State-of-the-art and implications of early supplier involvement: 5 years after the review of Johnsen (2009)

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Abstract: *This paper provides a comprehensive and critical review and synthesis of the current state of empirical research into supplier integration in new product development (NPD), which will be an update of Johnsen's literature review. This paper identified 10 trending topics, which are divided into 3 categories (buyer focus, buyer-supplier relationship, and supplier focus). By doing so, this paper could demonstrate factors that are crucial for the success of supplier integration projects by taking into account each category. From this base of the empirical research the analysis also identified that the early supplier involvement (ESI) in NPD research is still an emerging discipline.*

Keywords: Early supplier integration (ESI), New product development (NPD), buyer-supplier relationship, collaboration

1. Introduction

Since many companies in different industries are operating more globally, there is higher competition and thus, it is necessary for these companies to collaborate with external partners as well as to outsource specific tasks and commodity[1]. In other words, establishing and creating a network that can be used as a successful product development strategy in order to increase the market demand for a better quality and product innovation, is considered as a good strategy to seek competitive advantages[2]. Therefore, involving the supplier early but also closely into the new product development (NPD) is gaining more and more attention in the research field [3].

In 1989 Clark showed that the Japanese automobile manufacturers received a better lead-time as well as cost advantages compared to the European or American automobile manufacturers that did not collaborate closely with their suppliers or involved their suppliers early in the NPD process[4]. As a result, the concept of early supplier involvement (ESI) in NPD was propagated by Clark's research. Many other scholars tried to explain this concept in order to show the benefits and obstacles in involving the supplier early in the NPD process. Johnsen was the first, who designed a chronological literature review that presents a systematic synthesis of empirical research in supplier involvement in NPD from the origins in the 1980's up to 2008 [5]. There are many different definitions for ESI, for instance Bonaccorsi and Lipparini stated that ESI "is a strategy for appropriating supplier-originated innovations-alternative to the traditional procurement of improved devices developed autonomously by suppliers and then offered in the open market".[6] Comparatively, Hoegl and Wagner defined ESI in NPD as "the extent to which a buyer organisation shares responsibility with a supplier organisation for the development and design of the subsystems (or components) of a new product".[7] By working closely with the key suppliers the company has access to further information, knowledge as well as expertise concerning innovation, technology and new ideas[8]. Johnsen identified all the relevant factors that have an affect on the success of supplier involvement in NPD.

Nevertheless, until 2008 empirical findings on ESI outcomes showed positive as well as negative outcomes. The main positive outcomes are product innovation[9], shorter time-to-market[10], product quality, NPD time and cost[11], and process alignment and privileged relationship[12]. However, many other authors identified also negative outcomes, namely: no significant effect[13], no reduction in time-to-market[14], less impact on manufacturability[15] and, negative effects on cost, time and efficiency[16]. This paper analyses the finding of these recent 39 articles in order to see if the relationship between ESI and success is more positive or negative. Furthermore, Johnsen suggested four recommendations, which are relevant for future studies[17]. The first recommendation was to focus on the supplier's benefits since this topic is still not investigated sufficiently. The second recommendation was to focus on technology uncertainty, as the empirical findings concerning technology uncertainty are still controversial. Cultural context was suggested as the third recommendation since it can be seen as an impact factor on ESI outcomes. The last recommendation considered the concept of network because many researchers are still trying to find a significant link between the supply network and ESI and if this could have an impact on the ESI outcomes[18]. Moreover, this paper implemented a model, which indicates if the ESI in NPD research domain has matured or if it is still in the development phase. Therefore, an update of the empirical findings on ESI in NPD ranging from 2009 to 2013 is needed in order to see if recent empirical research used Johnsen's recommendations and if the results concerning performance benefits and success factors of ESI changed or remained the same; in other words, to see if the recent studies exhibit more positive than negative findings concerning ESI and success. This will be done by using Johnsen's findings[19] in order to identify ten trending topics in three main research fields: buyer focus, buyer-supplier focus, and supplier focus.

The findings of this paper showed that as opposed to the older papers, all recent papers show benefits from ESI. This could be interpreted in a way that the field has matured and companies have learned to integrate suppliers. In other words, the field has matured and ESI in NPD research is moving from the development phase to the consolidation phase. Additionally, the most cited trending topics were performance, timing and integration capabilities.

The next chapters of this literature review are structured in the following manner. The second chapter discusses previous

[1] See (Schiele, 2010, p. 138)
[2] See (McIvor & Humphreys, 2004, p. 180)
[3] See (Johnsen, 2009, p. 187)
[4] See(Clark, 1989, p. 1258)
[5] See (Johnsen, 2009)
[6] (Bonaccorsi & Lipparini, 1994, p. 139)
[7] (Hoegl & Wagner, 2005, p. 531)
[8] See (McIvor & Humphreys, 2004, p. 180)
[9] See (Koufteros, Edwin Cheng, & Lai, 2007, p. 847)
[10] See (Ragatz, Handfield, & Petersen, 2002, p. 390)
[11] See (Primo & Amundson, 2002, p. 50)
[12] See(Petersen, Handfield, & Ragatz, 2005, p. 377)
[13] See (Eisenhardt & Tabrizi, 1995, p. 101)
[14] See ((Hartley, Zirger, & Kamath, 1997, p. 68)
[15] See (Swink, 1999, p. 763)
[16] See (Littler, Leverick, & Wilson, 1998, p. 139)
[17] See (Johnsen, 2009, pp. 195-196)
[18] See (Johnsen, 2009, pp. 195-196)
[19] See (Johnsen, 2009, p. 194, Tab. 5)

literature reviews on ESI as well as their findings from the timeframe of 1980's until 2008. The methodology of this paper is explained in the third chapter. Chapter 4 is about the systematic literature review, which is separated into buyer focus, buyer-supplier relationship and supplier focus. Chapter 5 concentrates on the results and the 6th and last chapter entails the discussion as well as the conclusion. Additionally, future research and limitations are also explained in detail in the last chapter.

2. Previous literature reviews on ESI

In order to describe the development of ESI in NPD from 2009 to 2013 a small summary of the empirical findings regarding ESI before 2008 is given first. As mentioned earlier, the first Clark was the first who highlighted the concept of ESI in NPD. In 1991 Clark and Fujimoto explained the major performance gap concerning new product quality, cost and time-to-market by comparing the Japanese and the American as well as European automobile manufacturers. As a result, their research showed that involving suppliers in NPD was the key factor of this performance gap[20]. Furthermore, their research gave rise to the black and white box approach, which was also used by many other scholars. This approach classifies the level of supplier integration and how much responsibility is given to the suppliers. For example, if the buying company needs suppliers only for informal information then a white box approach is used[21]. If there are joint development activities in NPD then the grey box approach is used. If a buying company gives high responsibility to its supplier where the supplier is seen as the key driver and thus develops products or components for the buying company then a black box approach is used[22]. In the 1980's most of the empirical data stem from the automobile industry.[23] In the mid 1990s Cusomano found out that the Japanese rely heavily on the black box parts compared to the American and European[24]. Moreover, the type of buyer-supplier relationship characteristic in Japan was elucidated in a way that the Western automobile manufacturer was able to implement it[25]. Bonaccorsi and Lipparini's research distinguished three different models of involving the supplier: a traditional model, a Japanese model and a partnership model[26]. Furthermore, their research was also influenced by the network theory as well as buyer supplier interaction[27]. In the late 1990's Bidault, Despres and Butler were focusing on other critical success factors that could have an impact such as the timing of involving the supplier[28]. On the other hand many scientists were also emphasising supplier selection as a key success factor for ESI.[29] Ragatz, Handfield and Scannell showed in their research that trust, commitment, risk as well as reward sharing has an influence on the supplier relation development due to the fact that the supplier is more willing to work with the buying company if there is commitment and trust.[30] In most cases the success factors have shown a positive relationship to ESI. However, regarding the moderating role of technology uncertainty the empirical findings were contrarious. For instance, Wasti and Liker's findings showed that there is a positive influence on ESI when technology uncertainty is combined with suppliers capability due to the fact that suppliers need specific capabilities in order to deal with the technology uncertainty.[31] Correspondingly, Swink's findings showed that supplier involvement has a positive influence on improved manufacturability but if there is a high product newness then there is no positive influence on the improved manufacturability.[32] In the early 2000s Petersen, Handfield and Ragatz continued research concerning supplier selection as well as adaption. As a result, Petersen et al. suggested that supplier selection should underline the interrelating of culture and a supplier's capability.[33] Another focus of many researchers was on the role of networks in NPD because combining the network theory with supplier involvement in NPD would broaden the view as well as in the field of buyer-supplier relationship.[34] Johnsen's chronological literature review summarised all the empirical findings from 1980 until 2008 and thus implemented a model that shows a comprehensive list of success factors. These success factors are classified into three groups: supplier selection, supplier relationship and adaption, and internal customer capability.[35] Thereupon, all these success factors lead to a short time-to-market[36], improved product quality[37] and, produced development/ product cost[38].

3. Research methodology

3.1 Source identification

Only academic articles published in English peer-reviewed journals were used for the analysis. These academic articles can be retrieved directly through journal websites or electronic providers. Correspondingly, journals are the most common knowledge base for research community and especially used in order to validate research results as well as releasing new academic findings. Moreover, no grey literature was included in this literature review since this type of literature does not guarantee that any scientific standards were obtained. This can be seen as a limitation due to practical reasons but since the scope of the study is to investigate academic articles concerning ESI in NPD from 2009 until 2013, it is a common approach in similar studies.

3.2 Source selection

The iterative literature research approach by Tranfield was applied for this literature review.[39] The aim of this type of literature review is to minimise bias and errors by using series of techniques[40]. Furthermore, by applying an iterative literature research approach the literature review process was articulated into five steps, which are:

1. Journal selection
2. Determination of keyword for database search queries
3. Initial search in EBSCO and Scopus and assessment of results
4. Redefinition of keywords
5. Second search in EBSCO and Scopus and assessment of results.

Step 1: Selection of journals

Identification of journals which are relevant to ESI in NPD as well as the acquisition of relevant academic articles is part of the source selection and thus, very important for the research structure. There are many academic articles regarding ESI in NPD that were published between 2009 and 2013. However, the selection of relevant academic articles was limited to publications in a set of supply chain management journals with high journal impact factors as well as h-indices. Furthermore, ten additional journals, which are highly ranked in the field of

[20] See (Johnsen, 2009, p. 188)
[21] See (Petersen et al., 2005, p. 378)
[22] See (Petersen et al., 2005, p. 378)
[23] See (Johnsen, 2009, p. 188)
[24] See(Cusumano & Takeishi, 1991, p. 577)
[25] See (Lamming, 1993)
[26] See (Bonaccorsi & Lipparini, 1994, p. 136)
[27] See (Bonaccorsi & Lipparini, 1994, p. 144; Johnsen, 2009, p. 190)
[28] See (Bidault, Despres, & Butler, 1998)
[29] See (Wasti & Liker, 1997, p. 352)
[30] See (Ragatz, Handfield, & Scannell, 1997, p. 200)
[31] See (Wasti & Liker, 1997, p. 337)
[32] See (Swink, 1999, p. 703)
[33] See (Petersen et al., 2005, p. 385)
[34] See(Johnsen, 2009, p. 193)
[35] See (Johnsen, 2009, p. 193)
[36] See (Johnsen, 2009, p. 195)
[37] See (Ragatz et al., 2002, p. 390)
[38] See (Van Echtelt, Wynstra, Van Weele, & Duysters, 2008, p. 186)
[39] See (Tranfield, Denyer, & Smart, 2003, p. 209)
[40] See (Tranfield et al., 2003, p. 210)

technology and innovation management, were selected for this research.[41] In addition to that, further management journals, which are sustaining a superior position across different journal rankings, were supplemented to the list of journals. Consequently, few highly ranked journals were not included in this paper although these journals have relevant insight concerning the buyer-supplier relationship. But, since the focus of this paper is on the buyer-supplier relationship in NPD it would be more beneficial to use journals, which have a purchasing as well as innovative and technological perspective, as the R&D department and the purchasing department are more involved in the ESI in NPD process than the marketing department. In addition, since an iterative literature approach was used, it was crucial to select the journals first and therefore; it was not an option to use Google Scholar to include all academic outlets. The final list of selected journals for the review with their corresponding rankings is shown in Appendix.

Steps 2 to 5: Keyword determination, search, and assessment of results

The next step was to determine the main keywords for the data base search queries. In this case, three core keywords were determined but also complemented with appropriate synonyms in order to constitute the basis for the search syntax for the chosen scholarly search engines EBSCO and Scopus, which was relevant for the third step.

The fourth step dealt with redefining the keywords and thus, the following pairs of keywords were distinguished as being sufficiently close-fisted:

- *NPD* OR *New Product Development* OR *Product Development*
- *Relationship* OR *Cooperation* OR *Involvement* OR *Integration*
- *Supplier* OR *Purchasing*

After that a second search in EBSCO and Scopus was done in order to assess the results. As mentioned earlier the time horizon was restricted to articles that were published since 2009 and not covered by Johnsen's literature review. At the end, the reference lists of each relevant academic article were scanned in order to identify missing research articles. Notably, there are 3 exceptions made for the time horizon since two academic articles are from 2008 (but were not covered by Johnsen) and one crucial article from 2014.

3.3 Identification of ten trending topics for ESI & the research domain development

The goal of this paper is to identify trending topics in recently published research and thus a categorisation of the research findings is helpful for this literature review. Each academic article was read and coded individually in order to identify the final body of articles, which were relevant for the literature review. In particular, a variety of codes were formed as well as used to categorise the entire range of these 39 academic articles. In order to minimise the coding complexity a multiple stage categorisation approach was implemented. The codes have been derived inductively based on ground theory. The first step was to compare all the codes in order to specify similarities among the academic articles on a micro level. By doing so a first set of categories was developed, which was needed for the next step. Additionally, all emerging trending topics specified for each category were also formed and identified in this step. Appendix 2 lists the exact numbers of citations for every study. The next step resulted in ten distinct trending topics. These ten trending topics were checked for resemblance as well as grouped into broader categories, which then classified the ten trending topics into three foci of research. The three major research foci after the categorisation are: buyer focus, buyer-supplier relationship, and supplier focus. Moreover, these ten trending topics were put together with these three broad research categories in order to imply a framework for research on ESI in NPD. Figure 1 shows the framework with the three categorisations as well as the ten trending topics. Moreover, the NPD benefits on ESI are shown on the right side of the framework.

Furthermore, this research looks into the relationship between ESI and success. Langerak's model analyses the research domain over the time.[42] By doing so, Langerak was able to identify if a research topic is mature or still in the development phase. According to this model there are seven phases that indicate how developed a research topic is. The phases are[43]:

1. Ground theory approach (providing a solid ground upon which theory can be developed)
2. Antecedents (synthesizing exploratory findings to develop conceptual models and test the hypotheses)
3. Consequences (investigating the outcomes)
4. Contingency effects (reflecting on divergent empirical results by examining the moderating and mediating effects of factors)
5. Alternative explanation (reflecting on divergent empirical results by investigating alternative explanations for divergent results)
6. Meta analysis (quantitatively aggregating the results of previous empirical studies)
7. Contemporary studies (established research domain)

In other words by dividing each empirical study into these phases, one can see if the ESI research is matured or not. However, Harland, Lamming and Zheng have developed a similar framework, which examines if supply management is a discipline. Their framework is divided into 4 phases[44], which are:

1. No discipline and little theoretical consideration (broad ranges of themes, published work in low ranking journals)
2. Progress towards discipline (some publication in higher ranking journals, some common themes emerging)
3. An emerging discipline (evidence of coherence, quality and impact of the field, and maturing application of existing theory)
4. Respected and established discipline (new theory development and publication in top management journals).

The first two phases (early phases) "involve the improvement of coherence, quality and impact of published work in the field"[45]. Therefore, this paper implemented a new model, which combines both frameworks and, subsequently, will be used for the literature review. This model is divided into 5 phases, which are:

1. Emerging phase (grounded theory approach, qualitative studies, definition of the phenomenon)
2. Development phase (consequences, antecedents, first quantitative findings)
3. Consolidation phase (contingencies, high r^2)
4. Established phase (meta-studies, alternative explanations, country studies)
5. Decline phase (little new research, phenomenon fading, falsification, migration towards new topics)

[41] See(Linton & Thongpapanl, 2004, p. 138)

[42] See (Langerak, 2014, p. 11)
[43] See (Langerak, 2014, p. 11)
[44] See (Harland et al., 2006, p. 736)
[45] (Harland et al., 2006, p. 736)

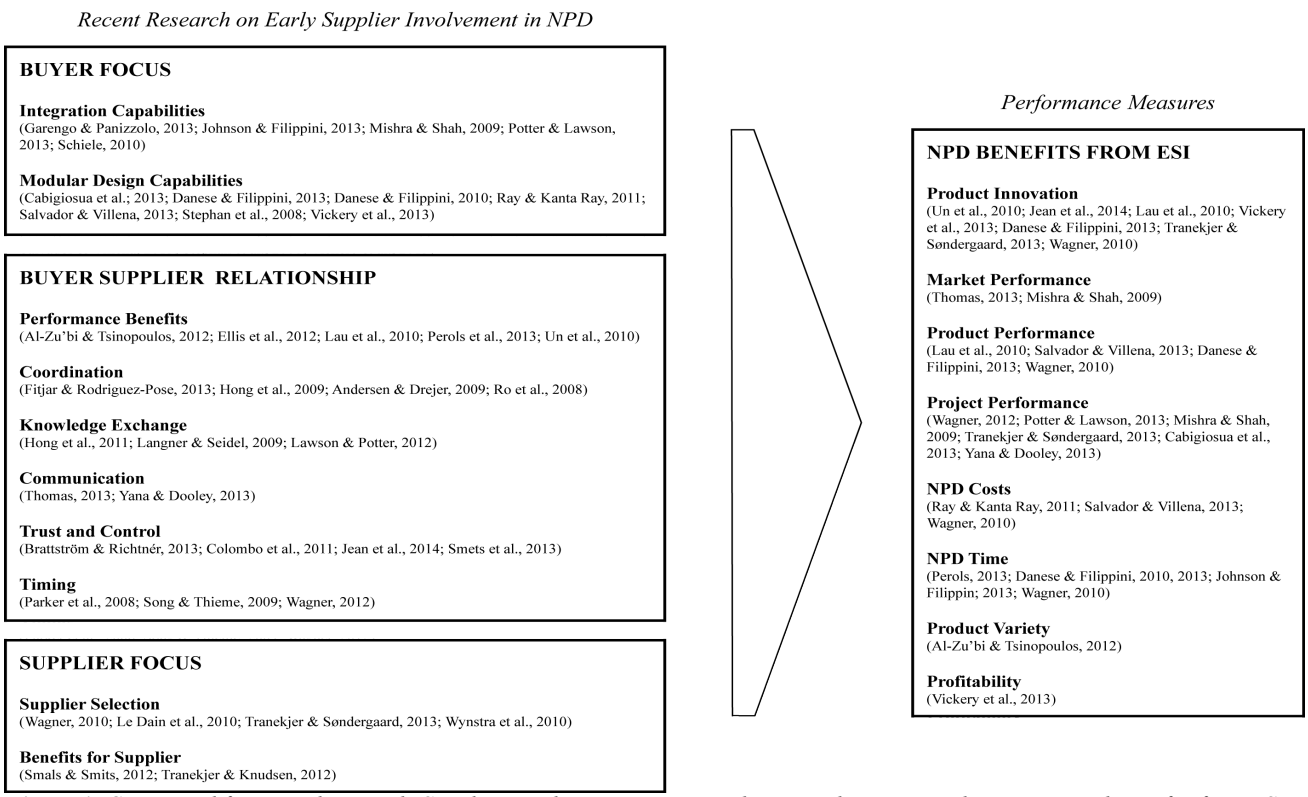

Figure 1: *Conceptual framework on Early Supplier Involvement in NPD with Research Foci, Trending Topics and Benefits from ESI*

4. Systematic literature overview of research from 2008-2013

4.1 Trending topics with buyer focus

This section is focusing on the buyer side by showing which trending topics are crucial for the buyers in order to integrate the supplier successfully. The two trending topics for the buyer focus are integration capabilities and modular design capabilities. All the relevant information is summarized in Table 1.

Integration capabilities

Integration capabilities is defined as the ability of a company to "obtain market and technical knowledge"[46] for the company's NPD process and see if the integration effects of internal as well as the external sources are mediated by this capability. However, many researchers such as Johnsen and Fillipini determine that if external parties are involved then it has a greater direct as well as indirect effect on the product success but also on the time performance compared to the internal integration of functions and departments.[47] Nevertheless, Mishra and Shah establish a new way of combining all the different parties together. In other words, how a company can involve simultaneously customers, suppliers as well as cross-functional teams in the NPD process. This type of capability is called collaborative competence.[48] This study confirms that collaborative competence has a direct impact on the project performance. Furthermore, this capability indirectly influences the market performance due to project performance. Additionally, Schiele stated that the procurement department has a dual role, which is to support the ESI during the NPD process but also to do a cost control on a company- wide level.[49] Schiele's recommendation for a company that wants to integrate supplier successfully in the NPD process is to have a shortly differentiated organisational structure[50] but also to have cross-functional innovation meetings[51] as well as proactive integration suppliers[52] in order to sustain this dual role within the organisations.

Garengo and Panizzolo identified that there are three enablers that help a company to enhance the integration processes that involve customers, suppliers and internal departments. Potter's and Lawson's findings were significant and verified that long-term commitment as well as the involvement orientation has an impact on the casual ambiguity within a company. Moreover, it showed a decrease in casual ambiguity within a company and that a lowered casual ambiguity has a positive effect on the buyer's performance.[53]

Modular design capabilities

According to Hsuan, modularisation is defined as "the opportunity for mixing-and-matching of components in a modular product design, in which the standard interfaces between components are specified to allow for a range of variations in components to be substituted into a product architecture".[54] Moreover, a company with modular design capabilities can decrease "the complexity of managing NPD projects"[55]. Cabigiousu, Zirpoli and Camuffo demonstrated that a level of technical knowledge of original equipment manufacturer eases the buyer-supplier relationship through interface stability.[56]

[46] (Johnson & Filippini, 2013, p. 102)
[47] See (Johnson & Filippini, 2013, p. 105)
[48] See (Mishra & Shah, 2009, p. 324)
[49] See (Schiele, 2010, p. 149)
[50] See (Schiele, 2010, p. 146)
[51] See (Schiele, 2010, p. 148)
[52] See (Schiele, 2010, p. 147)
[53] See (Potter & Lawson, 2013, p. 803)
[54] (Hsuan, 1999, pp. 197-198)
[55] (Salvador & Villena, 2013, p. 89)
[56] See (Cabigiosu, Zirpoli, & Camuffo, 2013, p. 673)

Table 1: *Recent studies focusing on the buyer-side*

Study	Trending Topic	Method of Data Analysis & Sample	Context	Focus	Performance Measure	Key Results	Phase	Journal
Garengo & Panizzolo (2013)	Integration Capabilities	Multiple case study with 22 SMEs	Italy, machine tool sector	Integration enablers for integrated product development (IPD) with suppliers	-	Organisational enablers (e.g. "guest engineering" and "supplier development committee"), technological enablers (e.g. simulation of products via CAD) as well as methodologies are used to enhance relationship.	4	Production Planning & Control
Johnson & Filippini (2013)	Integration Capabilities	Mediation model, 141 firms	U.S., Japan, manufacturing industry	The effects of internal and external collaboration practices on performance via integration capabilities	Product process, time performance	Integration capabilities moderate internal and external collaboration's influence on product success and time performance. External collaboration most strongly effects time performance.	3	Journal of Engineering and Technology Management
Mishra & Shah (2009)	Integration Capabilities	Structural equation modelling, 189 respondents	Multiple countries, multiple industries	Collaborative competence: simultaneous involvement of customers, suppliers and cross-functional teams in the NPD process	Project performance, market performance	Collaborative competence is a higher order construct of supplier, customer and cross-functional involvement. Collaborative competence impacts project performance significantly, a market performance is indirectly impacted, mediated through project performance.	4	Journal of Operations Management
Potter &Lawson (2013)	Integration Capabilities	Structural equation modelling, 119 R&D-intensive manufacturing firms	United Kingdom, electrical, aerospace, pharmaceutical and medical, chemicals, automotive	Supplier involvement's influence on causal ambiguity	Time to competitor imitation, new product advantage, project performance via causal ambiguity	Supplier involvement (involvement orientation and long-term commitment, not involvement depth) decreases causal ambiguity. Decreased causal ambiguity influence new product advantage and project performance positively (not competitor imitation).	4	Journal of Product Innovation Management
Schiele (2010)	Integration Capabilities	Qualitative benchmarking study with six best-practice firms	Six BME members: Deckel Maho Gildemeister, BMW; Leica Geosystems; Magna Steyr; B/S/H; Cherry	Contribution of purchasing to NPD	-	Purchasing department has a dual role: a) supporting innovation processes in cooperation with suppliers b) cost control on a firm-wide level. Organisational changes and tools are suggested.	4	R&D Management
Cabigiosu et al. (2013)	Modular Design Capabilities	Case study with one supplier and two carmakers	1 Japanese first tier supplier and 2 European carmakers, automotive	Definition of component-vehicle interfaces	Time, cost, quality	Level of technological knowledge of OEM eases buyer-supplier relationship. Co-development of same product in same market of different companies differs due to different interface definition processes and organisational solutions. Modularity can only leveraged by carmakers that know more than they do.	2	Research Policy
Danese & Filippini	Modular Design	Confirmatory factor analysis, 201	Worldwide; mechanical, electronics, and transportation equipment	Performance of modularity and early supplier	NPD time Product performance (innovativeness and	Product modularity has significant effect on NPD time and product performance. ESI partially mediates the impact of	3	IEEE Transactions on Engineering

(2013)	Capabilities	manufacturing plants	sectors	involvement	capabilities)	modularity.		Management

Study	Trending Topic	Method of Data Analysis & Sample	Context	Focus	Performance Measure	Key Results	Phase	Journal
Danese & Filippini (2010)	Modular Design Capabilities	Hierarchical regression analysis, 186 manufacturing plants	Worldwide; mechanical, electronics, and transportation equipment sectors	Performance of modularity and early supplier involvement	NPD time performance	Product modularity significantly affects NPD time performance. No significant support for positive interaction effect between modularity and ESI.	3	International Journal of Operations & Production Management
Ray & Kanta Ray (2011)	Modular Design Capabilities	Case study with Tata Motors (Nano car)	India, automotive	Product innovation in emerging markets and cost pressure	-	New combination of existing components enables a modular product for India's masses. Integration of suppliers in design phase for component design lowered manufacturing costs.	2	Technovation
Salvador & Villena (2013)	Modular Design Capabilities	Hierarchical linear regression, 165 firms	U.S., Germany, Sweden, Finland, Italy, Austria, Japan, and South Korea; electronics, machinery, and transportation equipment	Reduction of diseconomies of ESI by modular design competence	Product unit manufacturing costs, product technical performance (functionality, durability)	Modular design competence has a moderating effect for the relationship between ESI and manufacturing costs as well as product technical performance. The moderating effect is weaker for high product and process innovation in terms of manufacturing costs.	3	Journal of Supply Chain Management
Stephan et al. (2008)	Modular Design Capabilities	Case study with MCC (smart car)	Germany, automotive	Outsourcing and collaboration with suppliers for modular product and implications for organisational architecture of NPD	-	Modular design capabilities of Mercedes-Benz not sufficient to design smart's architecture. Tool to overcome these issues developed to assess a firm's component capabilities in NPD.	2	International Journal of Technology Management
Vickery et al. (2013)	Modular Design Capabilities	Structural equation modelling, 214 manufacturers	U.S., fabricated metal products, industrial and commercial machinery, electronics, transportation equipment	Relationship between ESI and performance mediated by product platform strategy (PPS)	Product innovation, profitability	Effect of ESI and internal integration on profitability and product innovation is mediated by product platform strategy. Product platform strategy has a significant effect on profitability.	3	IEEE Transactions on Engineering Management

Furthermore, it is crucial for a buying company to have component-specific knowledge since the definition of interfaces at the beginning is crucial to control the component performance and thus leveraging the modularity successfully.[57] In other words, modularity can only be leveraged by carmakers that are specialised in their niche [58]. Danese and Filippini empirical findings showed that modularity has a positive relationship with NPD time performance. More specifically, modularity reduces the NPD time and thus increases the product performance.[59] Furthermore, their empirical research showed that ESI is a mediator concerning the relationship between modularity and NPD time but also for the product performance.[60] Other empirical research such as Salvador's and Villena's indicated in their findings that a company that possesses modular design competence (MDC) benefits more from ESI with regard to technical performance and costs compared to companies with no MDC. Notwithstanding, manufacturing cost reductions are lower for innovative product as well as processes for company with MDC.[61] Ray and Kanta Ray's empirical findings identified that modularity combined with ESI enables lower manufacturing costs and therefore leads to a better feature accomplishment.[62] By conducting a case study in the automotive sector Stephan, Pfaffmann and Sanchez were able to implement a tool, which helps the buying company to evaluate the component capabilities as well as organisational architecture in NPD based on MCC's smart car.[63] Vickery's, Kouferous's and Droge's findings expose that product platform strategy (PPS) is a mediator, which positively impacts the relationship between ESI and performance [64]. Furthermore, this mediator is also positively related to profitability.[65]

4.2 Trending topics with buyer-supplier relationship

This section is analysing the trending topics that are crucial for the buyer-supplier relationship. 22 empirical researches have analysed the nature of the buyer-supplier relationship and thus the following trending topics are identified: communication, coordination, knowledge exchange, performance benefits, timing, and trust and control. All relevant information is illustrated in Table 2.

Communication

Many empirical articles analyse if the trending topic communication is beneficial regarding ESI in NPD and what kind of value it adds to the process. Thomas analysed in her research the effects of different means of communication on knowledge exchange on the relationship between the buyer and the supplier[66]. As a result, electronic communication such as email is positively associated with knowledge exchange and thus beneficial for the buyer-supplier relationship because it obtains the same level of information richness such as face-to-face communication.[67] In addition to that, email can be used to transfer information in a buyer-supplier relationship with efficient NPD while face-to-face communication can be considered a superior mediator in the case of effective NPD.[68] Yan and Dooley investigated in their studies the influence of communication intensity on project performance[69] and found out that higher communication intensity has a positive impact on project performance in joint NPD when relational uncertainty as well as task is high.[70] However, communication intensity is negatively associated with project performance in joint NPD when relational uncertainty as well as task is low. Task uncertainty deals with whether a product is complex or whether novel technology is involved.[71]

Coordination

There are a few empirical articles analysing the coordination strategies, which are crucial for ESI in NPD. However, these analyses are mainly from a buyer's perspective, as it helps buyers to understand how to coordinate as well as manage the interaction with their suppliers in the NPD process.

Hong, Pearson and Carr indicated that the supplier's technological capabilities (the supplier's technical capability as well as product modularity) and product characteristics have an impact on selecting the coordination strategy.[72] Andersen and Drejer did a case study and identified that rivalry among suppliers denotes the coordination process as well as the division of work but also decreases the interaction intensity.[73] Moreover, their findings also showed that rivalry aggravates the degree of openness.[74] The findings of Ro, Liker and Fixson demonstrated similarities concerning the extensive design responsibilities, which was given to the suppliers but the bureaucratic styles of Japanese and U.S. car manufactures was different. The U.S is using a coercive coordination style, while the Japanese are using the approach, which is defined as an enabling bureaucracy. [75] Consequently, the U.S. supplier bureaucracy decreases the degree of knowledge exchange but yet it leads to a cost advantage.[76] However, there are three barriers, which are: competitive bidding, trust issue, communication and poor coordination and these three barriers restrain the U.S. system from adapting the Japanese style of the supplier coordination.[77]

Knowledge exchange

This section is about the trending topic knowledge exchange. This is also referred to as shared knowledge[78], inter-firm knowledge transfer[79], or knowledge transfer[80]. Additionally, the cooperation between the buyer and the supplier is seen as a knowledge-intensive process that is crucial to the success of the NPD.[81] According to Langer and Seidel, a company should use competition between its suppliers in order to gather information as well as encourage knowledge transfers during the selection process.[82] Lawson and Potter stated that the learning motivation of the buyer regarding knowledge exchange is crucial due to the fact that it increases the inter-firm knowledge. In addition, the buyer's learning motivation intensifies the protectiveness of knowledge on the part of the supplier.[83] Furthermore, by improving the absorptive capacity a buyer is able to offset the supplier`s protectiveness. [84] Absorptive capacity is defined as „a set of organisational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability".[85] Hong, Doll, Revilla and Nahm focused in their research on the relationship between the shared knowledge of suppliers and strategic fit as well as its influence

[57] See (Cabigiosu et al., 2013, p. 674)
[58] See (Cabigiosu et al., 2013, p. 673)
[59] See (P. Danese & Filippini, 2013, p. 267)
[60] See (P. Danese & Filippini, 2013, p. 269)
[61] See (Salvador & Villena, 2013, p. 102)
[62] See (Ray & Kanta Ray, 2011, p. 225)
[63] See (Stephan, Pfaffmann, & Sanchez, 2008, p. 456)
[64] See (Vickery, Koufteros, & Droge, 2013, p. 757)
[65] See (Vickery et al., 2013, p. 757)
[66] See (Thomas, 2013, p. 891)
[67] See (Thomas, 2013, p. 896)
[68] See (Thomas, 2013, p. 896)
[69] See (Yan & Dooley, 2013, p. 525)
[70] See (Yan & Dooley, 2013, p. 538)
[71] See (Yan & Dooley, 2013, p. 538)
[72] See (Y. Hong, Pearson, & Carr, 2009, p. 1017)
[73] See (Andersen & Drejer, 2009, p. 700)
[74] See (Andersen & Drejer, 2009, p. 701)
[75] See (Ro, Liker, & Fixson, 2008, p. 373)
[76] See (Ro et al., 2008, p. 375)
[77] See (Ro et al., 2008, pp. 374-375)
[78] See (P. Hong, Doll, Revilla, & Nahm, 2011, p. 186)
[79] See (Lawson & Potter, 2012, p. 1228)
[80] See (Langner & Seidel, 2009, p. 1)
[81] See (Lawson & Potter, 2012, p. 1229)
[82] See (Langner & Seidel, 2009, p. 11)
[83] See (Lawson & Potter, 2012, p. 1242)
[84] See (Lawson & Potter, 2012, p. 1242)
[85] (Zahra & George, 2002, p. 186)

Table 2: *Recent studies focusing on the buyer-supplier relationship*

Study	Trending Topic	Method of Data Analysis & Sample	Context	Focus	Performance Measure	Key Results	Phase	Journal
Thomas (2013)	Communication	Structural equation modelling, 157 R&D project managers	U.S., manufacturing firms	Effectiveness of means of communication on knowledge exchange in buyer-supplier relationships	Buyer NPD performance, buyer market performance	Email has positive impact on knowledge exchange in buyer supplier relationships. Email mediates relationship with efficient NPD and face-to-face communication mediates relationship with effective NPD.	3	Industrial Marketing Management
Yan & Dooley (2013)	Communication	Ordinary least squares regression, 214 buyer–supplier joint NPD projects	U.S., multiple industries	Benefits of high communication intensity in buyer-supplier relationships	Project performance (design quality + design efficiency)	High communication intensity positively related to project performance when task or relational uncertainty is high. High communication intensity negatively related to project performance when task uncertainty is low.	3	Journal of Operations Management
Hong et al. (2009)	Coordination	Literature review	-	Buyer's coordination strategies to manage multiple suppliers' involvement in the product development process	Locus of control, information-processing structure	"four ideal types" of multiple supplier coordination strategies positioned along the axes "locus of control" and "information processing structure": centralised-programming strategy, centralised-feedback strategy, decentralised-programming strategy, and decentralised-feedback strategy.	2	International Journal of Operations & Production Management
Andersen & Drejer (2009)	Coordination	Case study with two projects	Denmark, turbine industry	Management of rival suppliers in NPD activities	-	Supplier rivalry increases the "formal division of work and formalises the coordination patterns selected by manufacturers" and "the focus and Programming of communication and decreases interaction intensity".	2	Technovation
Ro et al. (2008)	Coordination	Longitudinal study with 28 companies	U.S., Japan, automotive industry	Comparison between Japanese and U.S. management styles of supplier integration during the design process	-	The authors present an extensive comparison of predominant supplier management models of US and Japanese automobile manufacturers, including differences and similarities in various dimensions (e.g., supplier selection basis, supplier role in product development, timing of involvement, organisational design approach).	2	IEEE Transactions On Engineering Management
Hong et al. (2011)	Knowledge Exchange	Structural equation modelling, 285 NPD projects	U.S., Canada, Spain, manufacturing industry	Relationship between shared knowledge and strategic fit and its influence on performance outcomes of NPD	Value to customer, manufacturing costs, time to market	Significant relationship between shared knowledge and strategic fit. Strategic fit positively related to performance outcomes of NPD.	3	International Journal of Production Economics
Langner & Seidel (2009)	Knowledge Exchange	Case study with two collaborative concept cases	Europe, automotive industry	Effectiveness of competition among suppliers on knowledge transfer during supplier selection	-	Firms can use early information benefits of weak ties in order to gather knowledge.	2	Journal of Engineering and Technology Management

Study	Trending Topic	Method of Data Analysis & Sample	Context	Focus	Performance Measure	Key Results	Phase	Journal
Lawson & Potter (2012)	Knowledge Exchange	Confirmatory factor analysis, structural equation modelling, 153 R&D intensive manufacturing firms	United Kingdom, automotive, aerospace, pharmaceutical, electrical, chemical, and general manufacturing industries	Relationship between buyers' learning motivation and knowledge exchange	Interfirm knowledge transfer	Strong learning intent increase knowledge transfer. Increased supplier protectiveness can be overcome by buyer investment in absorptive capacity.	2	International Journal of Operations & Production Management
Al-Zu'bi & Tsinopoulos (2012)	Performance	Hierarchical regression analysis, 313 firms	United Kingdom, manufacturing industries	Effect of collaboration with suppliers and lead users on product variety of NPD projects	Product variety	A higher extent of collaboration with both lead users and with suppliers increases both dimensions of product variety (fundamental and peripheral). Lead user collaboration has a higher impact on product variety than supplier collaboration.	2	Journal of Product Innovation Management
Ellis et al. (2012)	Performance	Structural equation modelling, 233 respondents	U.S., automotive industry	Interrelationships among the buying firm's behaviours – i.e., provision of inducements, the supplier's perception of the buying firm's preferred status, and supplier reciprocation	-	Early supplier involvement and relational reliability positively affect preferred customer status. Preferred customer status is positively associated with supplier's willingness to share new technologies with the buyer. Preferred customer status fully mediates the benefits exchanged within a buyer supplier relationship.	3	Industrial Marketing Management
Lau et al. (2010)	Performance	Structural equation modelling, 251 firms	Hong Kong, manufacturing industry	Impact of supplier and customer integration processes (i.e., information sharing and co-development) on product innovation and product performance)	Product innovation, product performance	Sharing information with suppliers and product co-development with customers directly improves product performance. Product co-development with suppliers improves performance, mediated by innovation.	3	Journal of Product Innovation Management
Perols et al. (2013)	Performance	Structural equation modelling, partial least squares analysis, 116 firms	Worldwide, industrials, health care, information technology industries	Effect of supplier process and product integration on time-to-market	Time-to-market	Supplier product integration decelerates time-to-market while supplier process integration accelerates time-to-market. Supplier process and product integration are positively related to the adoption of external technologies, which in turn positively affects time-to market to an extent that depends on the level of external exploration activities.	3	Journal of Operations Management
Un et al. (2010)	Performance	Pooled logit model, 781 firms	Netherlands, manufacturing industry	Relative impact on product innovation of R&D collaborations with different parties (universities, suppliers, customers, competitors)	Product innovation	Various types of collaborations have a differential influence on product innovation. R&D collaborations with suppliers have the highest positive impact on product innovation, followed by collaborations with universities.	2	Journal of Product Innovation Management

Study	Trending Topic	Method of Data Analysis & Sample	Context	Focus	Performance Measure	Key Results	Phase	Journal
Parker et al. (2008)	Timing	Structural equation modelling; 116 NPD projects	Multiple countries, multiple industries	Influence of timing of supplier integration on project performance	Project performance	Early timing positively related to extent of supplier integration. Supplier integration is positively related to project performance. Timing is influenced by environmental factors.	3	Journal of Supply Chain Management
Song & Thieme (2009)	Timing	In-depth interviews with 22 senior executives, confirmatory factor analysis, 205 incremental and 110 radical NPD projects	Multiple countries, multiple industries	Effectiveness of supplier involvement in market intelligence gathering activities on innovation success in pre-design and commercialisation activities	Market share, seller concentration, ease of entry, market growth, relative size, relative costs	Supplier involvement in market intelligence gathering activities positively related to success in incremental innovations across pre-design and commercialisation activities. Supplier involvement in market gathering activities positively related to success in radical innovations only in commercialisation activities. Negative impact on success in radical innovations in pre-design activities.	3	Journal of Product Innovation Management
Wagner (2012)	Timing	Partial least squares structural equation modelling, 67 ESI projects, 16 firms	U.S., automotive, machine tools, household appliances, electronics industries	Role of suppliers in fuzzy front end and influence of supplier integration on focal firm's NPD outcomes	NPD project performance	High level of integration of suppliers in FFE phase has positive impact on project performance. Effect decreases with high supplier integration during later phases.	3	Journal of Supply Chain Management
Brattström & Richtnér (2013)	Trust and Control	Case study of four interorganisational product development collaborations	Heavy machinery industry	Effects of internal function integration on achieving trust and control	-	When buyer separates R&D and procurement department trust and control can be combined.	2	Journal of Product Innovation Management
Colombo et al. (2011)	Trust and Control	Multiple case study with interviews in an open innovation context	U.S., innovation consultancy industry	Benefits of trust in buyer-supplier relationships	Collaboration process, collaboration process organisation	Trust is important aspect in early buyer-supplier relationships. Trust facilitates knowledge exchange between buyer and supplier.	2	International Journal of Innovation Management
Jean et al. (2014)	Trust and Control	Partial least squares structural equation modelling, 170 suppliers	China, automotive industry	Impact of trust on product innovations in an emerging market under certain environmental conditions	Supplier innovation, performance	Trust positively related to product innovation in buyer-supplier relationships. Product innovation in buyer-supplier relationships is positively related to relationship performance. This effect is moderated by the environment.	2	Journal of Product Innovation Management
Smets et al. (2013)	Trust and Control	Systems dynamic model, scenario development, 1 supplier	Western Europe, Shipbuilding industry	Benefits of formal versus informal control	-	Formal control more efficient and effective than informal control. Formal control facilitates relationship between buyer and supplier in NPD.	2	Journal of Product Innovation Management

on performance outcomes of NPD.[86] The significant relationship between shared knowledge and strategic fit depicted that by sharing knowledge project teams can better cope with emerging problems while complying with organisational goals.[87]In addition to that strategic fit has also a positive relationship with manufacturing costs, time-to-market, and value to customer, which were considered as the three performance measures.[88]

Performance benefits

From 2008 until 2013 few empirical research have analysed the area of performance benefits in order to see what kind of advantages the buyer has for integrating the supplier early in the NPD. Al-Zu'bi and Tsinopoulus's findings demonstrated that if a company collaborates with its supplier closely during the NPD process then this would lead to an increase in product variety, which is offered to customers[89]. Un, Cuervo-Cazurra and Asakawa focused on the relative impact on product innovation R&D collaborations with various different external parties such as suppliers, customers, universities as well as competitors, since different types of collaboration would have a different impact on product innovation. Their findings revealed that product innovation R&D collaboration with suppliers would have the highest positive impact and university would be the second highest.[90] Lau, Tang and Yam's results showed that if a company shares information with suppliers and do a product co-development with its customer, it would directly improve the product performance.[91] However, product co-development with suppliers will only improve the product performance if it is mediated by innovation.[92] Perols's, Zimmermann's and Kortman's empirical findings demonstrated that "external technology adoption acts as a positive mediator for the relationships between both types of supplier integration and time-to-market".[93] Nevertheless, their findings also indicated that supplier process integration expedited time-to-market whereas supplier product integration slowed down the time-to-market.[94] Ellis, Henke Jr and Kull, investigated in their research the buying behaviours (relational reliability and ESI) since these buying behaviours can have an influence on the buyer's chance to access suppliers' innovative technologies as well as allocated resources. Therefore, their findings indicated that both buying behaviours are correlated with the fact if the supplier sees the buyer as attractive in order to give them the preferred customer status.[95] Accroding to Steinle and Schiele, a company „has preferred customer status with a supplier, if the supplier offers the buyer preferential resource allocation".[96] Furthermore, preferred customer status is seen as a full mediator concerning benefits that are related with technology exchange in a buyer-supplier relationship because if a buyer has the preferred customer status then the supplier is more willing to share new technology with the buyer.[97]

Trust and control

According to Brattström and Richter, trust can be seen as the main key performance driver for successful NPD collaborations.[98] Nevertheless, there is always the risk of dishonesty and this of course complicates the dominance of trust in a buyer-supplier integration process.[99] Therefore, control can be seen as the opposition of trust. There are controversial views concerning control because many researchers have stated that control can mitigate the impact on appropriation concerns but there are also researchers, which showed that control can lead to impede knowledge exchange.[100] As a result, Brattström and Richter stated that the best way of combining these two concepts is when the buying company separates the procurement and the R&D department[101], since the R&D department creates trust between both parties but control can only be gained by the procurement department.[102] Moreover, Colombo, Dell'era and Frattini's finding indicated that trust is considered being beneficial for the buyer-supplier relationship but buyers still want to have a certain amount of control. Furthermore, trust is seen as the central/main factor in the alignment and learning phase.[103] This phase includes alignment, which is the comprehension of a client's culture and learning, which is the investigation as well as comprehension of a client's market.[104] Smets, van Oorshot and Langerak debate that investing in a constant formal control is effective as well as efficient, as it helps to endorse the buyer-supplier relationship in NPD processes.[105] Moreover, formal control is less expensive than dealing with poor quality and delays.[106] Additionally, their results deny the idea of enhancing the informal control in situations of higher trust in order to build/form the best buyer-supplier relationship.[107]

Jean, Sinkovics and Hiebaum's findings demonstrated that trust is positively related to product innovation in a buyer-supplier relationship. In addition to that, this is positively related to relationship performance and is moderated by the environment.[108]

Timing

In 2005 Petersen et al. have emphasised that the timing of supplier involvement has a moderating effect on improved design as well as financial performance.[109] However, in 2008 Parker, Zsidisin and Ragatz stated "contingency models exploring the appropriate timing and level of integration with suppliers in NPD have yet to be empirically tested."[110] Furthermore, the latest research on this trending topic was mainly on the influence of timing on project performance.[111] Timing has a positive impact on the supplier involvement and as a result, supplier involvement has a positive impact on project performance. Furthermore, timing is measured by how early the supplier is involved in the NPD process.[112] Wagner's research analyses the role of suppliers in the fuzzy front end (FFE) phase and what kind of impact the supplier involvement has on the focal company's NPD outcomes.[113] Wagner described the FFE phase as a "non-routine and ill-defined processes, ad hoc decisions, and high levels of dynamism, uncertainty and equivocality."[114] His empirical findings illustrated that the higher the integration of supplier in the FFE phase, the better the impact on project performance.[115] Notably, the project performance decreases when the supplier is also intensely involved in the NPD stage.[116] Moreover, Song and

[86] See (P. Hong et al., 2011, p. 187)
[87] See (P. Hong et al., 2011, p. 193)
[88] See (P. Hong et al., 2011, p. 192)
[89] See(Al-Zu'bi & Tsinopoulos, 2012, p. 677)
[90] See (Un, Cuervo-Cazurra, & Asakawa, 2010, p. 683)
[91] See (Lau, Tang, & Yam, 2010, p. 772)
[92] See(Lau et al., 2010, pp. 771-772)
[93] (Perols, Zimmermann, & Kortmann, 2013, p. 163)
[94] See (Perols et al., 2013, p. 160)
[95] See (Ellis, Henke Jr, & Kull, 2012, p. 1265)
[96] (Steinle & Schiele, 2008, p. 11)
[97] See (Ellis et al., 2012, p. 1266)
[98] See (Brattström & Richtnér, 2014, p. 1)
[99] See (Brattström & Richtnér, 2014, p. 1)
[100] See (Brattström & Richtnér, 2014, p. 1)
[101] See (Brattström & Richtnér, 2014, p. 10)
[102] See (Brattström & Richtnér, 2014, p. 11)
[103] See (Colombo, Dell'era, & Frattini, 2011, p. 177)
[104] See (Colombo et al., 2011, p. 176)
[105] See (Smets, van Oorschot, & Langerak, 2013, p. 1145)
[106] See (Smets et al., 2013, p. 1156)
[107] See (Smets et al., 2013, p. 1156)
[108] See (Jean, Sinkovics, & Hiebaum, 2014, p. 110)
[109] See (Petersen et al., 2005, p. 385)
[110] (Parker, Zsidisin, & Ragatz, 2008, p. 71)
[111] See (Parker et al., 2008, p. 74) p-74
[112] See (Parker et al., 2008, p. 79)
[113] See (Wagner, 2012, p. 40)
[114] (Wagner, 2012, p. 37)
[115] See (Wagner, 2012, p. 43)
[116] See (Wagner, 2012, p. 45)

Thieme's findings demonstrated that there is a positive relationship between supplier integration in market intelligence and the success of incremental innovations.[117] This positive relationship is due to early stage pre-design activities.[118] Notwithstanding, their findings also demonstrated that there is a negative relationship between supplier integration in the market intelligence activities and success of radical innovation since there is a negative influence on the perceived product performance in the pre-design task.[119] Consequently, supplier integration in market gathering activities is advantageous for commercial tasks for radical innovations.[120]

4.3 Trending topics with supplier focus

Until 2008 there was not much empirical research focusing on the supplier side of NPD collaboration. However, this has changed due to the fact that many scholars such as Johnsen indicated that the supplier side is crucial for the success of ESI in NPD. The two trending topics of the supplier focus are supplier selection and supplier's benefit. All relevant information is illustrated in Table 3.

Benefits for supplier

There are only few research concerning the topic why a supplier would have an interest in contributing to the NPD process although there are many research concerning the benefits, which ESI in NPD brings for the buyer.

Therefore, this section will give insight to the trending topic of supplier benefit. Tranekjer and Knudsen analyse in their research the characteristics of suppliers (providers) in order to see the benefits that these providers can gain by supporting other company's innovation activities. This was done by conducting a quantitative survey in Danish SMEs.[121] Their findings indicated that suppliers (providers) are more product-innovative than non-providers[122] and thus, providers are more likely to experience substantial benefits from open innovation relationships (reciprocal outbound activities) if the integration is higher, since the supplier is engaging in more projects and therefore, has more mutual exchange relationship.[123] The research of Smals and Smits's findings determine one direct value source, which is the financial payment for sales volume and product development services and two indirect sources of values, which are the reputation of doing business with leading-edge companies and technological knowledge and product design. And these three value sources are offered by manufacturers to suppliers in innovation-orientated relationship.[124] Furthermore, the willingness of the supplier to join this innovation-oriented relationship is influenced by these value sources.[125]

Supplier selection

Wagner's research focused on the impact of supplier's downstream customer orientation as well as supplier–customer homophily on the buyer innovation performance.[126] Supplier-customer homophily is defined as "the similarity of the supplier and customer".[127] His empirical findings demonstrated "that downstream customer orientation and supplier–customer homophily have a significant impact on the customer firms' new product efficiency (i.e., project cost and project speed) and new product effectiveness (i.e., innovativeness), which in turn positively influence new product performance in terms of profitability, market share, and growth".[128] Tranekjer and Søndergaard's findings demonstrated that the strength of the buyer-supplier relationship has a positive influence on the market performance if the company is collaborating with suppliers that have a similar knowledge base.[129] Moreover, a company can increase the cost performance of NPD projects by integrating a mix of diverse types of knowledge sources such as market and science sources.[130] The research of Fitjar and Rodriguez-Pose demonstrated that both types of company involvement with university, research centres and consultants ('Science, Technology and Innovation' (STI) mode of innovation) and the involvement with customers and suppliers in 'Doing, Using and Interacting' (DUI) mode of innovation have an impact on the innovativeness of the company. Moreover, DUI has a positive impact on product and process innovation.[131] Accordingly, Calvi and Cheriti emphasised the "main challenge for a project team is to define the extent to which a client organisation shares responsibility with a supplier for the design and development of a supplied item"[132] and how the specific choice of supplier involvement configuration is related to supplier characteristics. In order to support the project teams in their selection decision, Le Dain et al. implemented a four-step approach[133], which is related to the concept of the supplier innovation matrix.[134] A company selects a degree of design collaboration, which corresponds the best to the development risk and to the degree of the supplier's autonomy.[135] Furthermore, Wynstra, Von Corswant and Wetzels's findings showed that "supplier product development activity is directly affected by the supplier's position in the supply chain and by an explicit strategic focus on innovation. These findings provide support for the conventional notion that first-tier suppliers are more active in product development for their customers compared with suppliers on lower tier levels".[136]

5. Quantitative analysis and implications for future research: Reviewing the relevance of identified trends

5.1 Methodology for quantitative analysis of trending topics

Conducting a quantitative analysis of the identified trending topics helped to estimate the significance of each trending topic and to acquire implications and conclusions for future research. The amount of academic citations of the 39 relevant articles were checked by using Scopus. The reason for checking the citations is that it indicates the article's credibility and furthermore, it also demonstrates which trending topic was the most relevant in previous research and therefore, citations were used for the assessment. Moreover, citations can be used to identify newly emerging areas of interest in supply management research but also determine the current notability of each trending topic due to the fact that the literature is focusing on recent academic literature.

The citations were calculated via the sum of citations of a trending topic in relation to the sum of papers of the trending topic in order to avoid any types of misinterpretations. In order to increase the interpretation abilities of the average citation per article the median year of all trending topics papers was evaluated. The median is calculated by listing all years numerically (starting from the lowest) and selecting the middle value of this list.

[117] See(Song & Thieme, 2009, p. 52)
[118] See (Song & Thieme, 2009, p. 52)
[119] See (Song & Thieme, 2009, p. 52)
[120] See (Song & Thieme, 2009, p. 53)
[121] See (Tina Lundø Tranekjer & Knudsen, 2012, p. 986)
[122] See (Tina Lundø Tranekjer & Knudsen, 2012, p. 992)
[123] See (Tina Lundø Tranekjer & Knudsen, 2012, p. 997)
[124] See (Smals & Smits, 2012, p. 156)
[125] See(Smals & Smits, 2012, p. 162)
[126] See (Wagner, 2010, p. 1139)
[127] (Wagner, 2010, p. 1139)
[128] (Wagner, 2010, p. 1139)
[129] See (T. L. Tranekjer & Søndergaard, 2013, p. 224)
[130] See (T. L. Tranekjer & Søndergaard, 2013, p. 224)
[131] See (Fitjar & Rodríguez-Pose, 2013, p. 137)
[132] (Le Dain, Calvi, & Cheriti, 2010, p. 78)
[133] See (Le Dain et al., 2010, p. 82)
[134] See (Le Dain et al., 2010, p. 79)
[135] See (Le Dain et al., 2010, p. 84)
[136] (Wynstra, Von Corswant, & Wetzels, 2010, pp. 635-636)

Table 3: *Recent studies focusing on the supplier-side*

Study	Trending Topic	Method of Data Analysis & Sample	Context	Focus	Performance Measure	Key Results	Phase	Journal
Smals & Smits (2012)	Benefits for Supplier	Longitudinal study with 2 companies	High-tech OEMs	Sources of value that ESI in NPD offers to suppliers, the change of these values changes over time	-	There is one direct (financial payment for sales volume and product development services) and 2 indirect (technological knowledge and product concepts directly related to product designs, and the reputation of doing business with leading-edge firms) sources of values that manufacturers offer to their suppliers in innovation-oriented relationships. These values ultimately influence the willingness of providers to invest in joint innovation.	2	Industrial Marketing Management
Tranekjer & Knudsen (2012)	Benefits for Supplier	Regression analysis, 355 firms	Denmark, multiple industries	Characteristics of providers (suppliers), potential benefits that can be achieved from supporting other firms' innovation activities	-	Provider firms are more product innovative than non-providers. Providers are more likely to experience substantial benefits from "reciprocal outbound activities" in open innovation relationships. if the involvement in the relationship is higher.	3	Jorunal of Product Innovation Management
Fitjar & Rodriguez-Pose (2013)	Supplier Selection	Logit regression, 1604 firms	Norway, multiple industries	Impact of learning styles "Science, Technology and Innovation" (STI) and "Doing, Using and Interacting" (DUI) on innovation.	Innovativeness	STI and DUI have an impact on the innovativeness of a firm, while supplier cooperations (DUI) especially influence product and process innovations.	4	Research Policy
Le Dain et al. (2010)	Supplier Selection	Action research within a single firm	Schneider Electric, electricity industry	Make-or-buy decisions in the context of design supplier involvement ("design-or-buy" decisions)	-	The research presented in this paper results in an approach to support project teams in their design-or-buy-design decision making in NPD projects.	2	Journal of Purchasing and Supply Management
Tranekjer & Søndergaard (2013)	Supplier Selection	Ordinary least square regressions, 342 firms	Denmark, low, medium, high technology industries	The impact of the mix of external partner types as well as the relationship strength on NPD performance at the project level	Market performance, cost, speed, novelty	The negative effect of involving one source type may be circumvented by mixing with other sources. Sources should be chosen (also) based on the degree of knowledge overlap and embeddedness.	3	International Journal of Technology Management
Wagner (2010)	Supplier Selection	Structural equation modelling, 45 suppliers	Switzerland, multiple industries	Effects of suppliers' downstream customer orientation and supplier–customer homophily (i.e., similarity of the supplier and the customer) on the customers' innovation performance	Innovativeness (effectiveness) NPD costs and speed (efficiency), Product profitability, Market share growth (performance)	Downstream customer orientation and supplier–customer homophily have a significant impact on the customer firms' new product efficiency and new product effectiveness, which in turn positively influence new product performance. Downstream customer orientation and supplier–customer homophily are important traits to be considered when suppliers are selected for inclusion in the customers' new product projects.	2 or 4	Industrial Marketing Management
Wynstra et al. (2010)	Supplier Selection	Ordinary least square regression, 161 firms	Sweden, automotive industry	Antecedents of supplier product development activity (supplier downstream position, supplier innovation strategy, customer development commitment)	-	Supplier product development activity is significantly affected by the position of the supplier in the supply chain and the supplier's strategic focus on innovation.	3	Journal of Product Innovation Management

5.2 Results of quantitative analysis

This section is about identifying the exact match of every cited paper as well as the sum of the total citations for each trending topic but also the sum for each category.

After reviewing all the relevant articles on ESI in NPD, the analysis showed that the main focus of empirical research was on the dyadic tie between the buyers and suppliers. More specifically, 20 empirical articles analysed the relationship between the buyer and supplier and the other 19 empirical articles analysed either the supplier or the buyer. In other words, more than half of the relevant articles were focusing on the buyer-supplier relationship. Compared to the other two foci (buyer focus and supplier focus), the buyer-supplier relationship identified six trending topics, whereas the buyer focus and supplier focus only have two trending topics and thus, the buyer-supplier relationship focus has the most sub-categories. The reason for the importance of the buyer-supplier relationship research is that ESI per se involves two actors (buyer and supplier). The most cited trending topic with the average citing is timing, which was cited 23.67 times per paper on average. Furthermore, timing is also one of the two trending topics with articles published in 2009 at median. Appendix 3 demonstrates the number of papers as well as the number of trending topics for each focus.

The most cited trending topic for the supplier focus is supplier selection with 5.8 citations per article on average. In the same context, the most cited trending topic regarding the buyer focus is integration capabilities with 13.2 citations per article. It is interesting to see that most of the integration capabilities articles were published in 2013 and already have more citations than most other sub-categories since this trending topic is recently new. However, the empirical article by Mishra and Shah, which was published in 2009 falls into the trending topic integration capabilities and it possesses the most citations of all reviewed articles at hand with 46 citations, followed by Lau et al. with 36 citations. Moreover, there are studies, which were not cited. This can be probably drawn back to the fact that theses studies are more recent than the study of Mishra and Shah, which was already published in 2009. Notably, there is a possibility of other trending topics, which were not mentioned here since the time horizon is only from 2008 to 2013.

To sum up, each trending topic was cited on an average 8.54 times and most of the reviewed empirical research was published in 2012. Appendix 4 shows all the quantification of trending topics with the average citations per paper.

6. Discussion and conclusions: where are we and where are we going?

The goal of this paper was to do an update of the empirical findings concerning ESI in NPD. After doing an extensive as well as iterative literature search the presented literature review identified three distinct research foci (buyer focus, buyer-supplier relationship, and supplier focus), trend topics as well as the benefits of ESI associated to NPD performance, which can be seen in Figure 1. The main two trending topics for the buyer side of supplier integration that were emphasised by many researchers are integration capabilities[137] and modular design capabilities[138]. As for trending topics with a focus on the buyer-supplier relationship, recent research emphasises the importance of performance,[139] coordination,[140] communication[141] and knowledge exchange[142] in order to assess how NPD collaborations between buyers and suppliers can be organised and managed effectively and efficiency. Moreover, the supplier-focused research identified a number of crucial supplier characteristics, which have an impact on the selection of collaboration partners and the knowledge sources but also the extent of supplier integration.[143]

Additionally, the review of the last 5 years of research into ESI in NPD showed that the main trending topics are in the buyer-supplier relationship focus with having 6 trending topics.

This paper makes two main contributions to the field of ESI in NPD. First, as mentioned earlier one of this paper's goal was to see if the results concerning performance benefits and success factors of ESI changed or remained the same during a timeframe of five years, since there was a contradicting view regarding the relationship between ESI and success until 2008, which was indicated in Johnsen's literature review. After analysing all these 39 empirical articles it became clear that all these recent empirical articles showed positive findings concerning ESI and success by confirming the hypothesis that ESI in NPD brings benefits as well as success to a company. In other words, more articles showed that there is a positive relationship between ESI and success, which is a new consideration since this was not the case until 2008. Until 2008 there were a few scholars that showed that ESI has a negative or no impact on success and thus, it was not clear to state if ESI in NPD brings benefits or not. Involving the supplier early in the NPD process brings many benefits, which was demonstrated by these empirical articles. Involving the supplier early in the NPD process leads to product innovation[144], a better market performance[145], a better product performance[146], a better project performance[147], NPD costs savings[148], NPD time savings[149], more product variety[150] and profitability[151]. Nevertheless, many authors also emphasised that it is important to select the right supplier, as this has an affect on the NPD process and the benefits resulting in this relationship[152]. In other words, the buying company should be sure of the suppliers' capability before implementing a coordination strategy with suppliers[153]. By knowing the capabilities of the suppliers the buyer is willing to increase his trust and thus, gives the supplier more responsibility[154], which motivates the supplier to share their knowledge and expertise with the buying company[155]. Overall, the findings of this paper showed that as opposed to the older papers, all recent papers show benefits from ESI. This could be interpreted in a way that the field has matured and companies have learned to integrate suppliers.

The second contribution is that this paper analysed the research domain of ESI in NPD over time by using the implemented framework. After identifying the phase of all the 39 empirical research, the result was that the main part of these research (17 articles) are in the consolidation phase. No empirical article is in the emerging phase and decline phase, 16 articles are in the development phase and 5 articles are in the established phase. In addition, the article of Wagner in 2010 is between two

[137] See (Johnson & Filippini, 2013, p. 120; Mishra & Shah, 2009, p. 324)
[138] See (P. Danese & Filippini, 2013, p. 267; Vickery et al., 2013, p. 757)
[139] See (Lau et al., 2010, p. 772; Perols et al., 2013, p. 163)
[140] See (Y. Hong et al., 2009, p. 1000)
[141] See (Thomas, 2013, p. 891; Yan & Dooley, 2013, p. 525)
[142] See (P. Hong et al., 2011, p. 187; Lawson & Potter, 2012, p. 1228)
[143] See (Wagner, 2012, p. 43; Wynstra et al., 2010, p. 636)
[144] See (P. Danese & Filippini, 2013, p. 260; Fitjar & Rodríguez-Pose, 2013, p. 137; Jean et al., 2014, p. 110; Lau et al., 2010, p. 772; Song & Thieme, 2009, p. 52; Tina Lundø Tranekjer & Knudsen, 2012, pp. 225-226; T. L. Tranekjer & Søndergaard, 2013, pp. 996-997; Un et al., 2010, p. 673; Vickery et al., 2013, p. 759; Wagner, 2010, p. 1146)
[145] See (Mishra & Shah, 2009, p. 325; Thomas, 2013, p. 890)
[146] See (P. Danese & Filippini, 2013, p. 260; P. Hong et al., 2011, p. 186; Lau et al., 2010, p. 772; Salvador & Villena, 2013, p. 102; Wagner, 2010, p. 1146; Wynstra et al., 2010, pp. 635-636)
[147] See (Cabigiosu et al., 2013; Mishra & Shah, 2009, p. 325; Parker et al., 2008, p. 80; Potter & Lawson, 2013, pp. 803-804; T. L. Tranekjer & Søndergaard, 2013, pp. 225-226; Wagner, 2012, p. 45; Yan & Dooley, 2013, p. 538)
[148] See (Ray & Kanta Ray, 2011, p. 216; Salvador & Villena, 2013, p. 102; Schiele, 2010, p. 149; Wagner, 2010, p. 1146)
[149] See (Pamela Danese & Filippini, 2010, p. 1204; P. Danese & Filippini, 2013, p. 260; Johnson & Filippini, 2013, p. 107; Parker et al., 2008, p. 80; Perols et al., 2013, p. 163; Wagner, 2010, p. 1146)
[150] See (Al-Zu'bi & Tsinopoulos, 2012, p. 677)
[151] See (Vickery et al., 2013, p. 759)
[152] See(Y. Hong et al., 2009, p. 1017)
[153] See (Y. Hong et al., 2009, p. 1017)
[154] See (Ro et al., 2008, p. 375)
[155] See (Andersen & Drejer, 2009, p. 701; Brattström & Richtnér, 2014, p. 1; Ellis et al., 2012, p. 1266; Smets et al., 2013, p. 1156)

phases -development phase and established phase. Moreover, it can be stated that this field of research has matured compared to 5 yeas ago since it moved from the development phase to the consolidation phase. Appendix 5 gives further and a more detailed information regarding the relationship of ESI in NPD and success and the research domain development.

Additionally, this paper also looks if these 39 empirical articles have taken into account Johnsen's recommendation (technology uncertainty, cultural context, concept of network and supplier's benefit) concerning future research about ESI in NPD. After reviewing all these empirical articles, it demonstrated that all these 39 articles mentioned or even took into account one or even more recommendations of Johnsen except of five articles, which did not use any recommendations of Johnsen. Furthermore, Ro et al. mentioned all four recommendations of Johnsen. The concept of network of studies was considered by 17 empirical researches, which almost counts for 50 per cent. Moreover, technology uncertainty, cultural context as well as the suppliers' benefit was incorporated by three empirical articles. In other words, this paper verifies that there are still existing research gaps based on Johnsen's recommendation. Additionally, this paper also looked at the suppliers' perspective concerning the ESI in NPD, which was not done by Johnsen since no empirical article investigated the supplier side until 2008. Appendix 6 summarized all the authors, who mentioned or took into account these recommendations and who did not.

Future research implications

In accordance to the findings of this literature review, Johnsen suggested to locate the main focus of ESI research on the buyer-supplier relationship[156] due to the fact that ESI involves multiple parties and thus, future research can expect to continue to be devoted to empirical analyses regarding this relationship. Furthermore, Johnsen also suggested other researchers to close the research gap concerning the supplier's side.[157] However, much empirical research still pays more attention to the buyer side or the buyer-supplier relationship, which indicated almost more than 80 per cent of reviewed studies, but still the literature search detected seven articles that are focusing on the supplier.

Johnsen highlighted that technology uncertainty is a mediator for ESI as well as its performance outcomes.[158] Despite the fact that technology uncertainty as well as the degree of innovation is crucial for ESI in NPD, only few authors examined this in the recent literature[159] and moreover were not even identified as trending topics. However, the degree of innovation as well as technology uncertainty is a field, which can be researched in the future in order to understand ESI better. Furthermore, many scholars identified additional mediators as well as moderators [160] such as project team effectiveness[161] and with this in mind, further possible explanations for the diverging ESI results ascertained by Johnsen can be provided.[162]

Moreover, the analysis of these 39 recent empirical articles demonstrated that only three articles looked at the cultural context although Johnsen suggested that the cultural context is an impact factor on ESI outcomes.[163] The cultural context was always combined with the geographic context by these three recent articles. Therefore, the influence of specific cultural as well as institutional context but also other contingency factors will remain an interesting topic for future studies, as it explores implications for NPD projects with cross-national or cross-cultural buyer-supplier relationship. As Hofstede stated culture is always likely to have an impact on the company's performance since every country is operating differently[164]. Although the concept of network was referred to as a future research topic by Johnsen, none of these recent articles covered this topic/ concept explicitly. Most of these articles mentioned it and explained this concept but the focus was not explicitly on it. Therefore, it can be assumed that the concept of network has been integrated in the open innovation discourse. Schiele stated that the rise of the open innovation paradigm[165], which was originally characterised coined by Chesbrough,[166] will have major and signifying impact on future research of ESI. A relevant recommendation for future research would be to focus more on the communication. Because it is very recent and still lacks citations and thus, it is crucial to support companies in the endorsement of the buyer-supplier relationship. Nevertheless, these recent articles demonstrated that there are other connections/ relationships to NPD co-development partners next to suppliers such as customers[167], cross-functional teams [168] and universities [169]; a consideration not explicitly mentioned by Johnsen. [170] Since the timing of supplier involvement in NPD was considered as an important topic by having an average of 23,67 citations per paper, *timing* is the most cited topic among all trending topics. Therefore, this consideration suggests that there is a shift in focus concerning ESI in NPD. The question is not anymore whether or not supplier integration improves NPD performance but rather about the analysis of conditions such as timing, under which ESI is the most successful. The last recommendation for future studies would be to see how this research domain develops in the future as well as to analyse the relationship between ESI and success in order to be sure that these recent articles did not have a too optimistic view, which can lead to a reporting bias.

Limitations

Similar to other research this literature review is not free of limitations. Starting with the first one, due to the strict selection of journals, which was based on academic quality criteria, the present list of relevant articles used for researching ESI in NPD cannot be claimed as complete. Therefore, other relevant article that falls into the category of ESI in NPD was not consciously included in order to guarantee the quality of the reviewed articles. Another limitation would be the selection criteria impact factor and h-index for journals since they d not guarantee a qualitative selection of 39 articles. The quantitative analysis of the identification of trending topics was done by citations and thus, can be seen as a limitation as well. Nevertheless, it is not advisable using the interpretation of the aggregated citation amount for a specific trending topic as sole assessment tool since the number of citations does not depend merely on the topic itself but predominantly on the respective paper's quality and the journal's prominence. The last limitation would be that scope and the extent of this paper is limited to 5 years.

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[156] See (Johnsen, 2009, p. 193)
[157] See (Johnsen, 2009, p. 195)
[158] See (Johnsen, 2009, p. 196)
[159] See (Song & Thieme, 2009, p. 52; Yan & Dooley, 2013, p. 525)
[160] See (Johnson & Filippini, 2013, p. 102; Mishra & Shah, 2009, p. 324; Potter & Lawson, 2013, p. 803)
[161] See (Johnson & Filippini, 2013)
[162] See(Johnsen, 2009, pp. 195-196)
[163] See (Johnsen, 2009, p. 195)
[164] See (Hofstede, 1980, p. 43)
[165] See (Schiele, 2010, p. 138)
[166] See(Chesbrough, 2003, p. 43)
[167] See (Fitjar & Rodríguez-Pose, 2013, p. 137; Johnson & Filippini, 2013, p. 105)
[168] See (Johnson & Filippini, 2013, p. 105; Schiele, 2010, p. 148)
[169] See(Un et al., 2010, p. 683)
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Appendix

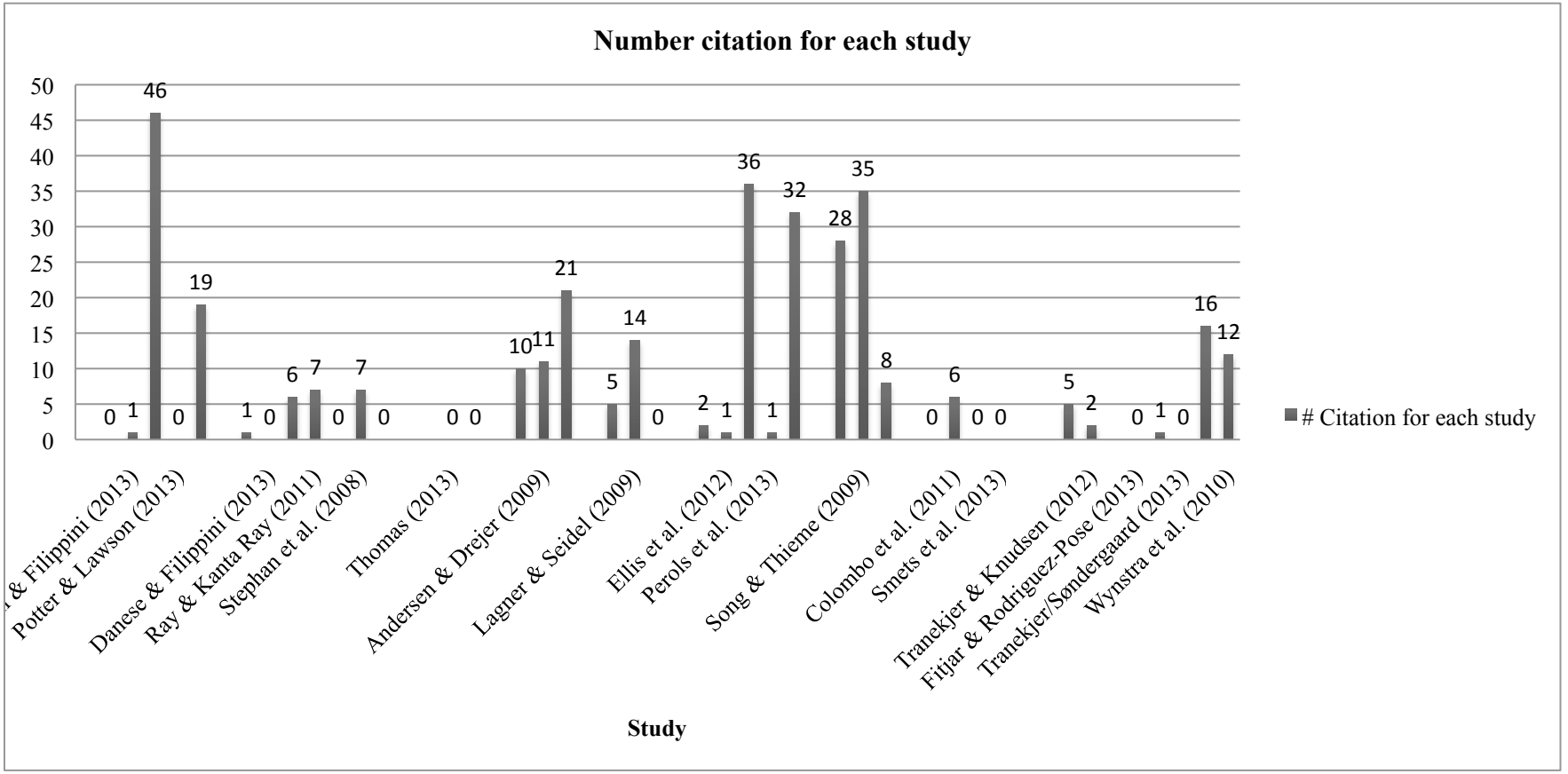
A1: *List of Selected Journals for Literature Review*

Journal	Impact Factor (JCR)	Jourqual2 Ranking	h-index
Academy of Management Review	7.90	14	146
Academy of Management Journal	5.91	13	160
Journal of Operations Management	4.40	85	96
Strategic Management Journal	3.37	31	146
Journal of Supply Chain Management	3.32	136	24
Technovation	3.12	462	51
Research Policy	2.85	32	110
Technological Forecasting and Social Change	2.11	n/a	46
Industrial Marketing Management	1.93	398	61
International Journal of Physical Distribution & Logistics Management	1.83	143	28
Supply Chain Management: An international Journal	1.68	n/a	50
R&D Management	1.58	231	48
Journal of Product Innovation Management	1.57	n/a	72
Research in Organizational Behavior	1.47	92	29
Journal of Purchasing & Supply Management	1.46	n/a	44
International Journal of Production and Operations	1.25	n/a	n/a
Technology Analysis & Strategic Management	1.10	441	n/a
Journal of Engineering & Technology Management	0.97	284	n/a
IEEE Transactions on Engineering Management	0.89	90	52

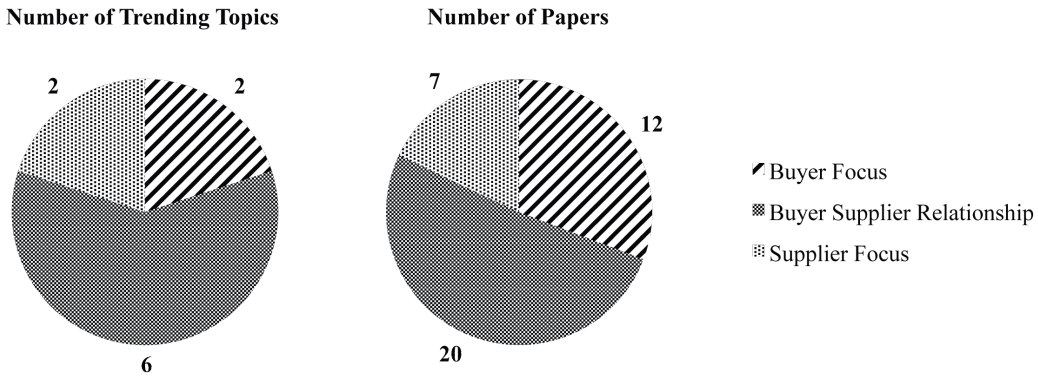
Research-Technology Management	0.71	n/a	37
International Journal of Technology Management	0.56	221	31
Supply Chain Management Review	n/a	542	n/a
International Journal of Procurement Management	n/a	n/a	n/a

A2: *Number of Citation according to each study*

The most cited study was the study of Mishra and Shah with 46 citations, followed by Lau et al. with 36 citations. Moreover, there are studies, which were not cited but this can be due to the fact that theses studies are more recent than the study of Mishra and Shah, which was published in 2009.



A3: Number of papers and number of trending topics of research focus categories



A4: Quantitative analysis of trending topics

This table shows the exact match of every cited paper as well as the sum of the total citations for each trending topic but also the sum for each category. In order to increase the interpretation abilities of the average citation per article the median year of all trending topics papers was evaluated. The median is calculated by listing all years numerically (starting from the lowest) and selecting the middle value of this list. The study of Mishra and Shah was cited the most with 46, followed by Lau et al. with 36 citations. The trending topic timing was cited the most with an average citation per paper of 23.67. Notably, there is a possibility of other trending topics, which were not mentioned here since the time horizon is only from 2008 to 2013.

	Trending Topic	Study	# Citation for each study	# Papers	# of total citations	Average Citations/Paper	Median of Year
Buyer Focus	Integration Capabilities			5	66	13,20	2013
		Garengo & Panizzolo (2013)	0				
		Johnson & Filippini (2013)	1				
		Mishra & Shah (2009)	46				
		Potter & Lawson (2013)	0				
		Schiele (2010)	19				
	Modular Design Capabilities			7	21	3,00	2013
		Cabigiosu et al. (2013)	1				
		Danese & Filippini (2013)	0				
		Danese & Filippini (2010)	6				
		Ray & Kanta Ray (2011)	7				
		Salvador & Villena (2013)	0				
		Stephan et al. (2008)	7				
		Vickery et al. (2013)	0				
Σ Buyer Focus				12	87	7,25	2013
Buyer Supplier Relationship	Communication			2	0	0,00	2013
		Thomas (2013)	0				
		Yan & Dooley (2013)	0				
	Coordination			4	42	10,50	2009
		Hong et al. (2009)	10				
		Andersen & Drejer (2009)	11				

		Ro et al. (2008)	21				
	Knowledge Exchange			3	19	6,33	2011
		Hong et al. (2011)	5				
		Lagner & Seidel (2009)	14				
		Lawson & Potter (2012)	0				
	Performance			5	72	14,40	2012
		Al Zu'bi & Tsinopoulos (2012)	2				
		Ellis et al. (2012)	1				
		Lau et al. (2010)	36				
		Perols et al. (2013)	1				
		Un et al. (2010)	32				
	Timing			3	71	23,67	2009
		Parker et al. (2008)	28				
		Song & Thieme (2009)	35				
		Wagner (2012)	8				
	Trust and Control			4	6	1,50	2013
		Brattström & Richtnér (2013)	0				
		Colombo et al. (2011)	6				
		Jean et al. (2014)	0				
		Smets et al. (2013)	0				
Σ Buyer Supplier Relationship				20	210	10,50	2012
Supplier Focus	Benefits for Supplier			2	7	3,50	2012
		Smals & Smits (2012)	5				
		Tranekjer & Knudsen (2012)	2				
	Supplier Characteristics			1	16	16,00	2010
		Fitjar & Rodriguez-Pose (2013)	0				
		Le Dain et al. (2010)	1				
		Tranekjer/Søndergaard (2013)	0				
		Wagner (2010)	16				
		Wynstra et al. (2010)	12				
Σ Supplier Focus				3	23	7,67	2012
Sum				**39**	**333**	**8,54**	**2012**

A5: Relationship between ESI in NPD and success & research domain development

Relationship between ESI in NPD and success

The first part is about the relationship between ESI in NPD and success. Until 2008 there was a more contradicting view regarding the relationship between ESI in NPD and success. In other words, it was difficult to see if there was a positive or negative relationship since these entire scholars had contradicting results. Therefore, it is even more crucial to see if this view changed or if there are more positive findings than negative ones and vice versa. After analysing these 39 empirical articles it could be demonstrated that this contradicting view changed, since all these 39 empirical articles showed in their studies that there is a positive relationship between ESI in NPD and success. According to Garengo and Panizzolo, ESI leads to success and to benefits, which many companies still do not recognise. Furthermore, innovative technological tools are essential for supporting the supplier integration, which will lead to better outcomes.[171] Johnson and Fillipini were able to show that if a company has integration capabilities then this will lead to product success and moreover to effective and efficient product development[172]. However, a company has to know how to use these

[171] See(Garengo & Panizzolo, 2012, p. 166)
[172] See (Johnson & Filippini, 2013, p. 107)

capabilities since this has an impact on the performance[173]. Similarly, Salvador and Villena indicated that a manufacturing company that has the capability of producing modular products, receives further benefits by involving the supplier in the NPD process, which is manufacturing cost reduction and a better technical performance[174]. Furthermore, Lau et al.'s findings also demonstrated that ESI in NPD would lead to a better product performance because the supplier is sharing his expertise and knowledge with the buying company[175]. In addition to that, the supplier's position in the supply chain is directly related to product performance.[176] Hong et al. emphasised that by having a team with a shared knowledge base a company can gain time, costs as well as value benefits[177]. According to Danese and Filippini product modularity is an abler of ESI in NPD, which in turn leads to improved product performance and a reduction of NPD time.[178] Wagner and Perols et al. showed that supplier involvement has a positive impact on project performance, NPD cost[179] and NPD time.[180] Furthermore, the findings of Ray and Kanta Ray showed "that collaboration with suppliers for component design and their early integration in the design phase substantially lowered costs and helped eliminate unnecessary frills whilst incorporating features valued by mass market".[181] Other positive benefits associated with ESI are project performance. Mishra and Shah indicated that the involvement of the supplier in the NPD process has a positive influence on the project performance due to the fact that ESI reduces the internal complexity of projects.[182] In addition, the buying company is improving its project performance by sharing knowledge and capabilities with the supplier[183]. However, the timing of when to involve the supplier is crucial for the project performance, since it is a significantly influencing factor on the success of NPD projects.[184] Wagner, who was mainly focusing on integrating the supplier in the FFE phase, demonstrated that a high level of ESI has a positive impact on the project performance.[185] The structural equation modelling of Thomas' studies "found a significant positive link between knowledge exchange and NPD performance, measured both in terms of effectiveness and efficiency, and a significant positive link between effective and efficient NPD and market performance".[186] Moreover, higher market performance can be gained because the supplier understands the buying company's need and thus, the supplier shares knowledge accordingly.[187] Jean et al.'s findings indicated that trust is positively associated with product innovation in the buyer-supplier relationship. This in turn is positively associated with relationship performance. In other words, the supplier is working more closely with the buyer if there is trust and thus, has a positive impact on the product innovation.[188] Moreover, the case study of Fitjar and Rodriguez-Pose showed that if the supplier is engaging in the NPD process then the buying company tends to be more innovative. Integrating the supplier promotes higher and greater level of process and product innovation.[189] Similar to Fitjar and Rodriguez-Pose studies, Un et al. indicated that close and tight collaboration with suppliers has a positive impact on the product innovation since both parties are working together and sharing information.[190] Comparatively, Song and Thieme's finding clarified that "supplier involvement in market intelligence gathering activities are positively related to success in incremental innovations across predesign and commercialization activities".[191] The hierarchical regression analysis of Al Zu'bi and Tsinopoulos' study revealed that there is a significant positive relationship between collaboration and product variety. To put it differently, if the supplier engages more intensively in the NPD process, it will lead to higher product variety[192]. The research of Vickery et al. demonstrated that PPS through product innovation affects profitability and by involving the supplier in the NPD then there will be a positive impact since supplier and customer integration are modelled as antecedents to PPS[193]. Another crucial factor that can have an impact on the NPD performance would be to integrate the purchasing department into the NPD process since the purchasing department has a dual role. The purchasing department would support the innovation process in collaboration with the supplier but also controlling the company-wide costs.[194] In this case the buying company can get more attractive and the chance of getting the preferred customer status is higher.

To sum up, ESI in NPD leads to product performance, product innovation, process performance, market performance, NPD cost, NPD time, profitability and product variety. The question that comes in mind would be why this view changed and if this could have to do with the fact that this research domain matured?

Research domain development

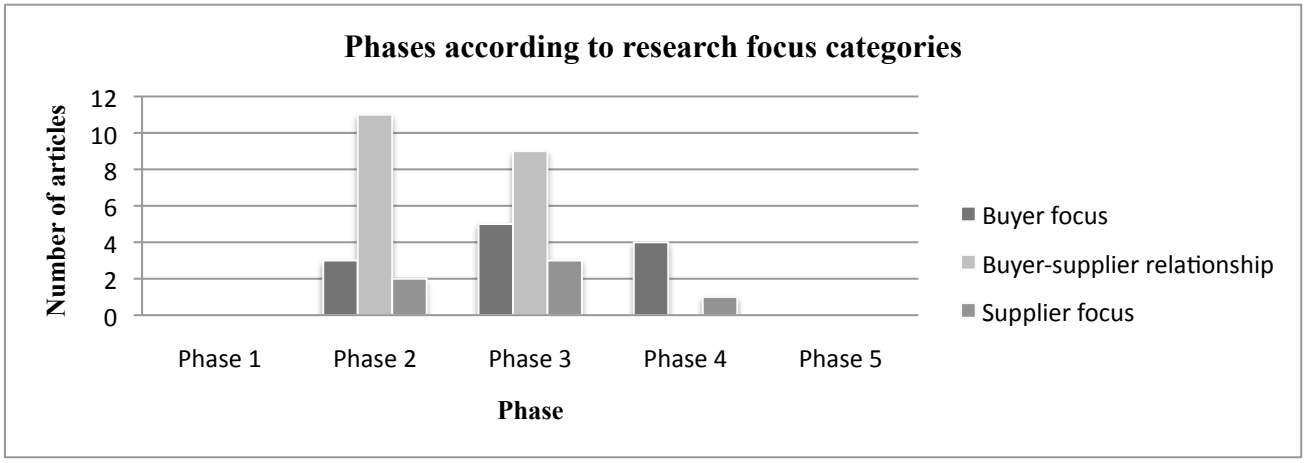
Analysing the research domain gives further insight in whether the ESI is still an emerging research domain or matured. Furthermore, as mentioned earlier, until 2008 there was a more contradicting view regarding the relationship between ESI in NPD and success, which could be the case because ESI research was not an emerging discipline, as there were not so many studies related to this topic. Therefore, it is crucial to investigate in this area. The analysis of all these articles showed that many articles are in phase 3 (consolidation phase); 17 articles to be precise. 16 articles are in phase 2 (development phase), followed by 5 articles in phase 4 (established phase). Moreover, only one article is between 2 phases (phase 2 and phase 4). The interesting part is that there are no articles in phase 1(emerging phase) and phase 5 (decline phase). Therefore, this indicates that ESI is neither a new topic, as otherwise articles would be in phase 1, nor is it a matured research domain since no articles are in phase 5. An article is in phase 4 if it applies a meta-analysis. However, until now no meta-analysis was done in ESI research. The reason for that could be that there are only few

[173] See (Johnson & Filippini, 2013, p. 95)
[174] See (Salvador & Villena, 2013, p. 102)
[175] See (Lau et al., 2010, p. 772)
[176] See (Wynstra et al., 2010, p. 636)
[177] See (P. Hong et al., 2011, p. 186)
[178] See (P. Danese & Filippini, 2013, p. 269)
[179] See (Wagner, 2010, p. 1146)
[180] See (Perols et al., 2013, p. 163; Wagner, 2010, p. 1146)
[181] (Ray & Kanta Ray, 2011, p. 216)
[182] See (Mishra & Shah, 2009, p. 35)
[183] See (Lawson & Potter, 2012, p. 1242)
[184] See (Parker et al., 2008, p. 80)
[185] See (Wagner, 2012, p. 45)
[186] (Thomas, 2013, p. 890)
[187] See (T. L. Tranekjer & Søndergaard, 2013, p. 226)
[188] See (Jean et al., 2014, p. 110)
[189] See (Fitjar & Rodríguez-Pose, 2013, p. 137)
[190] See (Un et al., 2010, p. 673)
[191] (Song & Thieme, 2009, p. 43)
[192] See (Al-Zu'bi & Tsinopoulos, 2012, p. 677)
[193] See (Vickery et al., 2013, p. 750)
[194] See(Schiele, 2010, p. 149)

literature reviews concerning ESI and one of them is the literature review of Johnsen. The table below lists these papers according to the phases.

Phase	Study	Number
Phase 1 (emerging phase)		0
Phase 2 (development phase)	Stephan et al. (2013); Al-Zu'bi & Tsinopoulos (2012); Un et al. (2010); Langner & Seidel (2009); Lawson & Potter (2012); Brattström & Richter (2013); Colombo et al.; Hong et al. (2009); Smals & Smits (2012); Jean et al. (2014); Cabigiosu et al. (2013); Ray & Kanta Ray (2011); Andersen & Drejer (2009); Ro et al. (2008); Smets et al. (2013); Le Dain et al. (2010)	16
Phase 3 (consolidation phase)	Hong et al. (2011); Lau et al. (2010); Perols et al. (2013); Thomas (2013); Parker et al. (2008); Tranekjer & Sondergaard (2013); Wynstra et al. (2010); Yan & Dooley (2013); Song & Thieme (2009); Salvador & Villena (2013); Ellis et al. (2012); Tranekjer & Knudsen (2012); Danese & Filipini (2010); Danese & Filippini (2013); Wagner (2012); Johnson & Filippini (2013)	17
Phase 4 (established phase)	Garengo & Panizzolo (2013); Mishra & Shah; Potter & Lawson (2013); Schiele (2010); Fitjar & Rodriguez-Pose (2013)	5
Phase 5 (decline phase)		0
Between phase 2 and 5	Wagner (2010)	1

Analysing the phases by looking at each category separately could show which category was more matured. Looking at figure below it is clear that the buyer-supplier relationship category is more in phase 2 and 3. The buyer focus category is between phase 3 and phase 4. However the supplier focus category, which is a rather new category, since there are not so many articles that take the supplier side into account, is more in phase 3. In this case, the buyer focus is more matured than in the other two categories since it is between phase 3 and 4. A reason for this could be that since the 1980's many empirical researches were looking at the buyer side and thus, this category is more mature than the two other categories.



The next step is to identify in which phase these empirical articles are according to Harland et al's framework. This research domain is an emerging discipline, which means that it is in phase 3. It is still not a discipline, since this domain did not develop any new theories but it shows evidence concerning coherency, quality and impact of the field. Moreover, it is reasonable that it is still an emerging discipline as the main part of these articles are in phase 3 according to this papers's framework and no articles are in phase 5, which in turn would be phase 4 of the Harland et al. framework. In this case, this research domain is an emerging discipline, as there is still room for future research.

A6: Johnsen's recommendations used by these 39 empirical studies

Recommendation	Study	Number
Network concept	Garengo & Panizzolo (2013); Mishra & Shah (2009); Stephan et al. (2013); Vickery et al. (2013); Al-Zu'bi & Tsinopoulos (2012); Lau et al. (2010); Perols et al. (2013); Un et al. (2010); Hong et al. (2011); Langner & Seidel (2009); Lawson & Potter (2012); Thomas (2013); Brattström & Richter (2013); Colombo et al. (2011); Parker et al. (2008); Tranekjer & Sondergaard	17

	(2013); Wynstra et al. (2010)	
Technology uncertainty	Hong et al. (2009); Yan & Dooley (2013); Song & Thieme (2009)	3
Cultural context	Johnson & Filippini (2013); Schiele (2010); Salvador & Villena (2013)	3
Supplier benefit	Ellis et al. (2012); Smals & Smits (2012); Tranekjer & Knudsen (2012)	3
Network concept & cultural context	Jean et al. (2014)	1
Network concept & technological uncertainty	Potter & Lawson (2013); Cabigiosu et al. (2013); Danese & Filipini (2010); Danese & Filippini (2013); Ray & Kanta Ray (2011); Andersen & Drejer (2009)	6
All recommendations	Ro et al. (2008)	1
No recommendation	Smets et al. (2013); Wagner (2010); Wagner (2012); Fitjar & Rodriguez-Pose (2013); Le Dain et al. (2010)	5