investigating the impact of specific functions, such as manufacturing or finance, further research could investigate which stages of the new product process might benefit from greater versus less team member diversity as well as the different contexts in which greater or less diversity might increase new product success.

Which stages to integrate. Finally, we expected that the effect of integration would vary across the different stages of the new product development process. Because of sample size restrictions, we were only able to test the impact of earlier (e.g., planning and development) versus later (e.g., launch) stages of the process. Although our hypothesis was not supported, we believe that a more in-depth examination of the process (i.e., a stage-by-stage analysis) could provide significant insights into how integration can most positively affect new product success. As we mentioned previously, the identification of particular stages that are more (or less) conducive to cross-functional integration and a more detailed examination of which functions should be integrated, when, and at what level (e.g., team versus organizational) could provide the basis for a more fluid type of organizational structure in which structures change and cross-functional team members enter and exit the new product process at varying stages.

Impact of Researcher-Controlled Variables: The Importance of Research Design Decisions

Of the two research design moderators included in our model, both significantly influenced the cross-functional integration–new product success relationship. These findings support the theory that estimates of relationship strength can depend on researchers' decisions (Mir and Watson 2000) and suggest that the true impact of cross-functional integration on new product success can be masked depending on how it is studied. Specifically, the integration–success correlations in our data set are larger on average for objective versus subjective measures of success. This finding is notable in that subjective measures are often perceived as being positively inflated compared with objective measures. Because objective scales are presumed to be more free of bias, researchers are usually urged to use them whenever possible (e.g., Ford, Smith, and Swasy 1990). However, our results indicate that either subjective measures of success may be more conservative than originally thought or objective measures are more significantly contaminated by the inclusion of noise in the form of market externalities. Regardless, our findings indicate that caution should be taken when interpreting cross-functional effectiveness with objective versus subjective measures and that additional research should be conducted to understand more fully the use and appropriateness of these measures for success.

In addition, our findings indicate that examining new product outcomes in terms of product effectiveness (e.g., innovativeness, superiority characteristics) rather than in terms of productivity or market performance measures results in stronger integration–success correlations. Although this also suggests that researchers can influence new product outcomes by selecting specific dependent variables, it has additional implications for managers in terms of managing their cross-functional teams. For example, if a firm's new product goals are tied to marketplace performance, the effectiveness of cross-functional integration may appear diminished compared with when goals are measured in terms of product characteristics. To develop, manage, and reward successful new product teams, managers must carefully consider benchmarks that directly reflect new product efforts (e.g., product effectiveness outcomes) or account for the additional factors, such as competitive rivalry, technological changes, and customer responses to marketing efforts, that might enhance or mitigate a product's performance in the marketplace. Furthermore, our findings suggest that further research on new product development should consider (1) a two-stage model in which product characteristics are investigated as outcomes of the new product process (and as antecedents to marketplace performance; e.g., Gatignon and Xuereb 1997) and (2) more complex contingency relationships between various external and internal factors with respect to both cross-functional integration and new product success.

Impact of Contextual Variables: Environments with a Stronger Impact

In addition to factors that managers or researchers can control, three contextual variables that have the ability to influence the cross-functional integration–success relationship emerged from our model. These findings have important managerial implications specific to the industry, product, and country environments in which a firm operates. We discuss each of these in turn.

Which industry accrues greater integration benefits? In our meta-analysis, we found that firms in high-tech industries may benefit more from cross-functional integration than firms in low-tech industries, likely because high-tech industries are characterized by greater complexities and turbulence. More specifically, high-technology firms face higher rates of product obsolescence and more intense competition and they invest more in R&D than low-tech firms. Cross-functional integration can enable these firms to achieve more rapid and efficient new product introductions because they can be more responsive to rapidly changing trends in technology and markets and can extract more from existing research. The managerial implication is that high-tech firms should strongly consider cross-functional integration a key to new product success. To maximize market responsiveness in such industries, managers evaluating organizational structures in high-tech firms should consider how information dissemination can be achieved most quickly and how key information can be identified and shared.

Which product accrues greater integration benefits? We also found that service products appeared to benefit more strongly from cross-functional integration than goods, perhaps because of their unique characteristics. The inseparability of services from their manufacturer implies that greater opportunities exist for customizing services to customers' specific needs. Customization requires expertise on the part of contact personnel, and cross-functional teams have a greater chance of understanding customers' needs, even when customers cannot effectively articulate them. Furthermore, although service variability offers opportunities for teams to design customized services, it also leads to greater uncertainty and increased perceptions of risk by consumers, which may be more effectively addressed by teamwork and cooperation among organizational functions. Finally, because services cannot be stored, teamwork among functions can enhance success of service products because supply and demand can be more readily matched when team members communicate (Atuahene-Gima 1996a). An important implication of our findings is that managers should recognize the potential for consumers to experience higher satisfaction levels for service products when cross-functional teams are implemented in the firm. Firms in service industries can capitalize on the enhanced ability of cross-functional teams to effect success by encouraging team members to better understand and communicate customer needs and to recognize and address potential areas of customer confusion.

Despite the findings regarding high-tech and service-based products, we do not recommend that firms in low-tech or goods industries avoid cross-functional integration when organizing for new product development. Indeed, the findings do not indicate that cross-functional integration is ineffective for low-tech products and goods but that the positive effects of integration on performance are even stronger for high-tech and service products. Because our preliminary findings indicate that, all else being equal, integration has a positive impact on success, managers in low-tech and goods-based industries should still consider cross-functional teamwork an important tool for success and should seek organizational structures and processes that can maximize the benefits. Further research can provide insights into the conditions that might lead to greater integration–success effects in specific industries. For example, would goods or low-tech products have greater integration–success effects when firms integrate at the team versus organization level? Would the effects be greater when specific functions are included/excluded in the new product team or when integration occurs at certain stages of the new product process? Do measurement artifacts, such as type of success investigated or subjective versus objective measures, affect the integration–success link more for these types of products? Additional insights such as these can contribute to the knowledge base and provide better guidelines for managers operating in these industries.

Which country environments accrue greater integration benefits? In our study, firms operating in non-Western countries report a stronger correlation between integration and success than those in Western countries. This is consistent with research in international business that suggests that differences exist in the collective cultures and norms of societies in key countries, which in turn affect the culture and climate of the organization. Hofstede (1980) identifies several dimensions along which employees' work-related values may differ according to their national backgrounds. Further research could apply these specific dimensions to enhance the understanding of culture and climate and their impact on the effectiveness of cross-functional integration (Kirca, Jayachandran, and Bearden 2005). For example, employees with greater dependence on other members of the organization (i.e., greater collectivism) or employees with a greater tendency to avoid competition among organization members (i.e., greater uncertainty avoidance) may be more likely to respond to cross-functional integration than employees who are more individualist or thrive on intrafirm competition. Meanwhile, managers implementing cross-functional integration in international settings should consider these issues when designing cross-functional teams, possibly providing additional training and supervision for functionally integrated teams with the added complexity of different nationalities. Managers operating in Western countries should recognize that effective integration may be more difficult to achieve than integration in non-Western countries and thus should take steps to ensure that the integration can be as successful as possible.

Conclusion

Our study began with the intention to bring clarity to a diverse set of studies on a key topic of interest in the area of new product development—namely, the impact of cross-functional integration on aspects of new product success. Our objective was to attempt to untangle the complex interrelationships that potentially affect this correlation. The findings indicate that though integration seems to affect new product success directly, the combination of integration with other key factors may be more important to consider. Note that most of the variables that significantly affect the integration–success relationship in our study are either managerially controlled or context specific. This suggests that managers can capitalize on their own knowledge of their products, firms, and external environments to structure a new product development team that can maximize success. Future studies in this area can be productive as researchers explore the nuances of successful cross-functional integration in different firms, with different new product processes, and in different environments, especially in the context of the many possible contingency effects such as those discussed herein.

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