University of Groningen

Measuring involvement of a network of users in NPD

Lynch, Patrick; O'Toole, Thomas; Biemans, Wim

Published in:
The Journal of Product Innovation Management

DOI:
[10.1111/jpim.12293](https://doi.org/10.1111/jpim.12293)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2016

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Lynch, P., O'Toole, T., & Biemans, W. (2016). Measuring involvement of a network of users in NPD. *The Journal of Product Innovation Management*, 33(2), 166-180. <https://doi.org/10.1111/jpim.12293>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Measuring Involvement of a Network of Customers in NPD

Patrick Lynch, Thomas O'Toole, and Wim Biemans

The new product development (NPD) literature is rife with suggestions to involve customers in the innovation process, and many firms collaborate with customers. But the extant literature does not offer much guidance concerning the nature and quality of involving such a network of customers. This paper contributes to the extant literature on customer involvement by identifying a comprehensive set of metrics to measure the involvement of a network of customers in NPD. It introduces metrics describing three aspects of customer involvement: (1) the rationale for involving a network of customers in NPD, (2) the network of customers involved in NPD, and (3) the interaction process between manufacturer and customers at the level of individual customers. These metrics help to understand the roles of customers, the timing of their involvement at each stage in the development process, the type and number of customers that are involved, as well as the frequency and intensity of their involvement.

The use of these metrics is illustrated by a study of customer network involvement by Irish business-to-business companies. Forty-six percent of the sampled firms (n = 1400) were actively involved in NPD, but very few of them involved customers in the early stages (n = 77). The involvement of customers in early NPD stages is significant, although manufacturers tend to go back to the same customers repeatedly. The intensity of customer involvement is also extensive, but even more so during the later NPD stages, especially for new products as opposed to product improvements.

By incorporating a network perspective, the proposed metrics for customer network involvement provide a new approach for researchers to study the involvement of customers in NPD.

Practitioner Points

- The paper provides a comprehensive metric for the involvement of a network of business-to-business customers in the early stages of NPD.
- An interactive rationale characterizes the involvement of manufacturers and customers with varying involvement of each throughout the early NPD stages.
- At a structural level, there is a major opportunity to involve more and more varied types of customers.
- The intensity of customer network involvement dimension of the metric provides insights into the dynamics of customer network involvement.

Introduction

Business-to-business (B2B) firms interact with a network of customers during the early stages of new product development (NPD) to reduce uncertainty and increase the likelihood of new product success. The level of interaction with customer networks varies in intensity and range, and to date no prior empiri-

cal study has attempted to propose a comprehensive metric to measure the extent to which a network of customers is involved in the NPD process. Early studies show that developing a product with superior benefits requires an understanding of customer needs and wants, a process that is ideally undertaken before actual development starts (Cooper, 1988; Stevens, Burley, and Divine, 1999). Without sufficient upfront customer interaction, significant problems may occur in later stages of the development process, including delays, increased costs, and product failure (Cooper and Kleinschmidt, 2000). The literature suggests that intense customer involvement in the early stages (from idea generation to concept development and testing) plays an important role in the NPD success (Gruner and Homburg, 2000; Herstatt and von Hippel, 1992; Lau, Tang, and Yam, 2010), but fails to clearly define and operationalize the concept of involving a network of customers (Athaide, Stump, and Joshi, 2003). This is partly caused by the literature's predominant focus on the macro analysis of sources and patterns of innovation within industries (Foxall and Johnston, 1987; Franke and Shah, 2003; Lüthje and Herstatt, 2004; Oliveira and von Hippel, 2009; Shaw, 1985; von Hippel, 1976, 1988; Voss, 1985) rather than on the nature and strength of customer interactions at a firm level (Athaide and Klink, 2009; Athaide and Zhang, 2011; Gales and

Address correspondence to: Thomas O'Toole, Head of School of Business, School of Business, Waterford Institute of Technology, Waterford, Ireland. E-mail: totoole@wit.ie. Tel: +353-51-302025.

Mansour-Cole, 1995). Given the increasing importance of involving a network of users, evident in the co-innovation and open innovation movements (Baldwin and von Hippel, 2011; Chesbrough, 2003), an attempt at developing a comprehensive metric for the involvement of a network of customers in the early stage of NPD in B2B markets is timely.

The most critical customer contributions are made during the early NPD stages, where new product ideas are generated and transformed into viable new product concepts. But the extant literature fails to clearly and comprehensively operationalize customer involvement in early NPD. This paper contributes to the literature on customer involvement by introducing a network perspective on customer involvement in NPD. It unravels the concept of customer network involvement into a set of underlying dimensions that captures (1) the reasons for involving a network of customers, (2) the structure of the customer network involved, and (3) the process of customer involvement at the dyadic level. It proposes a comprehensive set of metrics that helps researchers to understand customer involvement at both the network

(structure) and dyadic (process) level, and that suggests several avenues for future research. The paper is organized as follows. First, it discusses how customer involvement is traditionally conceptualized and operationalized. Subsequently, the methodology and findings are presented from a study aimed at exploring and operationalizing the full extent of customer involvement in early NPD. Next, it discusses the study's contributions to the extant literature, and implications and suggestions for future researchers in this area.

Conceptualizing and Operationalizing Customer Network Involvement

Over the years, several researchers have recognized the importance of intense (B2B) customer involvement in the early NPD stages (Biemans, 1992; Cooper, 1979; Gruner and Homburg, 2000; Parkinson, 1982; Rothwell et al., 1974; Shaw, 1985). Especially in B2B markets, customer need information may be costly, complex, and sticky (von Hippel, 1994), suggesting that conventional research tools are of limited use (Tidd, Bessant, and Pavitt, 2001). Traditional NPD research methods typically obtain data from representative customers and do not facilitate the discovery of new product ideas outside the familiar solution space or allow these customers to actively engage in designing really new solutions (Lüthje and Herstatt, 2004). In combination with the relatively small numbers of customers in many B2B markets, this has led researchers to advocate intense customer involvement to obtain innovative ideas (Cooper, 1979; Cooper and Kleinschmidt, 1996; Maidique and Zirger, 1984; Stevens et al., 1999) and reduce uncertainty by supplying manufacturers with more accurate customer need assessments (Cooper and Kleinschmidt, 2000; Johnsen and Ford, 2000; Tidd et al., 2001).

Unfortunately, the literature on customer involvement in early NPD offers widely varying and fragmented conceptualizations, leading to considerable confusion about its operationalization. Previous studies approach the concept from a mechanistic perspective, with the focal firm accessing a network of customers in a hierarchical rather than collaborative way (Biemans, 1991; Gruner and Homburg, 2000; Parkinson, 1982; Shaw, 1985). Consequently, these few empirical studies focus on easily measured variables, such as the number of customers involved or the stages to which they contribute, and ignore the influence customers have in the predevelopment stages (Ives and Olson, 1984). One of the core problems with these studies is that they do not measure the same set of variables, and they can

BIOGRAPHICAL SKETCHES

Dr. Patrick Lynch is a lecturer in marketing and is a director of the RIKON research group at the School of Business, Waterford Institute of Technology. His research specialism is service and business process innovation within organizational and network relationships, in particular close relationships. Current research interests include strategic innovation, knowledge transfer, interorganizational conflict, and regional tourism destination networks. His work has been widely published, and his book *Managerial Challenges in Irish Organisations: A Case Study Collection* has just been published by Blackhall.

Dr. Thomas O'Toole is the head of the School of Business at Waterford Institute of Technology, Ireland. His research interest is in the area of managing market relationships and networks, specifically the governance of interorganizational relationships. The 2nd edition of his coauthored book entitled *Strategic Market Relationships* is published by Wiley. He is an editorial board member of the *European Journal of Marketing*, and has published in journals such as *Journal of Business Research*, *Journal of Marketing Management*, *Industrial Marketing Management*, *Journal of Business and Industrial Marketing*, *European Journal of Purchasing and Supply*, *Marketing Intelligence and Planning*, and *Journal of Business Market Management*.

Dr. Wim Biemans is an associate professor at the University of Groningen, the Netherlands. His teaching and research focuses on B2B marketing and the role of marketing in new product development. His research is published in journals such as *Journal of Product Innovation Management*, *R&D Management*, *Technovation*, *Journal of Business Research*, *European Journal of Marketing*, *Journal of Business and Industrial Marketing*, and *Industrial Marketing Management*. In addition, he is the author of several books on product development and B2B marketing, including *Business to Business Marketing* (McGraw-Hill, 2010).

overestimate the level of involvement by not measuring the intensity of collaboration. Customer involvement is more complex than just the number of network ties with customers or the stages to which they contribute; it also refers to the complex cooperative interactions that occur at the dyadic level between manufacturers and single customers, and the link with other relationships within the same network (Gales and Mansour-Cole, 1995; Turnbull, Ford, and Cunningham, 1996). This is exemplified by another stream of literature, which offers rich, case-based descriptions of manufacturer–customer interactions, both from a dyad and a network perspective (Ford, Håkansson, and Johanson, 1986; Håkansson, 1987, 1990; Håkansson and Waluszewski, 2007; Laage-Hellman, 1997). While these studies provide rich descriptions of customer network involvement, they fail to offer conceptualizations and operationalizations of variables that can be used by researchers to study the extent of customer network involvement in NPD and, due to their contextual nature, by firms to improve their involvement of customer networks.

The current conceptualizations of customer network involvement as either easily measured variables (number of customers, NPD stages) or rich, contextual descriptions of interactions among NPD partners suggest a need for a comprehensive set of metrics detailing the full nature and strength of customer involvement in early NPD. This paper proposes a conceptualization of customer network involvement in terms of (1) the rationale of involving a network of customers in NPD, (2) the network structure of customer involvement in NPD, and (3) the interaction process at the dyadic level of manufacturer and customer. These three levels encompass the measures used in the two main streams of literature outlined above, are comprehensive by including both structure and process metrics, and ensure that both the nature and depth of customer network involvement is addressed.

The first metrics measure the rationale for involving a network of customers in NPD. Manufacturers tap into their customer networks because they need customer information or to access a customer's skills. The nature of the customer's contribution is closely related to the stage of the NPD process. For instance, customers may suggest ideas for new products, provide feedback on new product concepts, or assist in developing a prototype. Thus, the first metrics measure the extent to which the manufacturer and its network of customers are involved in the various NPD stages and the party that initiated the collaboration. The second set of metrics captures the structure of the customer network that is accessed by the manufacturer during NPD. This encompasses variables

such as the types of customers involved, the number of customers involved, and the timing and duration of customer involvement. These variables have all been measured in prior research, but both the types of customer involved and their number are infrequently used and less so in a collaborative NPD B2B setting. No single extant study provides a comprehensive picture of the nature of customer involvement capturing all the dimensions measured here. In practice, the structure of customer network involvement may vary significantly and depends on the nature of the innovation, the development tasks, and the availability and willingness of customers to be involved.

For instance, in Figure 1, customer network structure A describes a situation where a manufacturer of printing presses relies on new product suggestions from just a few customers, develops a new product largely by itself, and involves a local key customer to beta test the prototype, perfect the design, and act as a first customer. Product complexity and bulk requires the manufacturer to closely work with a trusted local customer to jointly perform the last NPD stages. Several of the manufacturer's developers are temporarily located at the customer site to ensure smooth progress through an iterative cycle of development, testing, and modification. In contrast, customer network structure B represents a situation where an aircraft manufacturer obtains new product ideas from a large number of international airlines, collaborates with carefully selected key customers during the development of the new aircraft, uses another airline to test the new aircraft and its systems during several test flights, and employs still another airline for the first commercial flight and to assist with promotional launch activities. The third set of metrics focuses on the interaction process that occurs between a manufacturer and an individual customer. This refers to the customer's participation and influence in NPD, and includes variables such as the organizational level at which the interaction takes place, the frequency of interaction at each stage, and the intensity of interaction. The measurement of the frequency of interaction at each stage of the NPD process by a network of customers is not a metric common to many studies (see, e.g., Biemans, 1991; Gales and Mansour-Cole, 1995; Gruner and Homburg, 2000; Shaw, 1985; Voss, 1985), and the intensity scale, designed to assess the depth of involvement, is a new metric developed for the current study. The use of this comprehensive set of metrics, encompassing rationale, network structure, and network process, is illustrated by the results from a study of customer involvement in early NPD in Irish B2B firms.

Figure 1. Different Customer Network Structures

Research Method

The companies for inclusion in this study were selected from a Kompas Ireland database, consisting of 2842 manufacturing companies dispersed across eight industries. Managing directors and NPD managers were selected as ideal respondents for this study because of their high level of knowledge about the company and its NPD activities (Rindfleisch and Moorman, 2001). Over a three-month period, 1400 companies were interviewed by telephone to identify those companies that engage in NPD activities in Ireland ($n = 572$) and involve their B2B customers in the early stages of the NPD process ($n = 77$). Subsequently, a mail questionnaire was administered to those companies identified as involving B2B customers in the early NPD stages ($n = 77$). The survey was developed in several stages: (1) constructs and items were borrowed from the extant literature, (2) content validity was established through sorting by three academics, (3) interviews with five NPD practitioners were used to refine the items, (4) the resulting items were pretested with nine companies, and (5) the questionnaire was subjected to a detailed review by a panel of six academics and practitioners. In general, the pretest and the panel review demonstrated a sound research instrument that measures the nature, intensity, and performance impact of customer involvement in the early stages of NPD. From

the 68 surveys administered (77 minus the 9 used for the pretest), 51 were returned. One survey was removed from consideration due to incomplete data, giving a 75% response rate. Table 1 offers more details about the sample of firms.

The suggested metrics to measure the involvement of a network of customers in NPD mostly use nominal scales, allowing for categorization of manufacturer–customer interactions. The type of customer involved is measured by an adapted version of Li and Calantone’s (1998) customer demandingness and sophistication scale. Table 2 presents the reliability analysis of this demandingness and sophistication scale.

The NPD stages during which manufacturers involve their network of customers in their NPD processes were assessed by identifying both the stages during which manufacturers initiated the involvement of their customer networks and the number of stages during which customers actually contributed to their NPD processes.

To measure the customer network involvement intensity during each of the early NPD stages, a new scale had to be developed that is applicable in all stages of the predevelopment process and allows for comparisons across stages. A multi-item measure of the customer network involvement intensity was developed following the procedure outlined by Hinkin (1995), using a deductive approach. A number of tentative items were either

Table 1. Sample Profile

Characteristics	%
Nature of business	
Pharmaceutical/chemical	16
Electrical and electronic engineering	18
Industrial machinery	18
Food, tobacco, and beverages	16
Metal manufacture	14
Timber, furniture, and paper	8
Telecommunications	8
Transport	2
Number of employees	
1–50	66
51–100	12
101–200	6
201–500	8
501–999	4
1000+	4
Turnover	
Under €5 million	58
€5 million–€9.99 million	12
€10 million–€19.99 million	10
€20 million–€49.99 million	10
€50 million–€99.99 million	8
€100 million plus	2
Ownership	
Irish owned	68
Foreign owned	32

n = 50.

borrowed or developed from the extant literature to represent the different elements of the construct being measured (see Table 3).

Next, to establish content validity, the construct and items were presented to three academics for sorting (Hinkin, 1995; Schriesheim and Hinkin, 1990). The academics were asked to state which items in the construct they believe represent the domain of the concept being measured and if there are any other items that should be included. To further eliminate items from consideration, a panel of judges, consisting of three academics and three NPD managers representative of the target population, was asked to allocate a fixed number of rating units

among the 11 items remaining after the initial sorting, to reflect their relative preferences for each item that best represented the concept, for example, project duration. The items were rated on a scale from 1 to 6, with 1 representing low preference and 6 the most preferred. The scores for each item were summated and those with the highest scores were selected (Table 3). An additional test for face validity was then conducted with NPD researchers at a conference, which indicated that the selected items appear to be measuring the concept. Following good practice (Li and Calantone, 1998), interviews were then conducted for item refinement. Five NPD practitioners were asked to comment on the relevance and clarity of the measure, and the items were refined accordingly.

For each of the six predevelopment stages, a five-item scale was administered to measure the customer network involvement intensity. In lieu of repeatedly presenting the same measure validation procedure for each of the six stages, the idea generation stage is used to illustrate in detail how the different diagnostic tests empirically support the conceptualization of the construct. This is followed by the overall measure validation results for each stage. For each of the six stages, the analysis of the validation tests revealed that item 5 was problematic and subsequently removed. Thus, the customer network involvement intensity in all six stages was ultimately examined using a four-item scale. For the idea generation stage, Table 4 describes construct items and presents the first and final iteration of results from the different diagnostic methods for this stage. In examining the first iteration of results, it can be clearly seen that item 5 is problematic with an item–total correlation of $-.462$. There is a strong argument for removing item 5 from consideration given that its removal significantly increases the alpha to $.891$ and its low communality figure ($.294$). In relation to exploratory factor analysis, the results indicate that the set of items as a whole is suitable to try to factor analyze ($.797$).

The next step was to redo the series of tests removing item 5, which is presented in Table 4, resulting in an alpha score of $.891$. The Kaiser–Meyer–Olkin (KMO) values for

Table 2. Type of Customer: Reliability Analysis of Demandingness and Sophistication Scale

Items	Item-to-Item Correlation	Coefficient Alpha
Our customers expect continuous improvements to existing products.	.432	.60
Our customers make suggestions as to how we should improve our products.	.319	
Our customers are highly sophisticated in terms of understanding technical specifications of our product.	.302	
Our customers demand high product quality and reliability.	.429	
Our customers are sensitive to product costs.	.312	

Table 3. Item Development for the Customer Network Involvement Intensity Scale

Intensity Concept Domain	Items Remaining after Sorting	Summated Scores from Judging Panel ^a	Literature Source
Communication frequency	1. The frequency of communication exchange with customers was high.	N/A	Developed from literature: Voss (1985), Gales and Mansour-Cole (1995), Biemans (1992)
Responsibility	2. The degree of responsibility held by the customer was high.	N/A	Developed from the literature: Biemans (1992), von Hippel (1976, 1977a, 1977b, 1978), Shaw (1985)
Project duration	3. The duration of joint work was long.	18	Borrowed from Gruner and Homburg (2000)
Activity level	4. The time-span of the development work was long.	30	Developed from literature: Biemans (1992)
	5. The user has no involvement.	11	Borrowed from Lucas (1974), Ives and Olson (1984)
	6. The user is involved in an unplanned, informal way, e.g., chance encounters, etc.	14	Biemans (1991)
	7. The user is involved through conducting market research such as questionnaires, interviews, etc.	20	Biemans (1991)
	8. The user and the manufacturer separately develop new ideas.	22	Biemans (1991)
	9. Activities in this stage were jointly performed.	33	Developed from literature: Gales and Mansour-Cole (1995), Biemans (1992)
Degree of interaction	10. Customers are fully represented on our product development team.	26	Developed from literature: Biemans (1992)
	11. The intensity of customer interaction was high.	N/A	Gruner and Homburg (2000)

The items printed in bold font were selected to measure the intensity of user involvement. ^a The items were rated on a scale from 1 to 6, with 1 representing low preference and 6 the most preferred.

the set of items and each individual item is now acceptable. One component measuring the customer network involvement intensity is extracted. The customer network involvement intensity component explains 75.6% of the variance in the pool of items.

Table 5 describes the remaining six stages and presents the Cronbach's alpha, factor analysis, and the average variance extracted for the customer network involvement intensity at each stage of the NPD process. An examination of the coefficient alphas shows that all exceed the minimum .8 value recommended by Nunnally (1978) for early stage research, and the .6 recommended value for exploratory research by Hair, Black, Babin, and Anderson (2009). The lowest item-total correlation is .592, and the factor analysis for each predevelopment stage reveals that the items load highly on a single factor, which provides support for the unidimensionality of the scale (Hair et al., 2009). In addition, within each stage, the average variance extracted is more than .7, and thus exceeds the generally acceptable cutoff levels (Gruner and Homburg, 2000). Overall, the data show satisfactory empirical support for our conceptualization of the construct. Measures were also included to control for market competitiveness, customer dependence, and length of the relationships. No differences between the firms were found on any of these measures.

How Irish B2B Firms Involve Customer Networks

The proposed set of metrics to measure the involvement of a network of customers in NPD is illustrated by a study of Irish B2B manufacturers that involve networks of customers during the early stages of the NPD process. The presentation of the findings follows the triptych of (1) customer network involvement rationale, (2) customer network involvement structure, and (3) customer network involvement process.

Customer Network Involvement Rationale: Reasons for Involving Customers

The first variable of interest is the rationale to involve a network of customers in NPD. The reasons for involving customers are governed by the nature of the desired customer contributions to the early NPD stages. Table 6 highlights that in the 50 development projects analyzed, customers were found to contribute to all six early NPD stages.

Table 6 illustrates a large variety of reasons why manufacturers involve customers from their network in

Table 4. Diagnostic Tests for Measure Validation of the Customer Involvement Intensity Scale Using the Idea Generation Stage as an Example

Item Number	First Iteration of Diagnostic Tests for Measure Validation Item Description	Internal Consistency		Factor Analysis			Number of Factors		Factor Loadings	
		Item–Total Correlation	Alpha if Item Is Deleted	Coefficient Alpha	Sampling Adequacy ^a	KMO ^b	Communality	Eigenvalue	Explained Variance (%)	Component 1
1	The frequency of communication exchange with customers was high.	.622	.524	.662	.797	.834	.766	3.247	64.948	.840
2	The intensity of customer interaction was high.	.671	.488			.814	.766	.821	16.424	.875
3	The degree of responsibility held by the customer was high.	.762	.415			.748	.721	.433	8.651	.849
4	Activities in this stage were jointly performed.	.733	.432			.779	.760	.311	6.215	.872
5	The time-span of development work was long.	–.462	.891			.852	.294	.188	3.770	–.542
In the second iteration of tests, item 5 was removed from consideration due to its low item–total correlation, its low communality figure, and that the alpha would rise to .89.										
Second Iteration of Diagnostic Tests for Measure Validation										
1	The frequency of communication exchange with customers was high.	.712	.878	.891	.778	.800	.701	3.024	75.596	.837
2	The intensity of customer interaction was high.	.766	.857			.800	.764	.473	11.814	.874
3	The degree of responsibility held by the customer was high.	.782	.852			.752	.771	.311	7.770	.878
4	Activities in this stage were jointly performed.	.794	.847			.767	.787	.193	4.820	.887

^{a,b} The KMO (Kaiser–Meyer–Olkin) measure of sampling adequacy for the set of items, and for each individual item.

Table 5. Results of Measure Validation for the Customer Involvement Intensity Scale in Each Stage of the NPD Process^a

Stage	Item Description	Cronbach's Alpha	Lowest Item–Total Correlation	Average Variance Extracted
Idea generation	The frequency of communication exchange with customers was high. The intensity of customer interaction was high. The degree of responsibility held by the customer was high. Activities in this stage were jointly performed.	.89	.712	.76
Idea screening	See above	.89	.592	.70
Preliminary market assessment	See above	.88	.702	.71
Preliminary technical assessment	See above	.94	.736	.80
Concept development	See above	.94	.796	.81
Concept testing	See above	.94	.783	.81

^a Reports final factor analysis for each stage of the NPD process based on the procedure outlined in Table 4 for idea generation.

their NPD efforts, ranging from having them contribute to the generation of ideas to assisting with idea screening, preliminary market and technology assessments, and product concept development and testing. It is interesting to note that only in the concept development ($t = 3.382$, $p = .001$) and the concept testing ($t = 2.125$, $p = .032$) stages there is a significant relationship between customer involvement and new product newness. In all but 6 of the 26 NPD cases (77%), customers contribute to the concept development stage, and in all but one new product case (96%) they contribute to concept testing. In contrast, for the product improvement projects ($n = 24$), these numbers are only 16% and 33%. The significance of customer contributions to early NPD activities is further illustrated by the fact that customers initiated 46% of the 50 development projects studied.

These findings support the generally accepted idea that manufacturers use their network of customers to obtain significant contributions to early NPD stages (Biemans, 1991; Holt, 1985; Lüthje, 2003; Parkinson, 1982; von Hippel, 1976, 1977a, 1977b, 1978; Voss, 1985). It also illustrates that multiple manufacturer–customer interactions occur throughout the predevelopment process, and customers play an active role in terms of project initiation. This remains consistent with Biemans's (1991) observation that von Hippel (1976, 1978) underestimates the role of the manufacturer during early NPD stages. For instance, although manufacturers are involved in idea generation in only 58% of the cases, this involvement increases immediately to 100% during the subsequent stages.

Table 6. Customer Network Contributions to Early NPD Stages

	Idea (%)	Screening (%)	Preliminary Market Assessment (%)	Preliminary Technical Assessment (%)	Concept Development (%)	Concept Test (%)
Involvement of customers						
New product ^a	50	62	77	65	77	96
Improved product ^b	63	71	75	67	16	33
Total	56	66	76	66	56	86
Involvement of manufacturers						
New product	32	100	100	100	100	100
Improved product	26	100	100	100	100	100
Total	58	100	100	100	100	100
NPD process initiated by						
Type of NPD	Customer (%)		Manufacturer (%)			
New product	24		28			
Improved product	22		26			
Total	46		54			

^a New product: $n = 26$. ^b Improved product: $n = 24$.

Customer Network Involvement Structure: Type of Customers

Having determined the nature of the customer contributions that they are looking for, manufacturers need to critically assess their network of customers to determine the most appropriate type of customers to provide these contributions. Several researchers suggest that “lead users”—that is, users who are more demanding and sophisticated than others and perceive market needs earlier than the market majority—are very suitable (Eisenberg, 2011; Lüthje, Herstatt, and von Hippel, 2005; Morrison, Roberts, and Midgley, 2004; Spann, Ernst, Skiera, and Soll, 2009; Urban and von Hippel, 1988; von Hippel, 1986, 1988). Because lead users are better prepared to develop new ideas for tomorrow’s products, firms may gain a competitive advantage by involving them in their NPD efforts (Lilien, Morrison, Searls, Sonnack, and von Hippel, 2002).

Most Irish manufacturers (82%) state that they interact with customers featuring lead user characteristics (very high or high demandingness and sophistication) (Table 7). The higher customer demandingness and sophistication found in new product projects in comparison to product improvements suggests that these customers are not satisfied with existing products and look for new products to replace the old ones (Li and Calantone, 1998). And in 46% of the cases, it is the customer who perceives a need in the market earlier than the majority of customers in those markets. Thus, maintaining network ties with customers results, in nearly half of the firms, in knowledge of needs ahead of the market, which should translate into new/improved product introductions before competitors and improved business performance. However, it must be stressed that while a significant per-

centage of customers initiate the process of NPD with a perceived market need, in only four cases does the customer have a conceived working solution for his problem, and in those instances the perceived solution was an improvement of an existing product.

Customer Network Involvement Structure: Size of the Customer Network

From a network structure perspective, another relevant question for manufacturers is how many customers to involve during each NPD stage. The average manufacturer involves approximately three customers in any particular predevelopment stage (Table 8). This emphasizes the need for accurate information about the desired nature of collaboration with all relevant customers in the manufacturer’s network.

The analysis shows that the mean number of customer ties employed during early NPD stages does not depend on the stage or type of development. The only significant difference in the data in Table 8 is the involvement of a higher number of customers in concept development for improved products than for new ones. Perhaps the reason that the size of the customer network is similar across the NPD stages is the fact that 70% of the respondents indicate that out of their network of customers they select the same few customers for all their development projects and that these customers are used throughout the process. This display of “network ossification” is a worrying phenomenon because it means that most Irish manufacturers make the mistake of limiting themselves to just a few select customers in all projects. This network ossification may result in groupthink, with high levels of familiarity creating a sense of unanimity that suppresses the expression of alternative perspectives, leading to poor group

Table 7. Type of Customer Involved

	New Product	Improved Product	Total
Fraction of customers who perceive needs and build solutions			
Customers who perceived a need ahead of the market	22%	24%	46%
Customers who conceived a full working solution	0%	8%	8%
Level of customer demandingness and sophistication			
Level			
1 = Very high	6%	16%	22%
2 = High	32%	28%	60%
3 = Medium	14%	4%	18%
4 = Low	0%	0%	0%
5 = Very low	0%	0%	0%
Mean customer demandingness and sophistication	2.12	1.68	1.91
New versus improved ANOVA	$F = 60.757, df 1, 298, p < .0005$		

$n = 50$.

Table 8. Number of Customers Involved per Type of NPD

Type of NPD	Idea	Screening	Preliminary Market Assessment	Preliminary Technical Assessment	Concept Development	Concept Testing
New product ^a	2.85	2.69	3.38	2.63	2.52	3.08
Improved product ^b	2.80	3.06	3.12	2.82	3.80	3.22
Total	2.82	2.88	3.26	2.72	2.94	3.14
New versus improved	$t = .076$ $df = 26$	$t = .777$ $df = 31$	$t = .520$ $df = 36$	$t = .404$ $df = 24$	$t = 2.32$ $df = 29$	$t = .290$ $df = 41$
<i>t</i> -tests	$p = .940^c$	$p = .443$	$p = .606$	$p = .689$	$p = .027$	$p = .773$

^a New product: $n = 26$. ^b Improved product: $n = 24$. ^c Two-tailed *t*-tests.

decisions (Esser, 1998; Janis, 1972). Involving only a select few familiar customers out of the total available network of customers may stifle innovation (Katz, 1982).

Customer Network Involvement Structure: Timing of Customer Involvement

Next, manufacturers need to decide on the timing of the collaboration with their network of customers. That is, both the development stage during which the manufacturer–customer collaboration begins and the duration of that collaboration need to be determined.

In almost three quarters of the cases, manufacturers initiate involvement of their customer network during the generation or screening of new product ideas (Table 9). There are no statistically significant differences between the timing of customer involvement for new and improved NPD projects (*t*-tests, $p < .05$). Looking at the duration of the manufacturer–customer collaboration, it is clear that most manufacturers collaborate with customers during multiple predevelopment stages. This demonstrates that manufacturers use their ties with customers

throughout the predevelopment process, with the vast majority commencing customer involvement during the first idea phase.

Customer Network Involvement Process: Management of the Collaboration

The first metric measuring the interaction process between manufacturer and customer at the dyadic level concerns the overall management of the collaborative relationship. Even though in almost half of the cases the NPD process was initiated by the customer (Table 6), Table 10 illustrates that even when the customer approaches the manufacturer, in only two cases does the customer go on to dominate decisions regarding inputs. In the vast majority of the development projects, decisions about inputs or contributions of the participants to the early stages are made either by the manufacturer or jointly by both the manufacturer and the customer. Similarly, respondents report that in all but two cases, management of the predevelopment stages was either done by the manufacturer or jointly by the manufacturer and customer.

Table 9. Timing and Duration of Customer Involvement

Type of NPD	Stages Where Customers' Involvement Was Initiated					
	Idea (%)	Screening (%)	Preliminary Market Assessment (%)	Preliminary Technical Assessment (%)	Concept Development (%)	Concept Test (%)
New product ^a	26	10	10	0	6	4
Improved product ^b	30	6	12	0	0	0
Total	56	16	22	0	6	4
	Number of Stages During Which Customers Were Involved					
	One Stage (%)	Two Stages (%)	Three Stages (%)	Four Stages (%)	Five Stages (%)	Six Stages (%)
New product	2	6	6	14	12	12
Improved product	0	12	12	6	10	8
Total	2	18	18	20	22	20

^a New product: $n = 26$. ^b Improved product: $n = 24$.

Table 10. Management of the Collaboration

Type of New Product Development	Control over Decisions Regarding Inputs			Predevelopment Stages Managed by		
	Customer (%)	Manufacturer (%)	Joint (%)	Customer (%)	Manufacturer (%)	Joint (%)
New product ^a	8	50	42	0	77	23
Improved product ^b	0	42	58	0	83	17
Total	4	46	50	0	80	20

^a New product: $n = 26$. ^b Improved product: $n = 24$.

Customer Network Involvement Process: Frequency of Interaction

A second proposed metric to assess the interaction process between a manufacturer and its customer network measures the frequency of interaction (measured by a single-item scale on a 5-point Likert scale).

The Irish manufacturers tend to interact frequently with their customers during early NPD stages, which does not depend on the stage or newness of the product (Table 11). The high contact frequency during all stages suggests an active involvement of customers in predevelopment activities. Other studies show that the greater the contact frequency during predevelopment activities, the greater the likelihood that the need uncertainty associated with the fuzzy front end will be reduced by supplying manufacturers with a more accurate assessment of customer requirements, and consequently a better fit between product idea and customer need (Biemans, 1992; Cooper and Kleinschmidt, 1995, 2000; Gales and Mansour-Cole, 1995; Li and Calantone, 1998; Shaw, 1985).

Customer Network Involvement Process: Intensity of Involvement

The present study also used a composite measure to assess the intensity of the collaborative relationship between manufacturer and customer. The four-item

measure developed here (Table 5) builds on existing single-item scales used to measure a comparable conceptualization of intensity (Gales and Mansour-Cole, 1995; Gruner and Homburg, 2000). The data from the intensity scale, expressed as percentages of high and low customer involvement in each stage of the NPD process, together with the mean involvement for new and improved products in each stage, offer a visual of what the sample firms are really doing (Table 12).

The overall intensity of customer involvement for each predevelopment stage, except the idea screening stage, exceeds the center of the scale. Many firms have no customer involvement during the first two stages, and this trend continues up to the concept development stage. The concept testing stage has the highest number of customers being involved by manufacturers and the highest mean intensity of involvement. These findings illustrate that the potential of involving a network of customers is not fully realized, even more so considering the fact that this study uses a census of manufacturers who involve customers, taken from a larger telephone survey. Given the small sample size, it is not possible to do multivariate data analysis, but a performance measure (adapted from Biemans, 1992; Bruce, Leverick, and Littler, 1995) is included to capture the benefits manufacturers perceive they got from involving a network of customers (Table 13).

The majority of respondents believe that accessing a network of customers during the early NPD stages ensures a strong understanding of customer requirements,

Table 11. Frequency of Customer Involvement^a

Type of NPD	Idea	Screening	Preliminary Market Assessment	Preliminary Technical Assessment	Concept Development	Concept Testing
New product ^b	3.69	3.25	3.55	3.47	3.70	3.84
Improved product ^c	3.60	2.88	3.33	3.06	3.00	3.56
Total	3.64	3.06	3.45	3.27	3.50	3.72
New versus improved	$t = .233$ $df = 26$	$t = .969$ $df = 31$	$t = .719$ $df = 36$	$t = .971$ $df = 31$	$t = .1734$ $df = 26$	$t = .719$ $df = 41$
<i>t</i> -tests	$p = .817^d$	$p = .340$	$p = .447$	$p = .339$	$p = .095$	$p = .379$

^a Mean number of manufacturer–customer interactions during each stage. ^b New product: $n = 26$. ^c Improved product: $n = 24$. ^d Two-tailed *t*-tests.

Table 12. Intensity of Customer Involvement Percentages^a

Intensity of Customer Involvement	Idea (%)	Screening (%)	Preliminary Market Assessment (%)	Preliminary Technical Assessment (%)	Concept Development (%)	Concept Testing (%)
5 (very high)	2	2	2	2	2	4
4 (high)	6	24	16	16	8	8
3 (moderate)	22	20	24	14	20	14
2 (low)	24	18	30	28	22	44
1 (very low)	2	2	4	6	4	16
0 (none)	44	34	24	34	44	14
Type of New Product Development						
New product ^b	3.21	2.81	3.13	3.37	3.41	3.61
Improved product ^c	3.25	2.89	3.08	3.08	2.84	3.53
Total	3.23	2.83	3.11	3.23	3.25	3.58

^a Mean intensity of customer involvement (1 = very low; 5 = very high). ^b New product: $n = 26$. ^c Improved product: $n = 24$.

and in general makes the NPD process more responsive to customer needs. In addition, it is perceived to accelerate the NPD process, reduce costs, and contribute to only good concepts proceeding to development. Although most respondents consider customer involvement to be beneficial, they nevertheless feel that it complicates the development process and makes it more difficult to control and manage. This finding underscores the need to carefully design and manage both a network of customers and individual customer relationships.

Concluding Discussion

Many firms involve multiple customers in their NPD efforts, which raises numerous issues about how to effectively design and manage the involvement of such a network of customers. Unfortunately, the extant literature is strongly biased toward either the use of a few easily quantifiable metrics, such as the number of customers to involve and the number of NPD stages to which they contribute (Gruner and Homburg, 2000;

Parkinson, 1982, 1985; Shaw, 1985), or rich case descriptions about lead users and interaction in networks (Håkansson, 1987; Laage-Hellman, 1997; Ritter, Wilkinson, and Johnston, 2004; von Hippel, 1986). These studies have in common that they fail to provide a set of metrics that adequately captures the complexities of a firm's collaborative relationships with a network of customers. This paper is the first to identify the relevant dimensions of accessing a network of customers and capture them in a comprehensive set of metrics, consisting of (Table 14):

1. the customer network involvement *rationale*: stages contributed to by customers, stages contributed to by the manufacturer, party initiating the collaboration;
2. the customer network involvement *structure*: type of customers involved, size of the customer network, timing of customer involvement, duration of customer involvement;
3. the customer network involvement *process*: responsibility for collaboration, frequency of interaction, intensity of interaction.

Table 13. The Effect of Involving Customers in the Early Stages of the NPD Process

How does customer involvement in predevelopment activities affect the product development process . . .	Agree/Strongly Agree (%)	Hard to Say (%)	Disagree/Strongly Disagree (%)
Ensures that only good concepts proceed to actual development	66	16	18
Reduces the cost incurred in actual product development	62	22	16
Accelerates the development process	74	10	16
Ensures a strong understanding of customer requirements	90	6	4
Makes product development more responsive to customer needs	94	0	6
Makes the product development process complicated ^a	66	14	20
Makes it more difficult to manage and control the process ^a	66	16	18

$n = 50$. ^a Items reversed and eliminated during scale purification ($\alpha = .718$).

Table 14. Metrics for the Involvement of a Network of Customers in NPD

Metric	Irish B2B Manufacturers
<i>Customer network involvement rationale</i>	
Stages contributed to by customers	Customers are involved in all early NPD stages. The extent of customer involvement is hardly related to the degree of new product newness.
Stages contributed to by manufacturer	Manufacturers are involved in idea generation in only 58% of the cases, but this increases to 100% during the subsequent stages.
Party initiating the collaboration	In almost half of the cases, customer involvement was initiated by the customer.
<i>Customer network involvement structure</i>	
Type of customers involved	Most manufacturers involve customers with lead user characteristics. But this typically only results in product improvements.
Size of the customer network	On average, manufacturers involve three customers during each early NPD stage, independent of product newness. Manufacturers often involve the same few customers throughout the NPD process.
Timing of customer involvement	In more than half of the cases, manufacturers initiated customer involvement during idea generation, independent of product newness.
Duration of customer involvement	One in five manufacturers involved customers during all early NPD stages. 60% of manufacturers involved customers during four or more early NPD stages.
<i>Customer network involvement process</i>	
Responsibility for collaboration	In almost all cases, decisions about inputs and overall management of the NPD process were either done by the manufacturer or jointly by the manufacturer and customer.
Frequency of interaction	On average, manufacturers interact 3–4 times with customers during each early NPD stage.
Intensity of interaction	Many manufacturers do not involve customers during the first two NPD stages; when customers are involved, the intensity of interaction is above the center of the scale.

Contributions to the Extant Literature

The metrics suggested in this paper reflect findings from previous studies. For instance, numerous studies have demonstrated that firms frequently use customer ties to improve the success of their innovation efforts, in industries such as scientific instruments, industrial machinery, software, and medical equipment (Biemans, 1992; Foxall and Tierney, 1984; Herstatt and von Hippel, 1992; Lettl, 2005; Lüthje, 2003; Oliveira and von Hippel, 2009; Parkinson, 1982; Shaw, 1985; von Hippel, 1976, 1977a; Voss, 1985). The proposed set of metrics also integrates the extensive literature about the role and characteristics of lead users (Franke and Shah, 2003; Herstatt and von Hippel, 1992; Hiennerth and Lettl, 2011; Lettl, 2005; Lüthje, 2003; Lüthje and Herstatt, 2004; Lüthje et al., 2005; Morrison, Roberts, and von Hippel, 2000; Morrison et al., 2004; von Hippel, 1976, 1977a, 1977b, 1978, 1986, 1989). And it reflects the findings from studies about collaborative networks and open innovation (Biemans, 1992; Chesbrough, 2003; Ford et al., 1986; Håkansson, 1987, 1990; Huizingh, 2011; Laage-Hellman, 1997). This paper offers several contributions to the extant literature.

First, in contrast to the extant literature that focuses on either dyadic interaction with customers or collaboration with a multitude of different partners, the present study shows how firms access customer networks for collab-

orative NPD. While the research stream started by von Hippel (1976, 1977a, 1977b, 1978) emphasizes that lead users develop innovative solutions, this study argues that it is not so much about the locus of innovation, but rather about the interaction between the key parties involved. Thus, the present study combines the literatures on customer involvement and collaborative networks by developing a comprehensive framework for the involvement of a network of customers in NPD.

Second, it presents a comprehensive set of metrics for the involvement of a network of B2B customers in NPD that reflects the decisions that firms need to make when they want to involve their network of customers in NPD. This holistic set of metrics both integrates the literatures on customer involvement in NPD, lead users, collaborative networks, and open innovation, and shifts the focus from dyadic collaborative relationships to involving a network of customers in NPD.

Third, by applying the metrics to an empirical context of Irish manufacturers (Table 14), the paper illustrates how manufacturers fail to fully realize the benefits of maintaining extensive customer ties during the early NPD stages: (1) many firms do not involve customers during the first two stages (Table 6), (2) when customers are involved in these stages, the involvement tends to be low (Table 12), (3) firms typically involve only two or three customers in early NPD stages (Table 8), and (4) customer involvement in new product idea screening tends to

be low (Table 12). These findings serve to counter the generally overwhelming positive literature extolling the virtues of collaboration in networks. In addition, they reintroduce the phenomenon of “customer network ossification,” which was first reported in a study of a Dutch medical equipment industry where manufacturers habitually involved the same set of customers again and again, usually because they were located nearby, and irrespective of the specific demands of the innovation project (Biemans, 1991).

Directions for Future Research

The set of metrics proposed in this paper offers an expanded perspective on customer network involvement in NPD and suggests various avenues for future research. Although the potential of the scales used in this study for explaining the intensity of customer network involvement across NPD stages is clear, further reliability testing along with modeling relationship between metrics and other variables (such as firm performance) will increase their power. In addition, the use of larger samples will allow researchers to put firms into comparative groups based on the strength of their involvement of customers. Explanation of this variation will provide direction for further customer network involvement model building and refinement.

Future researchers may also try to identify other metrics that fit within the triptych of customer network involvement rationale, network, and process, and add to their explanatory power. For instance, researchers may develop specific measures to assess the interaction between different customers that are simultaneously involved by a manufacturer. This will further refine the characteristics of the customer network tapped into by manufacturers. Future research should also focus on testing the reliability of the proposed metrics in other contexts. For instance, one might investigate whether these metrics are also applicable to B2C markets. In addition, it would be interesting to see if the customers’ perspectives varied from those of the manufacturers and what might explain any mismatch. Alternatively, future researchers may look beyond the early NPD stages and investigate the involvement of customers during the full NPD process.

This paper presents an expanded perspective on customer involvement in NPD, by looking not at single customers but a network of customers, and proposing a comprehensive set of metrics, including the rationale for customer network involvement, the structure of customer network involvement, and the process of interaction between manufacturer and customers. Such an expanded

perspective and understanding of customer network involvement in NPD also improves managers’ understanding of customer involvement at both the network (structure) and dyadic (process) level, which helps them effectively manage their network of customers and thus improve the effectiveness of their innovation efforts.

References

- Athaide, G. A., and R. R. Klink. 2009. Managing seller-buyer relationships during new product development. *Journal of Product Innovation Management* 26 (5): 566–77.
- Athaide, G. A., R. L. Stump, and A. W. Joshi. 2003. Understanding new product co-development relationships in technology-based, industrial markets. *Journal of Marketing Theory and Practice* 11 (3): 46–58.
- Athaide, G. A., and J. Q. Zhang. 2011. The determinants of seller-buyer interactions during new product development in technology-based industrial markets. *Journal of Product Innovation Management* 28 (S1): 146–58.
- Baldwin, C., and E. von Hippel. 2011. Modeling a paradigm shift: From producer innovation to user and open innovation. *Organizational Science* 22 (6): 1399–417.
- Biemans, W. G. 1991. User and third party involvement in developing medical equipment innovations. *Technovation* 11 (3): 163–83.
- Biemans, W. G. 1992. *Managing innovation within networks*. London: Routledge.
- Bruce, M., F. Leverick, and D. Littler. 1995. A management framework for collaborative product development. In *Product development: Meeting the challenge of the design-marketing interface*, ed. M. Bruce and W. G. Biemans, 161–80. Chichester, UK: John Wiley and Sons.
- Chesbrough, H. W. 2003. *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.
- Cooper, R. G. 1979. The dimensions of industrial new product success and failure. *Journal of Marketing* 43 (3): 93–103.
- Cooper, R. G. 1988. Predevelopment activities determine new product success. *Industrial Marketing Management* 17 (2): 237–47.
- Cooper, R. G., and E. J. Kleinschmidt. 1995. Benchmarking the firm’s critical success factors in new product development. *Journal of Product Innovation Management* 12 (5): 374–91.
- Cooper, R. G., and E. J. Kleinschmidt. 1996. Winning businesses in product development: The critical success factors. *Research-Technology Management* 50 (3): 52–66.
- Cooper, R. G., and E. J. Kleinschmidt. 2000. New product performance: What distinguishes the star products. *Australian Journal of Management* 25 (1): 17–46.
- Eisenberg, I. 2011. Lead-user research for breakthrough innovation. *Research-Technology Management* 54 (1): 50–58.
- Esser, J. K. 1998. Alive and well after 25 years: A review of groupthink research. *Organizational Behavior and Human Decision Processes* 73 (2/3): 116–41.
- Ford, D., H. Håkansson, and J. Johanson. 1986. How do companies interact? *Industrial Marketing and Purchasing* 1 (1): 26–41.
- Foxall, G., and B. Johnston. 1987. Strategies of user-initiated product innovation. *Technovation* 6 (1): 77–102.
- Foxall, G. R., and J. D. Tierney. 1984. From CAP 1 to CAP 2: User-initiated innovation from the user’s point of view. *Management Decision* 22 (5): 3–15.
- Franke, N., and S. Shah. 2003. How communities support innovative activities: An exploration of assistance and sharing among end users. *Research Policy* 32 (1): 157–78.
- Gales, L., and D. Mansour-Cole. 1995. User involvement in innovation projects: Toward an information processing model. *Journal of Engineering and Technology Management* 12 (1/2): 77–109.

- Gruner, K. E., and C. Homburg. 2000. Does customer interaction enhance new product success? *Journal of Business Research* 49 (1): 1–14.
- Hair, J. F., W. C. Black, B. J. Babin, and R. E. Anderson. 2009. *Multivariate data analysis* (7th ed.). Upper Saddle River, NJ: Pearson.
- Håkansson, H., ed. 1987. *Industrial technological development: A network approach*. London: Croom Helm.
- Håkansson, H. 1990. Technological collaboration in industrial networks. *European Management Journal* 8 (3): 371–79.
- Håkansson, H., and A. Waluszewski, eds. 2007. *Knowledge and innovation in business and industry: The importance of using others*. London: Routledge.
- Herstatt, C., and E. von Hippel. 1992. Developing new product concepts via the lead user method: A case study in a “low-tech” field. *Journal of Product Innovation Management* 9 (3): 213–21.
- Hienert, C., and C. Lettl. 2011. Exploring how peer communities enable lead user innovations to become standard equipment in the industry: Community pull effects. *Journal of Product Innovation Management* 28 (s1): 175–95.
- Hinkin, T. 1995. A review of scale development practices in the study of organisations. *Journal of Management* 21 (5): 967–88.
- Holt, K. 1985. User-oriented product innovation—Some research findings. *Technovation* 3 (3): 199–208.
- Huizingh, E. K. R. E. 2011. Open innovation: State of the art and future perspectives. *Technovation* 31 (1): 2–9.
- Ives, B., and M. H. Olson. 1984. User involvement and MIS success: A review of research. *Management Science* 30 (5): 586–603.
- Janis, I. L. 1972. *Victims of groupthink*. Boston: Houghton-Mifflin.
- Johnsen, T., and D. Ford. 2000. Managing collaborative innovation in complex networks: Findings from exploratory interviews. 16th Annual IMP Conference, September 7–9, Bath, England.
- Katz, R. 1982. The effects of group longevity on communication and performance. *Administrative Science Quarterly* 27 (1): 81–104.
- Laage-Hellman, J. 1997. *Business networks in Japan, supplier-customer interaction in product development*. London: Routledge.
- Lau, A. K. W., E. Tang, and R. C. M. Yam. 2010. Effects of supplier and customer integration on product innovation and performance: Empirical evidence in Hong Kong manufacturers. *Journal of Product Innovation Management* 27 (5): 761–77.
- Lettl, C. 2005. Users as inventors and developers of radical innovation. *Journal of Customer Behaviour* 4 (2): 277–97.
- Li, T., and R. J. Calantone. 1998. The impact of market knowledge competence on new product advantage: Conceptualization and empirical examination. *Journal of Marketing* 62 (4): 13–29.
- Lilien, G. L., P. D. Morrison, K. Searls, M. Sonnack, and E. von Hippel. 2002. Performance assessment of the lead user idea generation process for new product development. *Management Science* 48 (8): 1042–59.
- Lucas, H. 1974. *Towards creative systems design*. New York: Columbia University Press.
- Lüthje, C. 2003. Customers as co-inventors: An empirical analysis of the antecedents of customer-driven innovations in the field of medical equipment. Proceedings of the 32nd EMAC Conference, Glasgow, UK.
- Lüthje, C., and C. Herstatt. 2004. The lead user method: An outline of empirical findings and issues for future research. *R&D Management* 34 (5): 553–68.
- Lüthje, C., C. Herstatt, and E. von Hippel. 2005. User-innovators and “local” information: The case of mountain biking. *Research Policy* 34 (6): 951–65.
- Maidique, M. A., and B. J. Zirger. 1984. A study of success and failure in product innovation: The case of the U.S. electronics industry. *IEEE Transactions on Engineering Management* 31 (4): 192–203.
- Morrison, P. D., J. H. Roberts, and E. von Hippel. 2000. Determinants of user innovation and innovation sharing in a local market. *Management Science* 46 (12): 1513–27.
- Morrison, P. D., J. H. Roberts, and D. F. Midgley. 2004. The nature of lead users and measurement of leading edge status. *Research Policy* 33 (2): 351–62.
- Nunnally, J. 1978. *Psychometric theory*. New York: McGraw-Hill.
- Oliveira, P., and E. von Hippel. 2009. Users as service innovators: The case of banking services. MIT Sloan School of Management, Working Paper, 4748-09, 1–29.
- Parkinson, S. T. 1982. The role of users in successful new product development. *R&D Management* 12 (3): 123–31.
- Parkinson, S. T. 1985. Factors influencing buyer-seller relationships in the market for high-technology products. *Journal of Business Research* 13 (1): 49–60.
- Rindfleisch, A., and C. Moorman. 2001. The acquisition and utilization of information in new product alliances: A strength-of-ties perspective. *Journal of Marketing* 65 (2): 1–18.
- Ritter, T., I. F. Wilkinson, and W. J. Johnston. 2004. Managing in complex business networks. *Industrial Marketing Management* 33 (3): 175–83.
- Rothwell, R., C. Freeman, A. Horlsey, V. T. P. Jervis, A. B. Robertson, and J. Townsend. 1974. SAPHO updated: Project SAPHO phase II. *Research Policy* 3 (3): 258–91.
- Schriesheim, C. A., and T. Hinkin. 1990. Influence tactics used by subordinates: A theoretical and empirical analysis and refinement of the Kipnis, Schmidt, and Wilkinson subscales. *Journal of Applied Psychology* 75 (9): 246–57.
- Shaw, B. 1985. The role of the interaction between the user and the manufacturer in medical equipment innovation. *R&D Management* 15 (4): 283–92.
- Spann, M., H. Ernst, B. Skiera, and J. H. Soll. 2009. Identification of lead users for consumer products via virtual stock markets. *Journal of Product Innovation Management* 26 (3): 322–35.
- Stevens, G., J. Burley, and R. Divine. 1999. Creativity + business discipline = higher profits faster from new product development. *Journal of Product Innovation Management* 16 (5): 455–68.
- Tidd, J., J. R. Bessant, and K. Pavitt. 2001. *Managing innovation: Integrating technological, market, and organisational change*. Chichester, UK: John Wiley.
- Turnbull, P., D. Ford, and M. Cunningham. 1996. Interaction, relationships and networks in business markets: An evolving perspective. *Journal of Business & Industrial Marketing* 11 (3/4): 44–62.
- Urban, G. L., and E. von Hippel. 1988. Lead user analysis for the development of new industrial products. *Management Science* 34 (5): 569–82.
- von Hippel, E. 1976. The dominant role of users in the scientific instrument innovation process. *Research Policy* 5 (3): 212–39.
- von Hippel, E. 1977a. The dominant role of users in semiconductor and electronic subassembly process innovation. *IEEE Transactions on Engineering Management* 4 (2): 60–71.
- von Hippel, E. 1977b. Transferring process equipment innovations from user-innovators to equipment manufacturing firms. *R&D Management* 8 (1): 13–22.
- von Hippel, E. 1978. Successful industrial products from customer ideas: A paradigm, evidence and implications. *Journal of Marketing* 42 (1): 39–49.
- von Hippel, E. 1986. Lead users: A source of novel product concepts. *Management Science* 32 (7): 791–805.
- von Hippel, E. 1988. *The sources of innovation*. New York: Oxford University Press.
- von Hippel, E. 1989. New product ideas from lead users. *Research Technology Management* 32 (3): 24–7.
- von Hippel, E. 1994. Sticky information and the locus of problem solving: Implications for innovation. *Management Science* 40 (4): 429–39.
- Voss, C. A. 1985. The role of users in the development of applications software. *Journal of Product Innovation Management* 2 (2): 113–21.