

Effects of Collaborative Communication on NPD Collaboration Results: Two Routes of Influence*

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Although NPD collaboration with external partners has become the next generation in NPD practice, the discussion concerning how to organize collaboration so as to obtain better results is far from over. Since communication is the most important element in successful interfirm exchange, this study focuses on the impact of collaborative communication and its facets—frequency, formality, reciprocal feedback, and rationality—on NPD collaboration results. In order to explain how collaborative communication can best be managed to enhance NPD collaboration results, this research combines the relational and resource-based views, proposing the existence of two routes of influence: the direct resource-based route and the indirect relational route mediated by trust. Using a sample of 207 NPD collaboration projects of innovative firms, empirical findings indicate that reciprocal feedback–rationality and frequency play an important role in product quality and adherence to budget and schedule, respectively, even without trust. Moreover, the trust between partners substantially reinforces the positive influence of reciprocal feedback–rationality on NPD collaboration results and makes the effect of formality significant. Therefore, the two alternative routes are confirmed as important paths to new product success, which provides relevant managerial implications.

Practitioner Points

- Managers should choose and reinforce the specific configuration of collaborative communication that best fits in with their critical objectives.
- When the critical objective of a collaborative relationship is to develop a quality product, managers should invest their effort and resources in ensuring that communication is based on reciprocal feedback and rationality.
- If managers wish to meet cost and time objectives, they should not only emphasize reciprocal feedback and rationality but should also monitor trust generation.
- Since formal communication entails high costs and its impact on product quality is limited, managers should—using a cost-benefit analysis—assess whether or not they are interested in using this route.

Introduction

NPD collaboration with external partners has become the next generation in NPD practice (Emden, Calantone, and Droge, 2006) because of its benefits to the focal firm in terms of technological innovation (Un, Cuervo-Cazurra, and Asakawa, 2010), access to external resources (Hillebrand and Biemans, 2004), and since the risks and costs inherent in innovation are shared (Calia, Guerini, and Moura, 2006). For these reasons, there is greater emphasis on NPD collaboration with external parties and its importance is well noted by managers, scholars, and policy makers alike (Laursen and Salter, 2014; Michelfelder and Kratzer, 2013; Schleimer and Shulman, 2011). However, the discussion concerning how to organize collaboration so as to obtain better results is far from over since the failure rates of NPD collaboration projects are high, indicating that they entail both relational and performance risks (Schleimer and Faems, 2016).

Communication, defined as the exchange of information between partners (Bstieler, 2006), has been described as the most important element in successful interfirm exchange (Mohr, Fisher, and Nevin, 1996), since it underlies most aspects of organizational and interorganizational functioning (Mohr and Spekman, 1994). Communication thus stands out among the

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*The authors wish to acknowledge the financial support provided by the Spanish Ministry of Science and Technology (research project: ECO2013-47969-P) and the Seneca Foundation—Agency of Science and Technology of the Region of Murcia (Spain) (research project: 08663/PHCS/08).

usual determinants of NPD collaboration success (Barnes, Pashby, and Gibbons, 2002; Hoegl and Wagner, 2005; Schleimer and Shulman, 2011; Sivadas and Dwyer, 2000). The present research focuses exclusively on communication between firms rather than on the tasks carried out jointly, since the success of the work conducted in collaboration (beyond the correctness of the actual tasks) is deemed to depend on how well partners interact and communicate with one another (Hoegl and Gemuenden, 2001).

However, mere or simple communication might prove ineffective in collaborative NPD (Lam and Chin, 2005) since not all types of communication are equally beneficial for all types of interfirm relationships. Collaborative communication—a concept extended from the context of channel relationships (Chen, Li, and Arnod, 2013; Joshi, 2009; Mohr et al., 1996; Paulraj, Lado, and Chen, 2008)—could be considered the key element when managing successful NPD collaboration. This way of understanding communication, which can be viewed in terms of a specific combination of intensive, relationship-building

communication facets—frequency, formality, reciprocal feedback, and rationality—relies on developing cooperative attitudes and processes to guide and administer the relationship, creating an atmosphere of mutual support and respect (Mohr et al., 1996). The present work considers this type of communication and seeks to analyze how this complex construct influences collaboration results. To the best of our knowledge, in the field of NPD collaboration, only isolated dimensions of communication such as frequency and media richness have been empirically used or even considered since communication tends to be defined as one dimensional. As can be seen in the first two columns of Table 1, which shows the most relevant studies in the field of collaborative relationships, the only exceptions are the theoretical work of Roy, Sivakumar, and Wilkinson (2004) and the work of Badir and O'Connor (2015). Our first contribution is thus to employ, in the field of innovation and NPD collaboration, a construct which proves far more useful and comprehensive than the usual frequency or even communication quality construct (Bstieler and Hemmert, 2008; Hoegl and Wagner, 2005; Walter, Walter, and Müller, 2015).

Yet, there is no agreement between authors with regard to the mechanism through which communication influences NPD collaboration outcomes. The resource-based view sees collaborative communication as a source of competitive advantage since it helps partners to combine their idiosyncratic resources in unique ways (Gesing, Antons, Piening, Rese, and Salge, 2015), thereby improving NPD collaboration outcomes. In fact, collaborative communication has been described as the most important competitive resource in industrial markets (Chen et al., 2013) as it not only improves a firm's credibility but may also provide a convenient and simple means of gaining knowledge (Batt and Purchase, 2004) and achieving cooperation and coordination (Walter et al., 2015) that can create a unique, rare, inimitable, and nonsubstitutable relationship to enhance NPD (Fawcett, Jones, and Fawcett, 2012). This theory thus suggests that there is a direct relationship between collaborative communication and NPD collaboration results. As can be seen in the third column of Table 1, this has been the prevailing trend in the literature.

For its part, the relational perspective views communication as a process whereby trust is generated (Batt and Purchase, 2004; Bstieler, 2006; Bstieler and Hemmert, 2008). The relational view stems from the assumption that trust lies at the heart of NPD

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Table 1. Positioning of the Current Study Relative to the Most Relevant Studies in the Field of Collaborative Relationships

Study (NPD or Innovation Field?)	Communication as a Multidimensional Construct (Dimensions)	Discusses the Direct Impact of Commu- nication on Results	Discusses Both Communication and Trust (Examines Their Interactions)	Examines Possible Mediating Variables Between Communi- cation and Results (Which Ones?)	Results as Multidimensional
Mohr and Nevin (1990) No (Marketing channels)	Yes (Frequency, direction, modality, and content)	Yes	No	Yes (Qualitative channel outcomes)	Yes (Qualitative channel outcomes and quantitative performance)
Mohr and Spekman (1994) No (Partnership between firms)	Yes (Communication quality, informa- tion sharing, and participation in planning)	Yes	Yes (No)	No	Yes (Sales and satisfaction)
Mohr et al. (1996) No (Interfirm relationships)	Yes (Frequency, bidir- ectionality, for- mality, and non coercive content)	Yes	No	No, examines mod- erating variables	Yes (Satisfaction, commitment, and coordination)
Sivadas and Dwyer (2000) Yes (NPD business alliances)	No	Yes	Yes (No)	No	No
Sobrero and Roberts (2002) Yes (Supplier–manufacturer relationships in NPD projects)	No	Yes (Referred to as “information transferring mechanisms”)	No	No	Yes (Efficiency and learning)
Batt and Purchase (2004) No (Collaboration in networks and relationships)	No	No	Yes (No)	No	No
Roy et al. (2004) Yes (Innovation generation in supply chain relationships)	Yes (Quantity, scope and mode)	Yes (Referred to as “interaction”)	Yes (Yes, but through a moderation)	No, examines mod- erating variables	No
Hoegl and Wagner (2005) Yes (Buyer–supplier collaboration in product development)	No	Yes	No	No	Yes (Adherence to schedule, to development costs, to product cost, and to product quality)
Bstieler (2006) Yes (NPD partnerships)	No	No	Yes (Yes)	No	Yes (Partnership efficacy and project performance)
Panayides (2006) Yes (Relationship management to increase innovativeness)	No	No	Yes (No)	Yes (Innovativeness and improvements in logistics service quality)	No

Table 1. Continued

Study (NPD or Innovation Field?)	Communication as a Multidimensional Construct (Dimensions)	Discusses the Direct Impact of Commu- nication on Results	Discusses Both Communication and Trust (Examines Their Interactions)	Examines Possible Mediating Variables Between Communi- cation and Results (Which Ones?)	Results as Multidimensional
Bstieler and Hemmert (2008) Yes (Vertical product development partnerships)	No	No	Yes (Yes)	No	No (Trust generation as the dependent variable)
Paulraj et al. (2008) No (Collaborative buyer–supplier relationship)	No	Yes	No	No	Yes (Supplier performance and buyer performance)
Lawson, Petersen, Cousins, and Handfield (2009) Yes (Interorganizational product development teams)	No	Yes (Referred to as “knowledge sharing”)	No	No	Yes (Supplier product develop- ment outcomes, buyer prod- uct development perfor- mance, and financial performance)
Joshi (2009) No (Manufacturer–supplier relationships)	Yes (Frequency, formality, recip- rocal feedback, and rationality)	Yes	No	Yes (Supplier knowl- edge and supplier affective commitment)	No
Oke and Idiagbon-Oke (2010) Yes (Manufacturer–supplier NPD)	No	Yes (Communication channel richness)	No	No	Yes (Development time and ties)
Niedergassel and Leker (2011) Yes (Academic R&D collaboration projects)	No	Yes	No	No	No
Schleimer and Shulman (2011) Yes (Collaboration for innovation)	No	Yes	Yes (No)	No, examines mod- erating variables	No
Chen et al. (2013) No (Business relationships in industrial markets)	Yes (Frequency, reciprocal feed- back, formality, and rationality)	Yes	No	Yes (Market-linking capability and marketing capability)	Yes (Customer-focused perfor- mance, customer coopera- tion performance, and finan- cial performance)
Yan and Dooley (2013) Yes (Buyer–supplier collaboration in NPD)	No	Yes	No	No, examines mod- erating variables	Yes (Design quality and design efficiency)
Yan and Dooley (2014) Yes (Buyer–supplier collaboration in NPD)	No	Yes	No	No	Yes (Design quality and design efficiency)
Badir and O'Connor (2015) Yes (NPD alliances)	Yes (Frequency and media richness)	Yes	No	No	No (Weak versus strong ties)
Walter et al. (2015) Yes (R&D alliances between competitors)	No	No	No	No	No

collaboration and that without a foundation of trust, NPD collaboration can neither be built nor sustained (Fawcett et al., 2012; Morgan and Hunt, 1994). This suggests that collaborative communication may encourage the development of trust and, therefore, in turn contribute to superior collaboration results; that is, this view suggests an indirect effect of collaborative communication on NPD collaboration results mediated by trust. However, as Table 1 (fourth column) shows, this alternative and indirect path of influence of communication on NPD collaboration results has only been suggested by Bstieler (2006) and Bstieler and Hemmert (2008). Nevertheless, these two works exclude the possibility of a direct impact of communication on NPD collaboration results, neglecting the first path.

The present study uses the above viewpoints simultaneously in order to explain how collaborative communication can best be managed to enhance NPD collaboration results. Adopting such a conciliatory theoretical lens helps delve into the internal functioning of NPD collaboration. This attempt to embrace both theories in our work is the second contribution, since explanations are not confined to merely one framework or the other. Our main objective is to accurately describe and understand how collaborative communication influences NPD collaboration outcomes. In order to achieve this, the two theories must be used.

In sum, this study fills a gap in the field of collaborative NPD literature (1) by exploring the impact of collaborative communication on NPD collaboration results and (2) by proposing the existence of two simultaneous routes of influence: the direct resource-based route and the indirect relational route mediated by trust. This study heralds the first attempt to explore the effects of collaborative communication in the context of NPD collaborations. Previously, communication has been studied as a one-dimensional construct in the field of innovation and NPD collaboration. The exceptions are the theoretical work of Roy et al. (2004) and the work of Badir and O'Connor (2015), although neither of these works has modeled NPD performance as a multidimensional construct (last column of Table 1). Considering communication as a compendium of facets or dimensions—frequency, formality, reciprocal feedback, and rationality—and NPD performance as a multidimensional construct enriches our analysis, making it possible to refine our recommendations to practitioners in accordance with the specific impact of each communication dimension on each outcome dimension. Moreover, in the field of NPD the prevailing

theoretical trend has proposed a direct impact of communication on NPD collaboration results. However, to accurately describe and understand how communication influences NPD collaboration outcomes it is also necessary to take account of other routes of influence, for example, its indirect impact mediated by trust. Bstieler (2006) and Bstieler and Hemmert (2008)—the only studies to reflect this mediation—excluded the possibility of a direct impact of communication on NPD collaboration results, neglecting the prevailing theoretical trend. Therefore, ours is also the first research to consider both routes of influence simultaneously.

In the next section, the theoretical framework is introduced and the model is proposed. The research hypotheses are then developed. In the following section, the model is empirically tested against a large sample of collaborative projects from multiple industries. Finally, the results are discussed and some managerial implications and future research lines are offered.

Theoretical Framework

The resource based view suggests that a firm's competitiveness and innovativeness depends on its resources and capabilities (Gesing et al., 2015), and whether such resources and capabilities prove valuable, rare, inimitable, and nonsubstitutable (Barney, 1991). Collaborative communication, defined as the extent to which companies communicate with their partners on a frequent, formal, and reciprocal basis while using rationality as a way to influence each other (Joshi, 2009), can be seen as a source of competitive advantage since it helps partners to combine their idiosyncratic resources in unique ways (Gesing et al., 2015). In turn, this improves NPD collaboration outcomes. These arguments suggest a direct influence route between collaborative communication and NPD collaboration results, our proposed direct resource-based route.

In the second route, the indirect relational route, the relational view assumption that trust lies at the heart of NPD collaboration provides the starting point (Fawcett et al., 2012; Morgan and Hunt, 1994). Trust can be regarded as “the belief that an exchange partner would not act in self-interest at another's expense” (Uzzi, 1997) and has been posited by several authors as one of the most important factors when devising and developing fruitful collaboration (Crespin-Mazet

and Ghauri, 2007) and as a key ingredient in any relationship (Boersma, Buckley, and Ghauri, 2003). Trust is more crucial in successful joint new product development (Parker, 2000) than in other inter-organizational relationships, which are less uncertain and involve fewer risks (Blomqvist, Hurmelinna, and Seppänen, 2005). Collaborative development differs from other forms of interorganizational arrangements since there is a mutual transfer of valuable technological know-how between partners, while the incentives to prevent misappropriation are relatively weak (Bstieler, 2006). As a consequence, while also seeking to protect their own proprietary interests, partners also strive to establish trust (Littler, Leverick, and Bruce, 1995). From a relational perspective, trust provides partners with the assurance that knowledge and information will be used for the greater good, reducing uncertainty, the perception of opportunistic hazards, and the need for costly and inflexible formal safeguarding mechanisms (Faems, Janssens, Madhok, and van Looy, 2008; Szulanski, Cappetta, and Jensen, 2004).

Nevertheless, trust is not something that can be forced, but is rather the result of a gradual and consistent effort over time (Bstieler, 2006). In the second route proposed in this study, in line with the relational perspective, communication is seen as a process by which trust is generated (Batt and Purchase, 2004; Bstieler, 2006; Bstieler and Hemmert, 2008; Morgan and Hunt, 1994). Efforts to communicate in a collaborative manner during NPD collaboration are thus conjectured to enhance trust, which in turn is positively related to NPD collaboration outcomes; that is, trust is felt to be the catalyst driving the effect of collaborative communication on NPD collaboration results. Ergo, trust mediates the relationship between collaborative communication and NPD collaboration results shaping our indirect relational route.

NPD collaboration results are conceptualized as a multidimensional construct (Blindenbach-Driessen, van Dalen, and van den Ende, 2010; Griffin and Hauser, 1996; Hoegl and Wagner, 2005; Menor, Tatikonda, and Sampson, 2002) reflecting operational effectiveness, since the latter is an essential precondition to market success (Tatikonda and Montoya-Weiss, 2001), and given that these outcome levels are felt to be directly related with the interaction and communication pattern between the collaborators analyzed in this research. The effort put into development is therefore assessed, focusing on those outcomes which reflect how the NPD project was executed (Blindenbach-Driessen et al., 2010). Specifically, the focus is placed

on product quality as well as adherence to budget and schedule, two variables traditionally related to project management (Blindenbach-Driessen et al., 2010) and which are not only project execution outcomes but also key product-intrinsic characteristics—product superiority, cost, and timely availability to the marketplace—which, individually or collectively, might impact market success (Tatikonda and Montoya-Weiss, 2001). Product quality refers to the product's perceived superiority relative to competitive products (Tatikonda and Montoya-Weiss, 2001) and is a typical NPD performance measure (Blindenbach-Driessen et al., 2010; Hoegl and Wagner, 2005; Rodríguez-Escudero, Carbonell, and Munuera-Aleman, 2010). Adherence to budget and schedule address the extent to which the project has been developed on time and within budget and is also a common NPD performance measure (Blindenbach-Driessen et al., 2010; Knudsen and Mortensen, 2011; Rodríguez-Escudero et al., 2010).

Having discussed the theoretical framework (see Figure 1) the research hypotheses are set out in the following subsection. First, the resource-based route is explored, where collaborative communication directly influences NPD collaboration results. Second, the relational route is examined and hypotheses are developed for the mediating role of trust in the collaborative communication–NPD collaboration results relationship.

Hypothesis Development

The Impact of Collaborative Communication on NPD Collaboration Results (Resource-Based Route)

Consistent with the resource-based view explained previously, the first group of hypotheses conjectures that collaborative communication—frequency, formalization, reciprocal feedback, and rationality—within NPD collaboration, directly affects NPD collaboration outcomes, product quality and adherence to budget and schedules (H1a, b, c, and d).

The Impact of Collaborative Communication Dimensions on NPD Collaboration Results

Frequency, also referred to as communication quantity, describes the amount of communication between collaboration partners (Hoegl and Wagner, 2005); that is, frequency refers to the amount of contact between the companies that are collaborating (Mohr et al., 1996). This facet has been widely studied in previous research

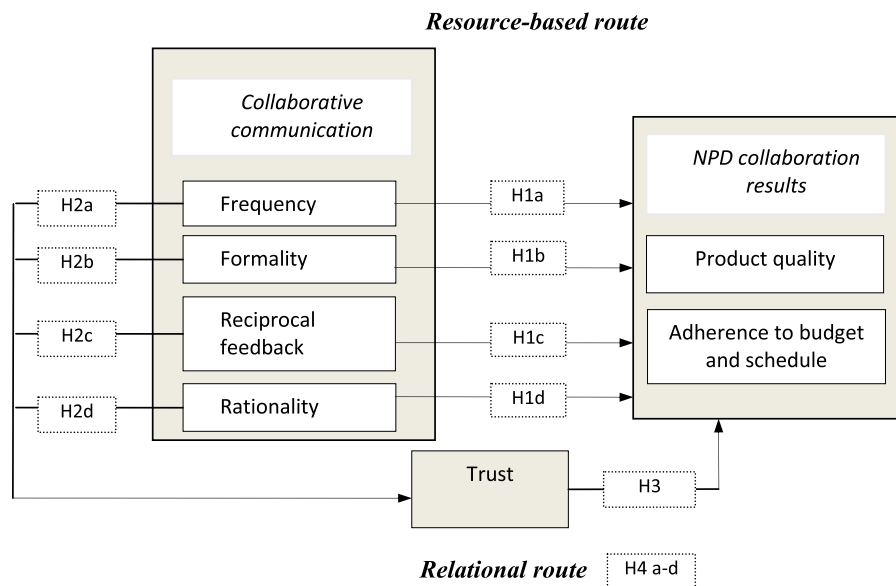


Figure 1. Theoretical Framework

due to its explanatory power of the intensity and outcomes of inter-firm relationships (Badir and O'Connor, 2015; Hillebrand and Biemans, 2004; Patzelt, Lechner, and Klaukien, 2011; Roy et al., 2004; Sobrero and Roberts, 2002). In fact, frequency of partner communication has been used as a proxy for tie strength by some authors (Patzelt et al., 2011). Since strong ties are viewed as having a higher degree of closeness and indebtedness than weak ties, they increase the likelihood that partners will share sensitive information with each other (Badir and O'Connor, 2015). This sensitive information forms the basis of knowledge transfer and superior product development, as does frequency. Moreover, when the information concerning the content and status of the joint work is shared frequently, all project members are likely to be better informed and able to incorporate this up-to-date information in their own work (Ragatz, Handfield, and Scannell, 1997), resulting in better quality products. Furthermore, frequent communication is necessary to ensure adequate project coordination (Mohr and Nevin, 1990), which in turn relates to adhering to the timeframes and budgets established during collaboration. Consequently:

H1a: Frequency positively affects NPD collaboration results—product quality and adherence to budget and schedule.

Formality (formal vs. informal modality) of communication refers to the extent to which contact between collaborators is routinized, planned, and

structured, as opposed to unplanned, fleeting, and ad hoc (Chen et al., 2013; Mohr et al., 1996); that is, formality represents the degree to which communication between partners is formalized, and in which formalization stresses the need to follow rules and procedures (Brockman, Rawlston, Jones, and Halstead, 2010) and refers to the extent to which partners rely on explicit rules when managing their relationship (Noordhoff, Kyriakopoulos, Moorman, Pauwels, and Dellaert, 2011; Sivadas and Dwyer, 2000).

Formal communication impacts NPD collaboration outcomes in three ways. First, it allows the inclusion of valuable information that may have been overlooked in an informal, less-structured development process (Noordhoff et al., 2011), thus contributing toward superior product development. Second, it reduces the amount of redundant information (Deshpandé and Zaltman, 1982). Lower levels of redundancy are more likely to provide access to novel information (Rindfleisch and Moorman, 2001), which in turn affects new product performance and competitiveness. Finally, this type of communication reduces transaction costs, since it engenders a level of transparency that reduces concerns about opportunism (Wathne and Heide, 2000). It also means that information is more structured and refined when it is shared rather than communicated in bits and pieces over time (Noordhoff et al., 2011), which saves time. Thus, formality is expected to directly help develop better new products within the budget and time constraints of the collaboration project.

H1b: Formality positively affects NPD collaboration results—product quality and adherence to budget and schedule.

Reciprocal feedback implies that communication between partners is bidirectional (Mohr et al., 1996). It embraces the intent of collaborative communication and focuses on communication in which each partner builds on what the other has said (Joshi, 2009). Therefore, reciprocal feedback means that one actor conveying information and knowledge is reciprocated by the other actor (Cantner, Meder, and Wolf, 2011). Reciprocal feedback reflects reciprocity between partners, which again lies at the heart of any collaboration since partners need to open their own knowledge stock in order, at the same time, to access the partner's knowledge stock (Cantner et al., 2011). Should this not occur, exchange of information and knowledge will not take place and collaboration will not come about.

Pervan, Bove, and Johnson (2009) stated that reciprocity is a strategic act designed to promote exchange so that mutual gain can continue, the mediating role of which between partners can prove even more important than trust. The effect of reciprocity on NPD collaboration outcomes is, therefore, different and independent of the effect of trust; that is, reciprocity is a source of competitive advantage since it directly helps forge a unique, rare, inimitable, and nonsubstitutable NPD collaboration relationship.

By establishing an ongoing and reciprocal pattern of communication with their partners, companies can convey their evolving expectations and provide their partners with timely performance feedback to align expectations at any given point in time (Joshi, 2009). These communication patterns enable close coordination between partners (Bidault, Despres, and Butler, 1998). In the absence of proper coordination, efficiency suffers and goal attainment is delayed or thwarted (Roy et al., 2004), with projects therefore not finishing on time and in budget. Reciprocal feedback also favors ensuring superior product development since, over time, reciprocal communication makes it possible to fine-tune collaboration. Reciprocal feedback on product design, quality, and other strategic options fosters learning among partners and enables them to differentiate their product from competitors' (Atuahene-Gima and Wei, 2011). Consequently, this communication pattern is critical to the development of quality products and adherence to budgets and schedule.

H1c: Reciprocal feedback positively affects NPD collaboration results—product quality and adherence to budget and schedule.

Rationality refers to the content of communication (Mohr and Nevin, 1990) and is defined in terms of presenting reasons, accompanied by supportive information, for associates to comply with a request (Payan and McFarland, 2005). Collaborators working on a common project should display mutual respect and grant assistance when needed, rather than trying to dominate and pressure the other partner (Hoegl and Wagner, 2005). Since rationality refers to the extent to which a company provides a rationale and clear evidence for why a partner should adopt a particular recommendation (Joshi, 2009), it fosters a cooperative rather than a competitive working atmosphere (Hoegl and Wagner, 2005).

Additionally, NPD is unpredictable and uncertain (Rice, O'Connor, Peters, and Morone, 1998) and requires participants to engage in more learning and unlearning and to develop new capabilities. Consequently, there is a greater need to reorient existing structures and processes (Nord and Tucker, 1987). In this context, rational communication proves even more important. Rationality makes it possible to state and explain all the decisions made by the partners during development, thus enhancing their understanding of any changes made during collaboration and making it easier to adopt them, thereby resulting in superior product development.

Furthermore, rationality plays a key part in reducing role ambiguity as well as role conflict, thus increasing the likelihood that a project's operational objectives will materialize (Nygaard and Dahlstrom, 2002). Conflict is defined as disagreement concerning the tasks performed and includes differences in viewpoints, ideas, and opinions (Lam, Chin, and Pun, 2007). Conflict is inevitable when different entities work together to achieve their objectives (Lam and Chin, 2005), and solving it involves much time and effort and may hinder adhering to both budget and schedule (Shaw, Shaw, and Enke, 2003). Since rationality is a particularly effective noncoercive way of securing compliance (Joshi, 2009), it may be deemed a constructive tool for functional conflict solving. Consequently:

H1d: Rationality positively affects NPD collaboration results—product quality and adherence to budget and schedule.

The Impact of Collaborative Communication on NPD Collaboration Results Through Trust (Relational Route)

As previously stated, in line with the relational perspective, in this second group of hypotheses, efforts to communicate in a collaborative manner during NPD collaboration are posited to enhance trust, which in turn is positively related to NPD collaboration results; that is, trust is modeled as an outcome of communication behavior and as an antecedent of NPD collaboration outcomes following Bstieler and Hemmert (2008), Bstieler (2006), and Blomqvist et al. (2005).

The Impact of Collaborative Communication Dimensions on Trust

With increasing tie strength, trust between partners increases (Patzelt et al., 2011), with “strength” having been defined as the frequency of interaction (Badir and O’Connor, 2015). Trust evolves when the knowledge and understanding of the people with whom one must interact grows, along with the actual experience of interacting (Bstieler, 2006). This process is only possible through frequent interaction. In addition, research into business relationships has highlighted the relevance of meaningful and frequent exchange of information to resolve disputes and align perceptions and expectations, thus fostering trust formation (Morgan and Hunt, 1994). Consequently:

H2a: Frequency positively affects trust.

Formality is used to secure convergence in viewpoints between partners, facilitating their understanding (Mohr et al., 1996) and fostering the development of trust by segmenting group members from their broader organizations and promoting a common set of in-group experiences (Lawson et al., 2009). Moreover, formality involves the use of specific structural formats designed to communicate expectations and share useful information and knowledge between team members (Lawson et al., 2009), thus creating a level of transparency that reduces concerns about opportunism (Wathne and Heide, 2000), which in turn is positively related to trust. Thus:

H2b: Formality positively affects trust.

Reciprocal feedback relates to mutual feedback between partners, which influences the content and

quality of communication, both being key ingredients in the success of any partnership and strong determinants of trust development (Mohr and Spekman, 1994; Morgan and Hunt, 1994). In fact, reciprocity—and indeed reciprocal feedback as a reflection of reciprocity—has frequently been linked to trust generation (Fulmer and Gelfand, 2012; Nguyen and Rose, 2009). Consistent with these arguments, Mandhavan and Grover (1998) maintain that past experience and feedback about progressive project success contribute to engender trust. Bstieler and Hemmert (2008) hold that trust grows through mutual behavior and perceptions, as people interact and reciprocate with the other party in day-to-day operations. Consequently, reciprocal feedback is deemed a necessary condition for developing trust between partners. Based on the previous statements, it is proposed that:

H2c: Reciprocal feedback positively affects trust.

Rationality proves a particularly effective noncoercive way to secure compliance (Joshi, 2009) that contributes to the perceived fairness of the relationship, which is positively related to trust formation (Bstieler, 2006). It can be considered as a constructive tool for solving conflicts, since it is the noncoercive influence strategy with the strongest positive effect on compliance (Payan and McFarland, 2005). This means that rationality plays a key part in reducing role ambiguity and role conflict (Nygaard and Dahlstrom, 2002), which in turn contributes to trust development. Therefore, it is proposed that:

H2d: Rationality positively affects trust.

Trust exists when one party has confidence in an exchange partner’s reliability and integrity (Morgan and Hunt, 1994). Trust is a social process related to the perception of someone else’s abilities, expertise, knowledge, motives, or intentions (Bstieler, 2006). The greater the trust, the more likely it is that interactions will be valued by the participants. The parties will do favors for each other based on the understanding that neither will take undue advantage and that everyone will adopt new initiatives with regard to existing innovations. Therefore, trust allows for more high-quality and valuable interactions, which help to develop new and superior products (Langfred, 2004; Nooteboom, Berger, and Noorderhaven, 1997). In addition, trust facilitates the sharing of information that is proprietary yet critical to generating innovation (Roy et al., 2004),

which will improve operational outcomes. Without trust, the purpose of interactions is often limited and these are unlikely to lead to NPD.

Furthermore, trust contributes to the adherence to budget and schedule in several ways. First, the presence of trust reduces transaction costs, since fewer safeguards against opportunistic behavior are required (Gulati, 1995). Second, trust enables partners to overcome many differences, facilitating mutual understanding between them and, therefore, mitigating the effects of unfavorable behaviors, such as conflicts, that consume time and resources (Bstieler, 2006). Finally, the greater the trust in a partner's ability to perform as agreed, the less need there is for repeated explanations (Roy et al., 2004), which also saves time and money and, in turn, ensures that deadlines and budgets are kept to. Consequently, the following hypothesis is proposed:

H3: Trust positively affects NPD collaboration results—product quality and adherence to budget and schedule.

More specifically, merging H2a–d with H3 implicitly suggests the existence of the following mediation effects, referred to in the present work as the relational route:

H4: Trust mediates the relationship between frequency (H4a), formality (H4b), reciprocal feedback (H4c), and rationality (H4d) and NPD collaboration results.

Methodology

Sample and Data Collection

In order to test our model, a cross-sectional survey methodology was employed to gather data. The initial sample included Spanish innovative firms (2679 companies) from diverse sectors (NAICS codes: 31, 32, and 33 manufacturing and 54 professional, scientific, and technical services) chosen because they all have high innovation and NPD collaboration rates. Specifically, the sectorial distribution of the population was as follows: NAIC 31, 14.97%; NAIC 32, 16.01%; NAIC 33, 59.01%; NAIC 54, 10.00%. The advantage of selecting diverse sectors is that it allows results to be generalized beyond the peculiarities of just one of them.

Senior executives in charge of NPD were asked by e-mail to participate in our study. Data were obtained

Table 2. Sample Characteristics

Number of Employees		Sales Volume (Mill. €)	
<50	36.7%	<10	44.4%
50–249	36.2%	10–50	30.4%
≥250	24.6%	>50	21.3%
No response	.5%	No response	3.9%
Mean	381.1	Mean	163.3

Type of Partner	Number of in Progress Projects		Percentage of Projects in Collaboration		
Supplier	20.8%	<3	23.7%	<10%	21.3%
Customer	21.3%	3–5	42.0%	10–25%	14.5%
Competitor	2.4%	6–10	16.9%	26–50%	26.6%
University	18.4%	11–25	13.5%	51–75%	5.8%
Techn. center	24.6%	>25	3.4%	>75%	26.6%
Others	12.6%	No response	.5%	No response	.5%
		Mean	8.87	Mean	44.6%

via a web-based questionnaire because extensive research points to lower costs and faster response time. Before gathering the data, the questionnaire was repeatedly pretested and refined with several managers. To minimize social desirability bias when measuring constructs, respondents were reminded that there were no right or wrong answers. In order to encourage key informants to cooperate without fear of reprisals, they were also informed that their responses would not be connected to their firms. All respondents were offered summaries of the results and a small gift in appreciation for their contribution.

After the first mailing and two waves of reminders, 207 complete questionnaires were returned. The sectorial distribution of the sample is as follows: NAIC 31, 3.86%; NAIC 32, 28.50%; NAIC 33, 43.48%; NAIC 54, 24.15%. The significant differences between the sectorial distribution of the population and the final sample should be noted. In particular, sample percentages are smaller than population percentages for NAICS 31 and 33 and are larger than the population for NAICS 32 and 54. This might be due to the different NPD collaboration rate of the sectors. In this way, the NPD collaboration rate of the NAICS 54 sector (44%¹) is much larger than the rest (between 23 and 24%, see footnote 1), which in turn leads to oversizing it. NAICS 32 includes chemical and pharmaceutical companies that are often distinguished by their high

¹All the collaboration rates have been calculated on the basis of data drawn from the Spanish Community Innovation Survey, which can be consulted on the Spanish National Statistics Institute (INE) website: <http://www.ine.es/jaxi/menu.do?type=pcaxis&path=%2Ft14%2Fp061&file=inebase&L=0>.

NPD rate. Companies involved in NPD collaboration from this sector are therefore more likely to be found.

Although one may assume that all the firms in the initial sample population are involved in innovation, this does not mean they collaborate with other firms. The average NPD collaboration rate of the companies in the chosen sectors is 26% (see footnote 1), exceeding the average collaboration rate of all the Spanish innovative companies, which stands at 19% (see footnote 1). Taking this into account, the response rate, calculated as 207 divided by 2.679, is certainly underestimated. Even though the response rate may be considered low, it is worth highlighting that the sample size is notably high in statistical terms.

Following the Armstrong and Overton (1977) procedure, early and late respondents were compared in order to control for nonresponse bias. No statistically significant differences were observed in the constructs of this research. Additionally, since the sample included firms of different industries, tests for inter- and between-group differences in the main constructs of the study were conducted. Analysis of the variance and post hoc Tukey multicomparison tests revealed no significant inter- and between-industry differences for any of the main constructs. A similar analysis was conducted to test for differences in the main variables vis-à-vis the type of market served by the new products (i.e., consumer vs. industrial). Results indicated that there are no significant differences. As a result of the previous analysis, it can be concluded that industry-related and market-related biases did not prove problematic in our sample.

The mean respondent firm had 381.1 employees, €163.6 million annual revenue, and 8.87 innovation projects in progress, 44.6% of whom were carried out in collaboration with other companies (Table 2). This implies that the sample firms are indeed likely to develop new products in collaboration with other companies and institutions and gives an idea of sample strength to explain the relationships postulated in this research.

Level of Analysis

The unit of analysis was the collaborative NPD project. After defining NPD collaboration as a close inter-organizational exchange relationship between two or more parties involved in conceiving, testing, producing, or marketing a new product (Bstieler, 2006; Bstieler and Hemmert, 2015), and expressly excluding

pure subcontracting because there is no active collaboration between partners, respondents were asked to choose the new product that had been developed in collaboration with another innovative organization and fully completed within the past 3 years, in which they had been most involved in terms of the effort, time, and resources invested. This requirement was included to ensure that sufficient information was available about the results of the products in question. Using a 7-point Likert scale, the involvement level of respondent firms in the development was found to be 5.61. They were then asked to focus on which partner of all those involved in the chosen collaborative NPD project participated most in terms of invested effort, time, and resources. A total of 20.8% of projects were developed in collaboration with suppliers, 21.3% with customers, 43% with research institutions (universities and technological centers), and 15% with other partners. Partners were located in the same region for 58.5% of the sample projects, in the same country (Spain) for 27.1%, and 14.5% were abroad.

Measurement Scales

Measurement of our constructs is essentially based on existing literature. Collaborative communication and its four facets were operationalized through seventeen items borrowed and adapted from Joshi (2009): frequency (three items), formality (five items), reciprocal feedback (six items), and rationality (three items). Trust was measured by five items based on Bstieler (2006). NPD collaboration results—product quality and adherence to budget and schedule—scales (nine items) were adapted from Tatikonda and Montoya-Weiss (2001), Blindenbach-Driessen et al. (2010), and Ledwith and O'Dwyer (2009).

Several control variables will be incorporated since existing literature points out that those additional factors also affect the dependent variables under consideration. Thus, for example, the innovative effort, which reflects the volume of resources a company devotes to innovative activities over a given period of time (Nieto and Quevedo, 2005), can affect new product superiority and quality (Cohen and Levinthal, 1990), can enhance adherence to fixed budgets and deadlines, and increase a company's chances of survival in the market (Rosenbusch, Brinckmann, and Bausch, 2010). Similarly, a company's absorptive capacity, namely its ability to recognize the value of new, external information, assimilate that information, and apply it to

Table 3. Construct Definition and Measures

Construct Name	Construct Measurement	Mean (SD)
Frequency ^a (n.a.)	Approximately how often does your company interact face-to-face, by phone, via electronic mail, or via fax with collaborator's ... - Marketing personnel? - Operations personnel? - R&D personnel?	1.85 (.98) 2.21 (1.09) 3.06 (.90)
Formality ^b ($\alpha = .90$, CR = .90, AVE = .65)	In our relationship with this collaborator ... We both adopted formal communication channels (i.e., channels were regularized and structured as opposed to casual and informal). We both wrote down the terms of our relationship in detail. We both developed a set schedule of times at which they communicate with our firm over the course of a particular transaction. We both explicitly verbalized and discussed the terms of our relationship. We both conveyed to our firm in detail the expectations from the relationship.	4.75 (1.77) 5.05 (1.81) 5.42 (1.54) 5.43 (1.45) 5.30 (1.54)
Reciprocal feedback ^b ($\alpha = .92$, CR=.93, AVE=.68)	In our relationship with this collaborator. . . We both solicit our views on new product ideas on an ongoing basis. We both respond promptly to communication from each other. We maintain sustained dialogue. We provide each other with a lot of feedback on each other's performance. We solicit each other's views on improvements to operational processes on an ongoing basis. We both work hard to ensure there is a lot of two-way communication between our firms.	5.40 (1.36) 5.16 (1.33) 5.35 (1.38) 5.19 (1.47) 5.08 (1.67) 5.36 (1.45)
Rationality ^b ($\alpha = .89$, CR = .89, AVE = .72)	In our relationship with this collaborator. . . We both provide specific information or data in order to make a case for a particular course of action they would like to implement. We both provide justification for a particular course of action through research findings that they make available. We share with the partner the results of our past experience when making a case for a particular course of action we would like them to follow.	4.89 (1.50) 5.00 (1.49) 5.25 (1.49)
Product quality ($\alpha = .90$, CR = .90, AVE = .69)	The new product provides our firm with a competitive advantage. The new product meets all the expected functionalities. The new product satisfies the clients' needs. The new product is of excellent (technical) quality.	5.43 (1.41) 5.49 (1.40) 5.33 (1.42) 5.35 (1.35)
Adherence to budget and schedule ^b ($\alpha = .86$, CR = .86, AVE = .56)	The new product development was less expensive than expected. The new product development tightened up cost estimates. The new product was developed in a shorter time than expected. The new product was developed quickly. The new product was launched on time.	3.76 (1.56) 4.32 (1.65) 3.24 (1.48) 3.40 (1.56) 3.89 (1.66)
Trust ^b ($\alpha = .94$, CR = .94, AVE = .77)	The collaborator's representatives were frank when dealing with us. In the partnership, promises made by the collaborator were reliable. The collaborator's representatives did not make unwarranted claims. If problems (such as delays) arose, the collaborator's representatives were honest about the problems. We felt the collaborator's representatives were on our side.	5.48 (1.44) 5.31 (1.41) 5.57 (1.40) 5.54 (1.34) 5.59 (1.39)
Absorptive capacity ($\alpha = .88$, CR = .74, AVE = .5)	We acquire externally generated knowledge about innovation. We assimilate the information obtained from external sources. We transform and exploit the acquired and assimilated knowledge in our innovation process.	5.66 (1.26) 5.66 (1.15) 5.55 (1.19)
Innovative effort (n.a.)	Number of employees working in R&D	23.78 (61.51)
Network capability ($\alpha = .88$, CR = .89, AVE = .46)	We invest enough time and effort in our relationships. We allocate the resources needed. We regularly discuss with our partners how we can support each other in our success	4.48 (1.42) 4.35 (1.40) 4.99 (1.37)

Table 3. Continued

Construct Name	Construct Measurement	Mean (SD)
	We know our partners well.	5.07 (1.26)
	We have the ability to build good personal relationships.	5.66 (1.13)
	We solve problems constructively with our partners.	5.51 (1.11)
	We can put ourselves in our partner's position and deal flexibly with them.	5.52 (1.15)
	We hold regular meetings.	5.10 (1.31)
	Information is often exchanged spontaneously.	4.99 (1.33)
	Employees develop informal contacts with each other.	4.97 (1.47)

α , Cronbach's alpha; CR, composite reliability; AVE, average variance extracted.

^a4-Point scale (1, several times per week; 2, several times per month; 3, several times per year; 4, never) (scores reversed).

^b7-Point Likert-type scales (1 = strongly disagree to 7 = strongly agree).

commercial ends (Cohen and Levinthal, 1990), is related with different exploration and exploitation innovations (Bierly, Damanpour, and Santoro, 2009) and may be closely linked to operational outcomes such as product quality and adherence to budget and schedule (Bougrain and Haudeville, 2002; Narula, 2004). Finally, firms need to be able to develop and utilize their inter-organizational relationships (Tortoriello and Krackhardt, 2010; Walter, Auer, and Ritter, 2006) in order to take advantage of these partnerships and thus be able to exchange and share information and resources. As a result, innovative efforts, absorptive capacity, and networking capability were included as control variables.

As regards the control variables, the absorptive capacity scale was based on the dimensions proposed by Zahra and George (2002). Following previous research, innovative effort was measured on the basis of the number of employees working in R&D (Nieto and Quevedo, 2005), while network capability was adapted from Walter et al. (2006). Overall, items were

measured using a seven-point Likert-type scale (1 = strongly disagree to 7 = strongly agree). Construct definitions, measures and the main descriptive statistics are listed in Table 3.

Unidimensionality, Reliability, and Validity

The psychometric properties of the reflective scales (all of them except frequency and innovative effort) were determined based on widely accepted procedures (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). Internal consistency, reliability, and convergent validity were analyzed by performing confirmatory factor analysis using AMOS 20.0. Composite reliability estimates and average variance extracted values exceeded the standards of .70 and .50 (except network capability) respectively, as suggested by Bagozzi, Yi, and Lynn (1991). Standardized item loadings were above .50 and significant ($p < .05$) and alpha coefficients

Table 4. Correlations and Descriptive Statistics

	Mean (SD)	1	2	3	4	5	6	7	8	9	10
1. Frequency	2.37 (.70)	n.a.									
2. Formality	5.19 (1.38)	.17*	.81								
3. Reciprocal feedback	5.26 (1.22)	.31**	.54**	.82							
4. Rationality	5.05 (1.35)	.28**	.63**	.77**	.85						
5. Product quality	5.40 (1.22)	.18*	.37**	.41**	.43**	.83					
6. Adherence budget–schedule	3.68 (1.30)	.22**	.17*	.27**	.23**	.32**	.75				
7. Trust	5.50 (1.26)	.10	.45**	.62**	.52**	.41**	.31**	.88			
8. Absorptive capacity	5.62 (1.09)	.08	.38**	.19**	.23**	.27**	.04	.14*	.71		
9. Innovative effort	23.78 (61.51)	−.09	.15*	.04	.09	.03	−.08	.10	.09	n.a.	
10. Network capability	5.06 (.92)	.20**	.51**	.42**	.44**	.24**	.11	.29**	.57**	.08	.68
11. Type of distribution (marker variable)	1.72 (.45)	−.01	−.05	−.11	−.01	−.04	−.12	.03	−.02	.14	.08

Notes: Bold numbers on the diagonal show the square root of AVE. n.a., not applicable.

*Significance level: $p < .05$ (two-tailed test).

**Significance level: $p < .01$ (two-tailed test).

exceeded .85. These statistics evidence the consistency, validity, and reliability of the scales.

Discriminant validity was assessed using the following two methods: (1) examining whether the average variance extracted for each construct is greater than the square of the correlation between the constructs (Fornell and Larcker, 1981) and (2) examining construct intercorrelations (MacKenzie, Podsakoff, and Podsakoff, 2005). Although the criteria proposed by Fornell and Larcker (1981) are fulfilled, it was found that the correlation between reciprocal feedback and rationality was significantly above .71 (it was .77), meaning that both constructs have more than half their variance in common. Additionally, factor analysis and collinearity diagnoses suggest that reciprocal feedback and rationality are statistically redundant, even though they may be conceptually distinct. Exploratory factor analysis offered only one factor with an eigenvalue exceeding the unit (6.09), which accounted for 67.5% of variance. Thus, a new construct—labeled reciprocal feedback–rationality was defined for the later analyses. The CR, AVE, and Cronbach's alpha for this construct are .94, .63, and .94, respectively.

Before testing the model, scale indicators were averaged to build a measure of each construct. The

correlations and other descriptive statistics of the constructs created are listed in Table 4.

Common Method Bias

As indicated in many studies, common method variance (CMV) is a potential problem that needs to be controlled, particularly in research in which the data for independent and dependent variables are obtained from a single informant. To cope with this problem, several a priori approaches and post hoc analyses were used. From an a priori viewpoint, when designing the questionnaire, we allow anonymous answers and distance the measurement of the dependent variables from the measurement of the independent ones (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003).

Additionally, and adopting a post hoc approach, the importance of common bias was tested by applying two statistical controls. Primarily, a confirmatory factor-analytic approach to Harman's one-factor test was used. In this test, a single-factor model—a model with all variables explained by one factor—was compared to the multifactor measurement model used in our research. The fit of the one-factor model was

Table 5. Standardized Parameters Estimates

	Model 1	Model 2
Hypothesized relationships		
Frequency → product quality	.05	.07 (H1a)
Frequency → adherence to budget and schedule	.15*	.18** (H1a)
Formality → product quality	.13*	.10 (H1b)
Formality → adherence to budget and schedule	.03	.00 (H1b)
Reciprocal feedback–rationality → product quality	.35**	.22** (H1c and d)
Reciprocal feedback–rationality → adherence to budget and schedule	.23**	.07 (H1c and d)
Frequency → trust		-.11* (H2a)
Formality → trust		.11* (H2b)
Reciprocal feedback–rationality → trust		.59** (H2c and d)
Trust → product quality		.23* (H3)
Trust → adherence to budget and schedule		.27** (H3)
Control relationships		
Absorptive capacity → product quality	.21**	.21**
Absorptive capacity → adherence to budget and schedule	-.01	.00
Innovative effort → product quality	-.01	-.02
Innovative effort → adherence to budget and schedule	-.07	-.08*
Network capability → product quality	-.11	-.11
Network capability → adherence to budget and schedule	-.03	-.03
R ² of trust		.40
R ² of adherence to budget and schedule	.10	.15
R ² of product quality	.24	.27
NFI	.97	.98
CFI	.97	.99
RMSEA	.23	.07

Note: Bold numbers show significant coefficients.

* $p < .05$ (one-tailed test).

** $p < .01$ (one-tailed test).

poorer than that of the original measurement model, indicating that a one common factor cannot explain the correlations of our research. Furthermore, Lindell and Whitney's (2001) marker variable approach was used. In our case, the extent to which product distribution was direct or indirect was designated as the marker variable. As suggested by Lindell and Whitney (2001), correlations were adjusted using the lowest positive correlation ($r = .03$) as a proxy of method variance. A comparison between correlations, before and after adjusting them, shows no difference in the significance level of the correlations. Taken together, previous findings show that the CMV is not a critical limitation in our data.

Analysis and Results

The results of the hypothesis testing are now explained. First, the contrast of direct effects (H1a–d, H2a–d, and H3) is examined, after which the indirect or mediation effects are examined (H4a–d). In order to determine the relevance of trust as a mediator variable, the parameters estimated for two models are provided (Table 5). Model 1 only includes the relationships between collaborative communication and NP collaboration results (product quality and adherence to budget and schedule) and Model 2 adds the mediation effect of trust. The comparison between models helped us to determine whether the direct effect of collaborative communication changes significantly when the mediation effect of trust is included, which would be the first

indication of the mediation effect. Formally, Model 2 will be used for hypotheses testing because it simultaneously includes both the resource-based route and the relational route.

Direct Effects

Covariance-based path analysis with maximum likelihood (ML) estimation (AMOS 20.0) was used to test our research model. The standardized parameter estimates of control and hypothesized relationships are presented in Table 5. Model 2 explains the variance of adherence to budget and schedule (15 vs. 10%) and product quality (27 vs. 24%) better than Model 1. Additionally, it explains 40% of trust variance and has better fit indexes (Model 1: NFI = .97, CFI = .97, RMSEA = .23; Model 2: NFI = .98, CFI = .99, RMSEA = .07).

H1a predicts a significant and positive direct impact of frequency on NPD collaboration results. This can be seen from the fact that frequency positively influences adherence to budget and schedule ($\beta = .18$, $p < .01$). However, the impact of frequency on product quality is not significant. Therefore, H1a is only partially supported. H1b is rejected since formality has no significant impact either on product quality or on adherence to budget and schedule. H1c–d are only partly supported because reciprocal feedback–rationality is positively related to product quality ($\beta = .22$, $p < .01$) but is not related with adherence to budget and schedule.

Table 6. Effects of Collaborative Communication on NPD Collaboration Results

	Total Effect (Model 1)	Resource-Based Route Direct Effect (H1a–d) (Model 2)	Relational Route Indirect Effects Through Trust (H4a–d)
Frequency → product quality	.05	.07	–.03*
Formality → product quality	.13*	.10	.03*
Reciprocal feedback–rationality → product quality	.35**	.22**	.13**
Frequency → adherence to budget–schedule	.15*	.18**	–.03*
Formality → adherence to budget–schedule	.03	.00	.03*
Reciprocal feedback–rationality → adherence to budget–schedule	.23**	.07	.16**

Notes: Bold numbers show significant coefficients. Observe that the estimates of the first and the second column coincide, respectively, with the Model 1 and the Model 2 estimates. As Model 1 does not include indirect effects, the direct effects of collaborative communication on NPD collaboration results proposed in this model are exactly the total effect. However, considering that Model 2 included trust, the effect of collaborative communication dimensions on NPD collaboration results in this model reflected strictly the direct effect or resource-based route. Significance levels are based on bootstrapped, bias-corrected confidence intervals.

* $p < .05$ (one-tailed test).

** $p < .01$ (one-tailed test).

Hypotheses H2a–d conjecture that collaborative communication dimensions positively affect trust. As can be seen in Table 5, frequency has a negative impact on trust ($\beta = -.11, p < .05$), such that H2a is rejected. However, H2b and H2c and d, which predict a significant and positive direct impact of formality and reciprocal feedback–rationality on trust, respectively, are confirmed ($\beta = .11, p < .05$ and $\beta = .59, p < .01$).

The results support H3. Specifically, trust has a significant positive effect on product quality ($\beta = .23, p < .05$) and adherence to budget and schedule ($\beta = .27, p < .01$).

Indirect Effects

Following Cheung and Lau's (2008) suggestion, a bootstrap procedure was employed to determine the bias-corrected confidence intervals of the indirect effects, thus allowing us to formally test the significance of mediation. Bootstrapping is a modern method of mediation analysis that goes beyond the limitations of traditional methods by providing an explicit estimation of the indirect effects, and acknowledges that evidence of a statistically significant association between independent (collaborative communication dimensions) and dependent (NPD collaboration outcomes) variables is not required for mediation (Hayes, 2013).

Table 6 (last column) shows the indirect effect between the dimensions of collaborative communication and NPD collaboration results. The relationship sequence of collaborative communication \rightarrow trust \rightarrow NPD collaboration results or relational route proposed in H4 implies the existence of a significant indirect effect of collaborative communication dimensions on NPD collaboration results, mediated by trust. Specifically, as can be seen from Table 6, frequency exerts a negative indirect influence on product quality and adherence to budget and schedule ($\beta = -.03, p < .05$ and $\beta = -.03, p < .05$, respectively). H4a is not supported. Similarly, the indirect relationships between formality and product quality ($\beta = .03, p < .05$) and between formality and adherence to budget and schedule ($\beta = .03, p < .05$) are both significant, although in this case both coefficients are positive (i.e., H4b is confirmed). Finally, reciprocal feedback–rationality is positively and indirectly related to product quality and adherence to budget and schedule ($\beta = .13, p < .01$ and $\beta = .16, p < .05$, respectively). Thus, H4c–d is also confirmed. In sum, even

though not all the hypotheses are confirmed, all the collaborative communication dimensions influence NPD collaboration results (both product quality and adherence to budget and schedule) through trust.

Robustness Analysis

Three additional studies were carried out to establish the robustness of the results. First, the model was estimated again after replacing the new construct labeled reciprocal feedback–rationality with each of the proposed original constructs; that is to say, two models that were similar to the one proposed were estimated, but each with one of the original variables considered in this research (reciprocal feedback and rationality). Differences in size, sign, or significance between the standardized parameter estimates obtained are minimal (Appendix A).

Second, given the ability of partial least squares (PLS) to cope with formative and reflective indicators, Smart PLS 3.5 software was used to provide parameter estimates for the proposed model, in order to determine whether the chosen estimation method introduced biases in the magnitude and significance of the coefficients. The findings (Appendix B) indicate that the estimations with covariance-based path analysis with ML and PLS are very similar. The main difference is related to the three path coefficients that involve the frequency variable. First, the coefficient of the relationship between frequency and product quality and frequency and adherence to budget and schedule are higher with PLS estimation; this is because PLS creates a latent construct which is notably different to ML, with only one significant item, the frequency of communication with the operations personnel (Appendix C). Contacts between operations personnel are the most decisive for product quality and for adherence to budget and schedule. This could be seen as proof of the importance of the operations department involvement in the collaboration. Marketing and R&D have traditionally been seen as the most important functions when developing a new product. Without neglecting their relevance, our results suggest that, once companies are engaged in a collaborative NPD project, more frequent contacts between the two companies' operations departments lead to better product quality and greater adherence to budget and schedule than do contacts between the companies' marketing and R&D departments. Furthermore, greater interaction between operations personnel eliminates the negative impact of

the initial construct of frequency on trust, that is, they do not generate mistrust.

Third, Henseler's PLS multigroup analysis approach (Henseler and Fassott, 2010) was employed to observe the robustness of findings across the type of partner, prior to categorizing collaboration in vertical (customer and supplier), and nonvertical relationships (universities and technological centers). Certain authors (Kaufmann and Tödtling, 2001) feel that the most important collaboration partners operate in the business sector—customer first (33.5% of firms) and suppliers second (21.9% of firms). These collaborations are considered vertical relationships. However, firms also cooperate outside these vertical relationships with other kinds of partners, such as universities or research centers (Miotti and Sachwald, 2003; Pittaway, Robertson, Munir, Denyer, and Neely, 2004). These are what are referred to as nonvertical relationships. Note that “competitors” and “others partners group” (15% of the sample) have been excluded from the multigroup analysis since these two subsamples lack the necessary size for operation. The results from Henseler's PLS-MGA reveal that our findings are robust across the two types of collaborations. No significant differences were found between the two groups (see column about the p -value of the differences between Groups 1 and 2 of Appendix D).

Overall, these three additional studies—reestimation of the model substituting the construct reciprocal feedback–rationality with the original variables considered in this research, PLS estimation and multigroup estimation by type of partner—bear out the robustness of our findings.

Discussion

Our research explores the direct (resource-based route) and indirect role (relational route) of collaborative communication on NPD collaboration results. As the collaborative communication construct has been divided into frequency, formality, reciprocal feedback, and rationality, a distinction may be made between which

dimensions have a direct and which an indirect effect. The main relationships found in the empirical analysis are shown in Figures 2 and 3 and are discussed below.

Which Collaborative Communication Dimensions Directly Explain NPD Collaboration Results? (H1)

Product quality is reinforced by collaborative communication. Specifically, reciprocal–rational communication between partners is beneficial to the development of quality new products. Our results thus support the idea that reciprocal feedback makes it easy to exchange the valuable resources and complex knowledge required to develop quality new products (Wincent, Anokhin, Örtqvist, and Autio, 2010), and that rationality fosters a cooperative atmosphere, where problems and conflicts are resolved in a constructive manner (Joshi, 2009), making such conflicts functional (Amason, 1996) and contributing to the stability and longevity of the collaboration.

On another front, partners are able to improve their results in terms of adherence to budget and schedule if they are in frequent contact. Interdependence between tasks is a characteristic of collaborative NPD. Under task interdependence, messages are more relevant and thus frequent communication proves more useful. A high level of communication frequency entails systematic information availability and improved coordination. It also prevents work interruptions and activity overlap (Hoegl and Wagner, 2005; Mohr and Nevin, 1990), which in turn helps to stick to the fixed budget and schedule. Regarding this effect, some authors maintain that firms have limited resources and capacities to process information (e.g., Hoegl and Wagner, 2005). Therefore, too many frequent contacts can have dysfunctional consequences and can negatively affect adherence to cost and schedules, since partners must invest too much time and too many resources in processing the information exchanged. Consequently, the possibility of a curvilinear relationship between

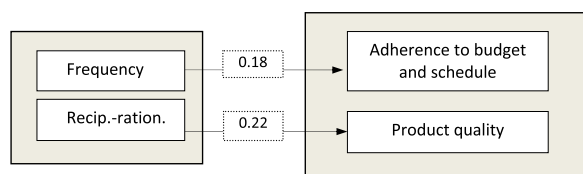


Figure 2. Direct Effects of Collaborative Communication on NPD Collaboration Results

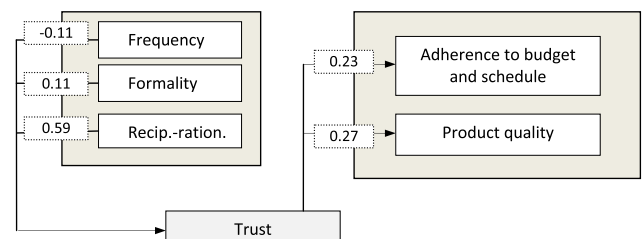


Figure 3. Effects of Collaborative Communication on NPD Collaboration Results Through Trust

frequency and adherence to budget and schedule has been considered. The curvilinear effect is not significant ($\beta = .08$), confirming the hypothesized effect and providing further evidence concerning the linear effect of frequent communication on adherence to budget and schedule for collaborative NPD.

However, formality and reciprocal feedback–rationality have no direct positive impact on adherence to budget and schedule. Although formality does reduce transaction costs (Wathne and Heide, 2000) and save time because of the structure and refinement of the information (Noordhoff et al., 2011), it also entails a great deal of red tape that can translate into costs and time. As regards the lack of a direct positive impact of reciprocal feedback–rationality on adherence to budget and schedule, this may be because reciprocal feedback represents the communication dimension in which each partner builds on what the other partner has said (Joshi, 2009), helping partners to fine-tune their collaboration but consuming time and resources. Another possible explanation relies on the effectiveness of coercive influence strategies as opposed to noncoercive influence strategies such as rationality in terms of time and resources. Coercive influence strategies motivate compliance based on the influence mechanism of source-controlled rewards and punishments, whereas noncoercive influence strategies operate by changing the attitude of the target about the desirability of the intended behavior (Payan and McFarland, 2005). Therefore, coercive influence strategies result in compliance without wasting time and effort in stating and explaining all the decisions made by partners during development.

Frequency and formality have no direct positive impact on product quality. On one hand, even when formality allows the inclusion of valuable information that may have been overlooked in an informal and less structured development process (Noordhoff et al., 2011), it also stifles new ideas and creativity (Brockman et al., 2010), which in turn hampers superior product development. On the other hand, too much frequency may hinder the quality of the new product developed in collaboration because information overload increases the likelihood that information related to items of lower priority will be discarded rather than stored for use at a later time, and because individuals' information-processing capacities and resources are limited (Hoegl and Wagner, 2005).

Therefore, collaborative communication directly influences NP collaboration results by (1) contributing reciprocal feedback–rationality to develop a higher

quality new product and (2) the impact of frequent contacts on the adherence to budget and schedule. The resource-based route involving the influence of collaborative communication on NPD collaboration results is confirmed.

Which Collaborative Communication Dimensions Indirectly Explain NPD Collaboration Results, Through Trust? (H4)

Our results reveal an indirect effect of reciprocal feedback–rationality on NPD collaboration results through trust. Both product quality and adherence to budget and schedule are indirectly reinforced by reciprocal feedback–rationality. Trust reduces opportunistic behavior, thereby cutting transaction costs, since fewer safeguards against opportunistic behavior are required (Gulati, 1995). Trust saves time, because there is less need for detailed discussions and explanations (Roy et al., 2004), and it also increases the willingness to share knowledge, resulting in better overall project performance (Niedergassel and Leker, 2011). Trust is the result of a gradual effort to achieve collaborative communication. Specifically, the reciprocal feedback–rationality dimensions are a fundamental part of this effort since (1) rationality contributes to the perceived fairness of the relationship (Bstieler, 2006) and dysfunctional conflict sources are dropped (Lam and Chin, 2005) and (2) the reciprocal feedback between partners improves partner coordination (Sivadas and Dwyer, 2000), which in turn makes it possible to develop trust (Mandhavan and Grover, 1998).

The positive impact of formality on trust confirms the influence of structured, planned, and routinized modes of communication on NPD collaboration results. Formality brings transparency to information exchange and reduces concerns about opportunism (Wathne and Heide, 2000). It enhances collaborator commitment by encouraging them to set clear objectives that fit in with collaboration goals (Kawakami, Maclachlan, and Stringfellow, 2012). Moreover, formality not only allows knowledge and understanding but also allows value, belief, and cultural systems to be conveyed, since it acts as a bridging mechanism that transcends vertical and horizontal boundaries (Lawson et al., 2009) and, as a consequence, helps to engender trust between partners, which in turn positively affects NPD collaboration results.

As regards the negative but significant impact of frequency on trust, it does not remain significant when

using PLS for the parameter estimation. PLS creates a latent construct with only one significant item, frequency of communication with operations personnel. These results thus suggest that frequent contacts between the operations personnel of the partner companies do not generate distrust since this frequency entails the exchange of meaningful relevant information that helps them understand and know each other and which contributes to the belief that the exchange partner would not act out of self-interest. Nevertheless, it seems that frequent contacts between the marketing personnel of the partner companies reflect a lack of harmony in the collaboration process, since their interaction is not as necessary as that between the operations personnel in terms of product quality and budget compliance. This might be because most collaborations in our sample relate to the generation, concept development, and product development stages of the idea (the average of these stages varies from 4.35 to 4.55 on a 7-point Likert scale) and not to the marketing stage (which averages 2.9 on a 7-point Likert scale). During the early stages of the NPD process, the contribution of the operations personnel is not only necessary but also crucial, while the contribution of the marketing department proves more decisive during the commercialization stage.

Hence, the relational route regarding the influence of collaborative communication is confirmed.

Conclusion

This study explores the direct impact of collaborative communication dimensions on NPD collaboration results (resource-based route) and their indirect impact through trust (relational route), using survey data from a sample of 207 collaborative new product development projects. Collaborative communication has been divided into frequency, formality, reciprocal feedback, and rationality. In addition, a distinction is drawn between product quality and adherence to budget and schedule as dimensions of NPD collaboration results. Which facet of communication influences each type of outcome may thus be determined.

Theoretical Implications

This study contributes to existing knowledge in several ways. First, even though the benefits of collaborative communication have been widely discussed in the context of channel relationships (Chen et al., 2013; Joshi,

2009; Mohr et al., 1996), as yet the effects of collaborative communication on the results of NPD collaboration remain unexplored. In this study, this knowledge gap is addressed by examining the connection between collaborative communication and NPD collaboration results.

Second, by looking at the mediating role of trust, collaborative communication is shown to affect different NPD collaboration outcomes via complementary theoretical routes (i.e., underlying mechanisms). More specifically, findings indicate that reciprocal feedback–rationality and frequency play an important role in product quality and adherence to budget and schedule, respectively, even without trust. These results do not diminish the importance of trust, since trust between partners significantly reinforces the positive effect of reciprocal feedback–rationality on NPD collaboration results and underpins the influence of formality. However, these results show that collaborative communication is not just an antecedent of trust but also a key element for developing fruitful NPD collaborations. In sum, the two alternative routes are important paths to new product success.

Managerial Implications

From a managerial perspective, this research stresses the value of planning and developing an effective collaborative communication strategy and investing in it. Whenever possible, all collaborative communication dimensions must be used because, either directly or indirectly, they have a positive impact on product quality or adherence to budget and schedule. Accordingly, partners should communicate with one another frequently (particularly operations personnel) and formally and on a reciprocal basis, while using rationality as a way to influence one another effectively. By enhancing the ability to implement these communication dimensions, firms could achieve the NPD project's goals—product quality as well as adherence to budget and schedule—more effectively. However, not all the communication dimensions analyzed have the same impact on the different dimensions of NPD results and not all of them use the same influence route. Consequently, managers should choose and reinforce the specific configuration of collaborative communication that best fits in with their critical objectives.

Specifically, when the critical objective of a collaborative relationship is to develop a quality product, managers should invest their effort and resources in

ensuring that communication is based on reciprocal feedback and rationality. Formality can also help to achieve this objective, although its route of influence involves generating trust. Therefore, since formal communication entails high costs and its impact on product quality is limited, managers should—using a cost-benefit analysis—assess whether or not they are interested in using this route.

As with product quality, both dimensions, reciprocal feedback and rationality, affect adherence to budget and schedule. However, unlike product quality, their influence is not direct but is mediated by trust. Hence, if managers wish to meet cost and time objectives, they should not only emphasize reciprocal feedback and rationality but should also monitor trust generation since trust is how to keep to the schedule and budget. In any case, as an alternative route to trust, the recommendation to managers is to stimulate frequent contacts (particularly operations personnel) between the NPD collaboration partners, due to their positive direct influence on adherence to budget and schedule.

Limitations and Future Research

This study has certain limitations, which point the way to future research. From a methodological point of view, when data are collected using self-report measures from a single informant, there is a potential bias involving CMV, and although procedural and statistical remedies were used to control for method bias, it cannot be completely ruled out. In order to address this concern, future research may seek to gather information from multiple sources and informants. Another methodological issue concerns the scope of the data collected, which was based on the viewpoint of focal firms about themselves and their partners. This article does not include direct data from the partnering firms in question, which is a perspective that future research should take into account. Third, all constructs were measured retrospectively and may thus be affected by hindsight bias. Since one can assume that the degree of retrospective distortions will increase over time, participants were asked to answer with respect to a recent project developed in collaboration. Furthermore, as pointed out by Christensen-Szalanski and Fobian (1991), informant familiarity with the task reduces the degree of retrospective distortions. Managers in the sample reported that they were the person responsible for the chosen NPD collaboration project, in which

firm involvement in terms of their effort, time, and resources invested averaged 5.61 on a scale of 1–7. Nevertheless, in order to prevent hindsight bias effects completely, longitudinal follow-up studies would be needed.

Fourth, due to a need for a parsimonious model, only two dimensions of NPD collaboration, namely communication and trust, are explored. This study did not include dimensions such as the extent of each partner's contribution, participants' hierarchical level in the collaboration or the degree of project formalization. For example, there might be a possible moderating effect of the lack of perceived balance or proportionality in partners' resources contribution and relationship investments—involvement asymmetry (Thomas and Esper, 2010)—on the proposed relationships. Involvement asymmetry entails the most involved partner (the organization contributing more resources than the other party) having more bargaining power since it owns most of the resources used in the collaboration (Gambardella and Panico, 2014), which in turn reduces the need for feedback and compliance (Jablin, 1987) and, therefore, the importance of reciprocal feedback and rationality. Yet, at the same time, the most involved partner becomes vulnerable to opportunistic behavior from the less involved one (Jap, 2001) and needs to rely on governance mechanisms such as trust in order to prevent resource misappropriation as a result of being unable to draft all-inclusive contracts in an NPD collaboration context (Blomqvist et al., 2005). Therefore, based on the contingency view, future studies could take this collaboration dimension into account in order to gain deeper insights into NPD collaboration.

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Appendix A. Standardized Parameter Estimates Comparison between Reciprocal Feedback–Rationality, Reciprocal Feedback, and Rationality

	Reciprocal Feedback–Rationality	Reciprocal Feedback	Rationality
Product quality	.22*	.16*	.22*
Adherence to budget and schedule	.07	.06	.05
Trust	.59**	.57**	.41**

Significance levels are based on bootstrapped, bias-corrected confidence intervals. Bold numbers show significant coefficients.

* $p < .05$ (one-tailed test).

** $p < .01$ (one-tailed test).

Appendix B. Standardized Parameter Estimates and Significance Levels Comparison Between Covariance-Based Path Analysis with ML and PLS Estimation^a

	Covariance-Based Path Analysis with ML Estimation	PLS Estimation ^b
Frequency → product quality	.07	.12⁺
Frequency → adherence to budget and schedule	.18**	.21**
Formality → product quality	.10	.10
Formality → adherence to budget and schedule	.00	.00

Appendix B. Continued

Reciprocal feedback–rationality → product quality	.22**	.20*
Reciprocal feedback–rationality → adherence to budget and schedule	.07	.09
Frequency → trust	–.11*	–.05
Formality → trust	.11*	.10⁺
Reciprocal feedback–rationality → trust	.59**	.59**
Trust → product quality	.23*	.22*
Trust → adherence to budget and schedule	.27**	.25**
Absorptive capacity → product quality	.21*	.21*
Absorptive capacity → adherence to budget and schedule	.00	.01
Innovative effort → product quality	–.02	–.01
Innovative effort → adherence to budget and schedule	–.08*	–.07
Network capability → product quality	–.11	–.07
Network capability → adherence to budget and schedule	–.03	–.02
R^2 of trust	.40	.43
R^2 of adherence to budget and schedule	.15	.21
R^2 of product quality	.27	.31

Bold numbers show significant coefficients.

^aThe comparison is realized between ML and PLS estimations of Model 2.

^bSignificance levels are based on bootstrapped, bias-corrected confidence intervals.

* $p < .05$ (one-tailed test).

** $p < .01$ (one-tailed test).

⁺ $p = .07$ (one-tailed test).

Appendix C. The Weights and Loadings Estimates with PLS^a

Construct Name	Construct Measurement	Loadings	Weights
Frequency	Approximately how often does your company interact face-to-face, by phone, via electronic mail, or via fax with collaborator's ...		
	- Marketing personnel?		.000
	- Operations personnel?		.837**
	- R&D personnel?		.209
Formality	In our relationship with this collaborator ...		
	We both adopted formal communication channels (i.e., channels are regularized and structured as opposed to being casual and informal).	.782**	
	We both wrote down the terms of our relationship in detail.	.836**	
	We both developed a set schedule of times at which they communicate with our firm over the course of a particular transaction.	.868**	
	We both explicitly verbalized and discussed the terms of our relationship.	.857**	
	We both conveyed in detail to our firm the expectations from the relationship.	.899**	
Reciprocal feedback/rationality	In our relationship with this collaborator ...		
	We both solicit our views on new product ideas on an ongoing basis.	.802**	
	We both respond promptly to communications from each other.	.751**	
	We maintain sustained dialogue.	.907**	
	We provide each other with a lot of feedback on each other's performance.	.889**	
	We solicit each other's views on improvements to operational processes on an ongoing basis.	.736**	
	We both work hard to ensure there is a lot of two-way communication between our firms.	.877**	

Appendix C. Continued

Construct Name	Construct Measurement	Loadings	Weights
	We both provide specific information or data in order to make a case for a particular course of action they would like to implement.	.776**	
	We both provide justification for a particular course of action through research findings that they make available.	.822**	
	We share the results of our past experience in making a case for a particular course of action we would like them to follow.	.818**	
Product quality	The new product provides our firm with a competitive advantage.	.813**	
	The new product meets all the expected functionalities.	.910**	
	The new product satisfies the clients' needs.	.913**	
	The new product is of excellent (technical) quality.	.850**	
Adherence to budget and schedule	The new product development was less expensive than expected.	.788**	
	The new product development tightened up cost estimates.	.855**	
	The new product was developed in a shorter time than expected.	.757**	
	The new product was developed quickly.	.738**	
	The new product was launched on time.	.863**	
Trust	The collaborator's representatives were frank when dealing with us	.897**	
	In this partnership, promises made by the collaborator were reliable	.902**	
	The collaborator's representatives did not make unwarranted claims	.866**	
	If problems (such as delays) arose, the collaborator's representatives were honest about the problems	.941**	
	We felt the collaborator's representatives were on our side	.908**	

^aThe control variable loadings (absorptive capacity, innovative effort, and network capability) are omitted for simplicity, although the contrast of the PLS model included these variables.

** $p < .01$ (one-tailed test).

Appendix D. Standardized Parameter Estimates of PLS-MGA by Type of Partner^a

	Group 1 Nonvertical (92 Cases)	Group 2 Vertical (84 Cases)	<i>p</i> -Value of the Differences Between Group 1 and Group 2
Frequency → product quality	.15 ⁺	.02	.180
Frequency → adherence to budget and schedule	.26*	.32*	.676
Formality → product quality	.11	.09	.974
Formality → adherence to budget and schedule	−.12	−.11	.256
Reciprocal feedback–rationality → product quality	.27*	.07	.172
Reciprocal feedback–rationality → adherence to budget and schedule	.08	.04	.381
Frequency → trust	−.04	−.05	.844
Formality → trust	.03	.12	.704
Reciprocal feedback–rationality → trust	.54**	.59**	.568
Trust → product quality	.26*	.37**	.735
Trust → adherence to budget and schedule	.26*	.21*	.419

¹Significance levels were estimated using bias-corrected bootstrap confidence intervals.

^{2a}PLS-MGA analysis was run including control variables.

³* $p < .05$ (one-tailed test).

⁴** $p < .01$ (one-tailed test).

⁵⁺ $p < .10$ (one-tailed test).