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WHAT IS THE BEST PHASE OF MANAGING INTER-FIRM RELATIONSHIPS IN SUPPLY CHAINS?

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Abstract

The level of innovation in a product should determine the best stage at which inter-relationship collaboration in a supply chain is engaged in developing new products. Unfortunately, there is a lack of consensus in the relevant literature on the specific stage for inter-relationship collaboration in a supply chain in transformative technologies. For example, the inter-relationship collaboration in a supply chain becomes significant at a later stage of disruptive innovation when the most cutting-edge product or technology must be marketed. On the other hand, inter-relationship collaboration in a supply chain should be included in the innovation process at a much earlier stage to ensure a more comprehensive supplier engagement. Several researchers have examined suppliers' role in product innovations; nevertheless, none of the published supplier integration models are directly connected to the issue of at what point suppliers need to be integrated into the product innovation process. Therefore, this article aims to propose a blueprint for inter-relationship collaboration in a supply chain during product innovation phases, with an emphasis on the stage of involvement applicable to both incremental and disruptive innovation. In addition, various aspects concerning inter-relationship collaboration in a supply chain in the different phases of product invention are subjected to an in-depth investigation.

Keywords: *Supply chain management, Inter-firm relationship, Disruptive innovation.*

Jel Code: *M11, M19, L23, O31, O32*

Tedarik Zincirinde Firmalar Arası Ilişkileri Yönetmenin En Iyi Aşaması Hangisidir?

Öz

Bir üründeki yenilik düzeyi, yeni ürünler geliştirme sürecinde bir tedarik zincirindeki ilişkiler arası işbirliğinin devreye girdiği en iyi aşamayı belirlemelidir. Dönüştürücü teknolojilerde bir tedarik zincirinde ilişkiler arası işbirliğine yönelik belirli bir aşamaya ilişkin ilgili literatürde fikir birliği eksikliği vardır. Bir tedarik zincirindeki ilişkiler arası işbirliği, yıkıcı yeniliğin daha sonraki bir aşamasında, en son teknoloji ürünü veya teknolojinin pazarlanması gerektiğinde önemli hale gelir. Öte yandan, tedarik zincirindeki ilişkiler arası işbirliği, tedarikçinin sürece daha kapsamlı bir şekilde dâhi olmasını sağlamak için yenilik sürecine çok daha erken bir aşamada dâhil edilmelidir. Birkaç araştırmacı, tedarikçilerin ürün yeniliklerinde oynadığı rolü inceledi; bununla birlikte, yayınlanan tedarikçi entegrasyon modellerinin hiçbiri, tedarikçilerin ürün inovasyon sürecinde hangi noktada entegre edilmesi gerektiği konusuyla doğrudan bağlantılı değildir. Bu nedenle, bu makalenin amacı, hem artımlı yenilik hem de yıkıcı yenilik için geçerli olan katılım aşamasına vurgu yaparak, ürün yenilik aşamalarında bir tedarik zincirinde ilişkiler arası işbirliği için bir plan önermektir. Ek olarak, ürün keşfinin farklı aşamalarında bir tedarik zincirindeki ilişkiler arası işbirliğine ilişkin çeşitli yönler derinlemesine bir araştırmaya tabi tutulur.

Anahtar Kelimeler: *Tedarik zinciri yönetimi, Firmalar arası ilişki, Yıkıcı inovasyon.*

Jel Kodu: *M11, M19, L23, O31, O32*

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1. Introduction

One of the most effective methods to get an edge over the competition is establishing a position of technological leadership by providing novel solutions (Zhou & Li, 2012). However, the internal resources of a corporation are hardly adequate to produce novel goods in today's complicated technical world (Grant & BadenFuller, 2004).

It has been suggested that supplier involvement in innovation activities might provide a strategic advantage (Luzzini et al., 2015). Companies want their supply chain partners to be a part of their innovation efforts so that they may reap the benefits of their participation in the process. This integration's benefits include more accessible access to new technologies, shorter development times, lower costs, better qualitative products, and higher performance (Ragatz et al., 2002; Mikkelsen & Johnsen, 2019; Song & Di Benedetto, 2008).

One of the most notable aspects of a healthy relationship amongst a firm and a supplier in a supply chain is determining the best moment to include the supplier in the product development process. Wagner & Hoegl (2006) claimed that organizations pursuing the supplier participation approach must pay particular attention to many contingency elements, such as time for success. To accomplish this, it is beneficial and realistic to have access to empirical data on the link between time as a contingency element and the effectiveness of supplier engagement in product innovation development. To that purpose, this research presents actual data on the connection between the timing of suppliers' engagement in product development and strategy success. In addition, the research aims to address the issue of whether the timing of engagement has a substantial impact on the result of product development.

Previous studies have looked at the factors that lead to innovations in supplier-buyer partnerships (Pulles, Veldman, & Schiele, 2014; Wagner & Bode, 2014), but the impact of interactions in supply chains on innovation has received less attention (Roy & Sivakumar, 2010). According to recent studies, more empirical research is needed to understand better the connections between suppliers and buyers (Wu & Choi, 2005). Despite the significance placed on supplier inclusion or engagement in new product innovation, there is evidence that, in many cases, supplier involvement in product innovation has resulted in no substantial contribution to product success (Wagner & Hoegl, 2006). The timing of the suppliers' engagement is often regarded as or assumed to be responsible for the success or failure of the suppliers' involvement (Hartley et al., 1997; Koufteros et al., 2005; Lilien & Yoon, 1990). However, empirical data are scarce on the time of supplier engagement in product development and its influence on product development success (Cousins & Lawson, 2007). When analyzing the inter-relationship collaboration in a supply chain in developing new products, many supplier-involvement models do not differentiate between the outcomes appearing in incremental or disruptive innovative developments when determining the optimal point for supplier involvement. This is because the results may occur in either type of innovative development. The research on when suppliers should get involved in disruptive innovation reaches different conclusions. In the later stage of disruptive innovation, when the new revolutionary product or technology has to be marketed, Pinkse et al. (2014) thought supplier engagement is vital and should be a priority. Several researchers have investigated the role that suppliers play in developing new products; however, no published supplier-integration models directly address the question of whether or not the point when suppliers are integrated depends on the innovation of the product. This study presents a supplier participation model in product innovation development processes for disruptive and incremental creative goods, focusing on the engagement time to fill the void created due to this gap.

The envisioned product's innovativeness serves as a determinant of the time when suppliers are included in the product innovation process. The degree of gradual or disruptive innovation may also impact the degree to which suppliers participate in joint projects with buyers. A better focus could improve the level of managerial understanding of inter-organizational collaboration in product innovation on the affiliation between the timing of supplier integration and collaborative project organization, as well as the dependence of these factors on the degree of innovation. According to the findings of this research, there are two crucial aspects of supplier integration in product innovation: first, in terms of the timing of the engagement of suppliers, at what point in the buyer's product innovation process is it most beneficial to include suppliers to achieve the highest possible level of innovation performance? Second, in terms of the engagement phase and the degree of a joint effort between the provider and the customer, is there a distinction between incremental and disruptive innovation?

The rest of the study is organized as follows: the relevant literature review is presented in section 2. Methods, data, and metrics are discussed in Section 3. Part 4 summarises the findings, while Section 5 outlines the discussion, conclusion, and recommendations.

2. Related Literature Review

Market unpredictability and economic risks are hallmarks of disruptive inventions. Typically, such innovations are founded on entirely novel technical ideas, materials, and structures, allowing for substantial enhancements to the performance of the goods or services. In addition to satisfying as-yet-unidentified demands and spawning new economic sectors, radical innovations can impact preexisting value chains (Salomo et al., 2007). While disruptive innovations have an undeniably favourable effect on the long-term performance of businesses, they are far less common than incremental ones. Competitive advantages may result from either process or product improvements, depending on whether the innovations result in cost savings or increased consumer demand (McGrath et al., 1996). Rents consistent with the Ricardian or Schumpeterian theories may be achieved (von Hippel, 1988).

This means that research and development efforts inside businesses are more crucial than ever. Paradigm shift, or realigning the innovation process, is increasingly the subject of innovation management studies nowadays. Firms incorporate suppliers and other external companies into their product innovation activities (Chesbrough, 2003; Ragatz, 1997) to outsource portions of the risks and use capabilities that cannot be obtained within the business. Strategic communication of the innovation basis between at least two firms can lead to the development of novel services and products that aid in outperforming competitors and generating rents in the best-case scenario. In reality, all companies in a value creation chain need to be included in a connection analysis.

The literature on innovation alliances and networks stresses the need to pool resources to develop novel competencies (Sampson, 2007). For instance, firms may have access to innovative and distinctive resources by partnering with organizations with abundant external resources (Dyer & Singh, 1998). In particular, the "collaborative advantage" paradigm recognizes the importance of links across stages in the supply chain (Dyer, 2000).

Theoretically, supply chain relational rents allow companies to combine internal and external resources to get an edge in the market (Dyer & Singh, 1998). Chesbrough (2003) emphasizes the benefits of using outside sources in the framework of "open innovation," citing the expanded skills of suppliers as an example. Several studies have shown that a company's technical leadership and innovative performance may largely be attributed to its suppliers (e.g., von Hippel, 1988). Despite its importance, researchers agree that research on suppliers' innovative skills has been scant (Gassmann et al., 2010). This article examines how buyer-supplier partnerships might benefit from supply-chain cooperation as a foundation for creative supplier contribution. Many businesses rely on their supply networks as a means through which to get access to relevant outside information (Choi & Krause, 2006).

Buyers face several challenges and dangers when choosing the most qualified supplier to collaborate with on product creation (Eisenhardt & Tabrizi 1995; Johnsen et al. 2006). It might be challenging, for instance, to choose the most relevant and beneficial supplier for a ground-breaking endeavour. Uncertain circumstances make enlisting suppliers in the early phases more difficult since the novel product's needs are unclear. Studies show buyers prefer supplier integrations later in the innovation process when making changes is more manageable, rather than earlier, when the invention is still in the conceptualization phase (Eisenhardt & Tabrizi 1995). As less time is needed to bring the new product to market and make quick decisions, a less intense buyer-supplier project structure results from late engagement. Hence, a project structure that emphasizes customer and vendor communication would be optimal here.

According to findings from studies on early inter-relationship collaboration in a supply chain at an early stage, this leads to superior outcomes in innovation process solutions compared to late supplier involvement (Handfield et al. 1999). It should come as no surprise that early participation by suppliers is more difficult to accomplish in unpredictable and dynamic circumstances. It is challenging for businesses to determine which suppliers may be necessary for their product creation process without taking excessive risk (Johnsen et al. 2006). For instance, it is not easy to guess which providers may be the most valued. As a result, some businesses incorporate their suppliers late in the innovation process rather than early on to achieve more significant variability in the late design phase of the progression (Eisenhardt & Tabrizi, 1995). Innovations with a shorter life cycle and constant increases in overall operations will be released later to the marketplace to apply the most current technological components of the supply partners in product development. This is so the market can keep up with the most recent technology. Suppliers' engagement in new product development may be crucial in ensuring that the product meets market quality requirements, is feature-rich and suitably priced, and its launch and distribution are properly scheduled (Koufteros et al., 2005). As a result, the suppliers' engagement in product development has drawn significant research. These studies typically support the assumption that involving suppliers is a realistic approach to enhancing product salability and minimizing uncertainty in product development and marketing (Fliess & Becker, 2006; Petersen et al., 2005; Wagner & Hoegl, 2006).

Regarding these items, the suppliers do not often become involved in the development efforts until much later. Short-term agreements with suppliers would boost the flexibility of manufacturers, which is essential for adopting disruptive innovations and technical refinements in the product (Ragatz et al., 2002; Phillips et al., 2006). As a result, the degree of innovation is an essential consideration for the timing of suppliers' participation in product innovation activities. The next portion of this article addresses the question of at what stage the ideal integration of suppliers' incremental and disruptive innovation processes may be achieved.

3. Research Methodology

2.1. Research model and variables

This research examined the inter-relationship collaboration in a supply chain in developing new products based on data from over 200 different innovative companies in the year 2011. The purpose of the survey was to collect quantitative data on the integration of suppliers in the various stages of product innovation. A logistic regression model assesses the factors influencing the optimal stage for supplier involvement in new product development activities (Hair et al., 2019).

Participation from suppliers at all stages of the product innovation process may serve as a powerful catalyst for advancing both the product itself and the associated process development (Petersen et al., 2005). There are several steps involved in the creative process. At first, the customer pitches an original concept for a product. In the second phase, commercial and technical viability are validated, notwithstanding their current murkiness. The service, process, or product concept is developed and evaluated in the third stage. The product, service, or process is planned for mass manufacture in the fourth stage. A pilot study is conducted in the fifth stage, prototypes are created, and product evaluations are begun (Petersen et al. 2005). The new product's commercialization is a significant consideration in the latter phases of the invention process.

According to the literature, including suppliers early in the product innovation process yields superior outcomes than incorporating them late (Handfield et al. 1999). Vendors will likely be chosen in advance of the start of planned initiatives. It is best to bring them in during the planning stages (Eisenhardt and Tabrizi, 1995). If the buyer involves the supplier early in the product invention process, the supplier may be integrated immediately. A collaborative project structure is preferable to late involvements because of the increased intensity of the interaction between the provider and the consumer.

The reasons that influence the level of integration of suppliers at different phases of product development are subjected to an analysis using a logistic regression model. A binary logistic regression analysis is used to estimate the model using SPSS version 25 (SPSS 25 (2017)). At each step of the product innovation process, the following aspects of the supplier's engagement and their impact on that involvement are investigated and analyzed:

Table 1. *Variables*

Name	Type	Unit
Dependent Variable		
Stages in product development		
Phase 1 (Yes – No)	Binary	Coded into 0 and 1
Phase 2 (Yes – No)	Binary	Coded into 0 and 1
Phase 3 (Yes – No)	Binary	Coded into 0 and 1
Phase 4 (Yes – No)	Binary	Coded into 0 and 1
Phase 5 (Yes – No)	Binary	Coded into 0 and 1
Independent Variable		
Innovation degree (Incremental – Disruptive)	Binary	Coded into 0 and 1
Experience (from one to two years, three to four years, five to six years, seven to eight years, nine to ten years, or more than ten years).	Categorical	Coded into 1 and 6
Sourcing Strategy (Single Sourcing, Dual Sourcing, or Multiple Sourcing)	Categorical	Coded into 1 and 3
Sourcing Location (Local Sourcing – Global Sourcing)	Binary	Coded into 0 and 1
Supplier portion (Single part – Components- Module – System – Service – Raw Material)	Categorical	Coded into 1 and 4
Form for Collaborative Work (None – White Box – Black Box – Grey Box)	Categorical	Coded into 1 and 4

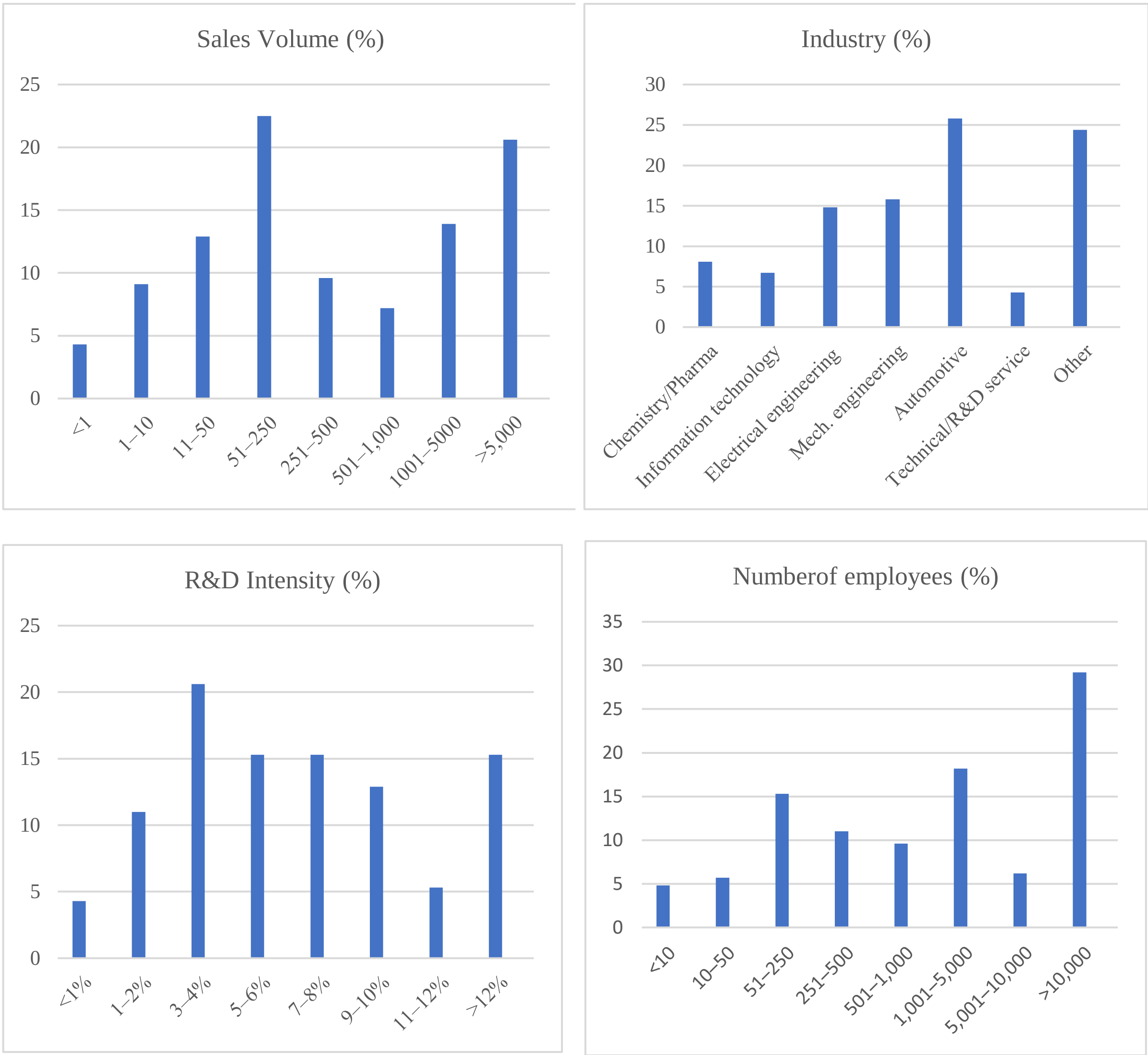
2.2. Study group

In each step of the product innovation process, we investigated the influence of various aspects of inter-relationship collaboration in a supply chain. A survey was sent online to companies interacting with suppliers in new product development activities. The Innovation List, produced once yearly, served as a model framework for identifying sectors that highly emphasize technical innovation. Participants are chosen for this study actively developed highly innovative products in German-speaking nations.

2.3. Research process and data collection

The participants were directly approached via mail. A structured questionnaire was used to gather quantitative data for an NPD initiative in which buyers included a supplier in the NPD process. In addition, a cross-sector primary survey was used to conduct the current research. The sample is defined by the respondents' position in the purchasing business, the firm's industry affiliation, the number of workers, yearly turnover, and R&D costs. The current analysis incorporates information from over 200 different companies. Table 1 provides an outline of the key characteristics of the assessed firms.

Table 2. *Descriptive statistics*



2.4. Research Ethics

This study, titled "What is the best phase of managing inter-firm relationships in supply chains?" has been prepared in accordance with publication and research ethics. In the preparation of this article, academic research rules and principles were adhered to. I declare that this study has been prepared in accordance with research ethics.

4. Findings

The Nagelkerke R2 test statistic and the omnibus test for model coefficients were used to assess overall model fit. The estimations are based on a chi-square ($\chi 2$) distribution, and the results indicate that all nonsignificant p statistics match our model. In addition, the Wald test was performed to determine the importance of each dependent variable. Finally, we evaluated the proper case category ratio and determined that all values over the 60% barrier were good and those above 70% were beneficial, as Hair et al.(2019) suggested.

The binary logistic regression model's evaluations reveal the impact of various factors on the implementation of the supplier in each phase of the new product development actions (Table 2). The total model is statistically significant ($\chi 2$ (55) = 88.369, $p < 0.01$ for phase 1, $\chi 2$ (55) = 77,686, $p < 0.05$ for phase 2, $\chi 2$ (55) = 99.456, $p < 0.001$ for phase 3, $\chi 2$ (55) = 93.713, $p < 0.001$ for phase 4, and $\chi 2$ (55) = 88,081, $p < 0.01$ for phase 5. As a result, the model efficiently distinguishes between respondents who engage in or do not engage in various new product development phases. The Nagelkerke R2 ranges from 0. 419 to 0.614.

The binary logistic regression model estimates shed light on the possible forces motivating supplier participation in each product creation process. According to our research results, the effects of including suppliers in the various phases of the product innovation process vary depending on whether or not the innovations included are incremental or disruptive. Suppliers are often brought on board early in disruptive innovation projects' ideation, concept development, and prototype phases. On the other hand, suppliers are brought in at an earlier stage of the idea development process through incremental innovations. In addition, incremental innovation negatively affects the intensity of engagement in the late phases, such as manufacturing and prototype development. In prototype development, experience with the provider is quite essential. The sourcing strategy does not substantially influence suppliers' engagement in the various phases of product invention. Global suppliers negatively affect the early and very late supplier participation processes. Single parts and raw materials are necessary components during the product design stage. In addition, the manufacturing and production stages emphasize using single-part and module-based systems. At each level of product innovation, the grey-box method is used, the black-box method is utilized throughout the stages of idea development and product development, and the white-box method is crucial during the product development stage.

Table 3. *Results*

	Phase 1		**Phase 2**		**Phase 3**		**Phase 4**		**Phase 5**	
Variables in the Equation	β (SE)	Odds Ratio	β (SE)	Odds Ratio	β (SE)	Odds Ratio	β (SE)	Odds Ratio	β (SE)	Odds Ratio
Innovation degree										
Incremental Innovation	1,021* (0,59)	2,776	-0,006 (0,503)	0,994	-1,03 (0,7)	0,357	-3,769*** (1,302)	0,023	-1,091* (0,58)	0,336
Radical Innovation	2,141**** (0,605)	8,504	0,868* (0,523)	2,382	0,627 (0,827)	1,871	-3,421*** (1,234)	0,033	0,022 (0,62)	1,023

Experience (ref. < 1 year)										
1-2 year	0,476 (0,773)	1,609	0,038 (0,673)	1,039	-0,656 (0,938)	0,519	2,17 (1,457)	8,762	2,362** (1,05)	10,617
3-4 year	0,365 (0,76)	1,441	0,411 (0,655)	1,508	-0,607 (0,917)	0,545	2,221** (1,119)	9,218	0,814 (0,708)	2,257
5-6 year	1,613** (0,802)	5,018	0,35 (0,738)	1,419	0,146 (1,124)	1,158	2,547* (1,378)	12,765	0,702 (0,835)	2,017
7-8 year	1,272 (0,979)	3,569	1,65* (0,863)	5,209	1,505 (1,19)	4,505	6,003** (2,408)	404,649	0,67 (0,898)	1,955
9-10 year	-1,643 (1,745)	0,193	21,714 (17280,844)	2693813503,07864	20,476 (15390,982)	781043540,807026	-0,211 (2,147)	0,81	-2,64 (1,653)	0,071
> 10 year	1,232 (0,804)	3,428	-0,181 (0,7)	0,834	-0,45 (1,123)	0,637	-0,135 (1,175)	0,874	1,134 (0,854)	3,108
Sourcing Strategy (ref. Other)										
Single Sourcing	0,308 (1,316)	1,36	0,253 (1,102)	1,287	0,924 (1,543)	2,518	-5,368 (14,54)	0,005	1,462 (1,338)	4,315
Dual Sourcing	-0,521 (1,315)	0,594	-0,041 (1,099)	0,96	1,179 (1,533)	3,253	-4,877 (14,531)	0,008	2,255 (1,395)	9,538
Multiple Sourcing	0,883 (1,258)	2,418	-0,151 (1,082)	0,86	2,167 (1,601)	8,729	-4,564 (14,534)	0,01	1,811 (1,402)	6,114
Sourcing Location (ref.Mix)										
Local Sourcing	-1,837 (1,542)	0,159	-1,087 (1,55)	0,337	-19,962 (15166,308)	0	-22,803 (13530,54)	0	-2,631 (2,376)	0,072
Global Sourcing	-2,689* (1,509)	0,068	-1,053 (1,534)	0,349	-20,366 (15166,308)	0	-24,399 (13530,54)	0	-4,028* (2,428)	0,018
Supplier part (ref. Other)										
Single part (standard / norm part)	-0,876 (1,736)	0,417	-0,638 (1,498)	0,528	-2,304 (2,506)	0,1	8,015 (13,301)	3026,655	4,031** (2,004)	56,29
Components (mounting connection)	-2,446 (1,67)	0,087	-0,173 (1,428)	0,842	-1,073 (2,614)	0,342	8,113 (13,246)	3338,729	2,93 (1,926)	18,721
Module (complete module)	0,583 (1,588)	1,791	-0,278 (1,379)	0,757	-2,499 (2,359)	0,082	6,365 (13,156)	581,13	3,375* (1,893)	29,216
System (uniform functionality)	0,414 (1,631)	1,513	0,7 (1,447)	2,015	-0,657 (2,582)	0,519	8,624 (13,283)	5564,65	1,932 (1,913)	6,906
Service	1,577 (1,608)	4,842	0,831 (1,398)	2,295	-2,883 (2,267)	0,056	4,671 (13,148)	106,809	-0,25 (1,82)	0,779
Raw material / Material	1,05 (1,741)	2,859	-0,805 (1,586)	0,447	-5,053* (2,638)	0,006	5,082 (13,151)	161,03	2,689 (2,073)	14,715
Collaboration Form (ref. None)										
White	1,525 (1,604)	4,593	2,123 (1,31)	8,353	3,582** (1,432)	35,93	0,49 (1,52)	1,633	0,429 (1,089)	1,535
Black-Box	2,267 (1,647)	9,655	3,399** (1,325)	29,929	4,407*** (1,45)	82,027	1,662 (1,738)	5,272	1,199 (1,098)	3,317
Grey-Box	2,701* (1,617)	14,895	3,571*** (1,296)	35,544	5,905**** (1,492)	367,043	3,843** (1,733)	46,657	2,231** (1,088)	9,313

*p < 0.1; **p < 0.05; *** p < 0.01; **** p < 0.001

5. Discussion, Conclusion and Recommendations

This study contributes to the literature on buyer-supplier cooperation in creating new products. Our examination of the many elements that influence the engagement of suppliers in the various phases of the product creation process is the aspect of this article that sets it apart from similar works (Koufteros et al., 2005; Ragatz et al.,2002; Wagner & Hoegl, 2006; Wynstra & ten Pierick, 2000).

Our study reveals managerial insights regarding supplier involvement in each product innovation stage based on innovation degree, experience, sourcing strategy, sourcing location, supplier part, collaboration form, and sector. These insights are gleaned depending on the innovation degree, sourcing strategy, sourcing location, and supplier part. According to the findings of our study, disruptive innovation efforts have a higher degree of supplier integration than incremental innovation activities at every stage of the product development process.

This study aims to stimulate a debate among researchers about whether or not the process of developing disruptive products differs from that of small-scale innovation related to the stage of involvement and whether or not it calls for a particular kind of inter-relationship collaboration in a supply chain. The degree of product innovation affects the interaction between the supplier and the customer throughout the product innovation process. On the other hand, the rate of product innovation is one factor that has a role in the timing of the beginning of interactions between buyers and suppliers. The problems examined in this research article give rise to more thoughts and considerations. The analysis finds several levels of participation on the part of the suppliers. As opposed to breakthrough development efforts, incremental innovation often requires greater involvement from relevant suppliers. In disruptive innovation projects, an organization for developing the interface project in collaboration with the provider is appropriate. In less creative projects, collaborative cooperation with the supplier is required to fulfil the output objectives that have been set, which are assessed by the level of cost, level of quality, level of time, and level of manufacturability.

On the other hand, Ragatz et al. (2002) believe that the supplier has to be involved at a much earlier stage of the innovation process to ensure a more widespread supplier engagement. The primary distinction is in the kind of provider and the extent to which they are involved. For example, Wynstra & ten Pierick (2000) pointed out that assembly providers must be included in the process at an earlier level. Nevertheless, they considered that this viewpoint lacked comprehensive knowledge of the actual contribution made by suppliers and instead focused only on their prospective contributions. They noted that occasionally disruptive innovation would require a modest technical change in the new product and that the timing and role of suppliers' participation would not be comparable to creating an entirely new product. As a result, our study supports a comprehensive understanding of the appropriate timing of supplier involvement in the innovation procedure. The primary focus of our model is on the role that suppliers are anticipated to play and their contribution to the innovation procedure. These findings of inter-relationship collaborations in supply chain models do not differentiate between incremental and disruptive innovations in terms of the ideal stage of inter-relationship collaboration in a supply chain in the product innovation stages. Many of these models do not differentiate between incremental and disruptive innovations (Cousins & Lawson, 2007; Hartley et al., 1997; Lilien & Yoon, 1990). In contrast, this paper considers the degree of innovation required to accomplish the goals of supplier integration and builds a model to identify the best moment of supplier integration in the innovation phase.

When planning the project's structure, it is necessary to consider the degree of innovation required to accomplish the goals of supplier integration. These models should also focus on the supplier's needs and the projected contribution that the supplier will make to the innovation process.

The processes of interface development and collaborative development may be differentiated from one another. Cooperation should be performed via established interfaces, for instance, to guarantee flexibility in selecting suppliers when there is a low level of innovation. The structure of projects via collaboration is the approach that should be preferred for disruptive innovation. The benefit comes from the activities included in the product invention process being carried out together. Information on the elements favourable to the supplier's integration concerning the degree of innovation may be gleaned from the variations in the impact factors identified during an in-depth empirical inquiry.

Regarding incremental innovation, having the supplier involved early on helps intensify the integration. Early engagement with projects involving incremental innovation results in a project structure that emphasizes collaboration more. This is preferable to using the expertise gained with the provider during the whole innovation process. When it comes to disruptive innovation, the mutual interdependence of the parties involved and the significance of the acquisition item are brought to the forefront.

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