

On the effectiveness of supplier development programs: the role of supply-side moderators

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Abstract

Given the managerial/financial commitments needed for supplier development programs, buying firms need to be selective of the suppliers they engage for development. This paper examines the moderating role of five supply-side factors (i.e. supplier size, supply share, product complexity, buyer-supplier integration, and the supplier's management systems) in the relationship between supplier development and supplier performance, through a structural model, which is developed theoretically, and tested empirically using survey data of 142 firms.

The results indicate that when supplier development is in the form of buyer direct involvement, its impact on supplier performance is significantly moderated by supplier size, product complexity, buyer-supplier integration, and the supplier's management systems. Meanwhile, the impact of supplier development, in the form of assessment/certification, is moderated by buyer-supplier integration. The outcomes of this paper fill the gaps in the existing knowledge of supplier development, and show the sensitivity of supplier development programs to some newly introduced supply-side factors.

Keywords: Supplier development, Supplier performance, Supplier size, Product complexity, Supply Share, Supplier Integration, Management System.

1. Introduction and theoretical background

1.1 Supplier development

For innovation and competitive advantage to emerge, the supply chain capabilities are core and need continual development (Li et al. 2012; Linton 2017; Oh et al. 2016). Supplier development is known as a systematic approach to leverage capacity and capability improvements across the supply chain. Krause (1999, p. 205) defines supplier development as “any effort of a buying firm with a supplier to increase its performance and/or capabilities.” This definition is still a foundation for supplier development research and practice (Bai and Sarkis 2016). The literature

reemphasizes the cost of supplier poor performance which reaches to four percent of the manufacturing buying firm's sales (Howgate Sable 2017: a survey on 40 global senior executives), and expects supplier development programs to improve supplier capabilities (Chen et al. 2015; Blome et al. 2014), facilitate collaborative product design (Lawson 2015), enhance production quality and flexibility (Carr and Kaynak 2007; Chang et al. 2006), boost supplier operational and financial performance (Arroyo-López 2012; Krause et al. 2007; Narasimhan et al. 2008b), extend supply chain social responsibility (Zhang et al. 2017), increase supplier satisfaction (Ghijsen et al. 2010), contribute to the firm's improvement initiatives such as TQM and JIT (Gupta and Heragu 1991; McAdam 2004), and improve supply chain collaborations (Blonska et al. 2013; Humphreys et al. 2004; Wang and Hu 2017). Some empirical studies and executive reports also show how supplier development helps product and process innovation (e.g. a comparative study in the automotive sector by Hertenstein and Williamson 2018; and multiple innovation initiatives case studies in pulp and paper industry by Onufrey 2020), supply-base reduction (e.g. IKEA major supplier reduction from 2000 to 1000: Jiang et al. 2018), and how it increases the suppliers' sales (e.g. ASDA's supplier development program has resulted in £11 million extra sales for its suppliers: ASDA 2019).

Supplier development programs are usually capital intensive (Mizgier et al. 2017), in both private and public sectors (Obwegeser and Muller 2018). Recent studies report typically high rates for supplier development programs - e.g. US\$100K-2M in mining sector (World Bank 2015), and US\$132.7bn contribution of ExxonMobil to its supplier development programs (World Bank 2008). The success or failure of supplier development programs may be, however, influenced by various non-capital enablers and barriers such as supply chain configuration (Caniato et al. 2013), complexity of the development program (Busse et al. 2016), buyer commitment to and support for supplier development (Carr and Kaynak 2007; Talluri et al. 2010), top management involvement (Modi and Moberg 2007), buyer-supplier relationship

(Mortensen and Arlbjørn 2012; Wagner 2011), cost sharing (Zeng et al. 2018), information sharing (Routroy et al. 2016), trust (Li et al. 2012), socio-economic and cultural similarities (Busse et al. 2016), supplier resource competency and commitment (Krause 1999; Kumar and Routroy 2018; Savic et al. 2017), supplier status and current performance (De Toni and Nassimbeni 2000; Handfield et al. 2006; Krause et al. 1998; Routroy et al. 2016), supplier willingness/complacency (Kumar and Routroy 2018; Lascelles and Dale 1990), collaboration with other buyers (Friedl and Wagner 2016), purchasing power and price (Lascelles and Dale 1990), supply volume (Bai and Sarkis 2016), or even buyer attractiveness for supplier (Mortensen and Arlbjørn 2012) and the supplier's opportunistic behavior (Li et al. 2017).

1.2 The key role of moderators

Over and above the enablers and barriers, there are moderators, which specifically determine the magnitude of the development program's impact on supplier capabilities and performance. It should be noted that the term performance refers to an extensive range of business outcomes such as product quality, service delivery, innovation, sustainability and cost (Maestrini et al. 2018; Terpend and Ashenbaum 2012). Meanwhile, this research focuses on quality and delivery, as two key performance factors that are predominantly emphasized by supplier development programs – further justification for this choice is provided in Section 3.

Given the resource-intensiveness and strategic significance of the supplier development programs for the whole supply chain, it is crucial to identify the factors which can moderate their success, and understand the scale and scope of their impacts. This informs buyers and suppliers about the infrastructures, resources and relationships, required for supplier development programs. Wagner (2006a) and Salimian et al. (2017) consider the buying firm's size as a key moderator which indicates the buyer's ability to allocate resources for supplier development programs, and subsequently affects their effectiveness. Buyer control mechanisms

(Tse et al. 2018), motivation (Kim et al. 2015), and cost drivers (Lo et al. 2018) have been also found relevant moderators for supply chain programs. Beside the buyer-oriented moderators, the literature mainly underlines the moderating role of buyer-supplier relationship, and shows how the impact of supplier development is higher in well-established and closer buyer–supplier relationships (Arroyo-López et al. 2012; Blonska et al. 2013; Nagati and Rebolledo 2013; Salimian et al. 2017; Wagner 2011). In the same context, Wagner and Krause (2009) and Kurniawan et al. (2017) address human interaction, employee exchange, and risk taking culture in the buyer-supplier relationship as key moderators for supplier development programs. Some studies also show that better-performing suppliers can benefit more from buyer-led supplier development programs (De Toni and Nassimbeni 2000; Kim et al. 2015). Figure 1 summarizes the literature on supplier development program moderators, and organizes them into three groups: supply-side moderators; buyer-side moderators; and moderators related to both or embedded in the buyer-supplier links.

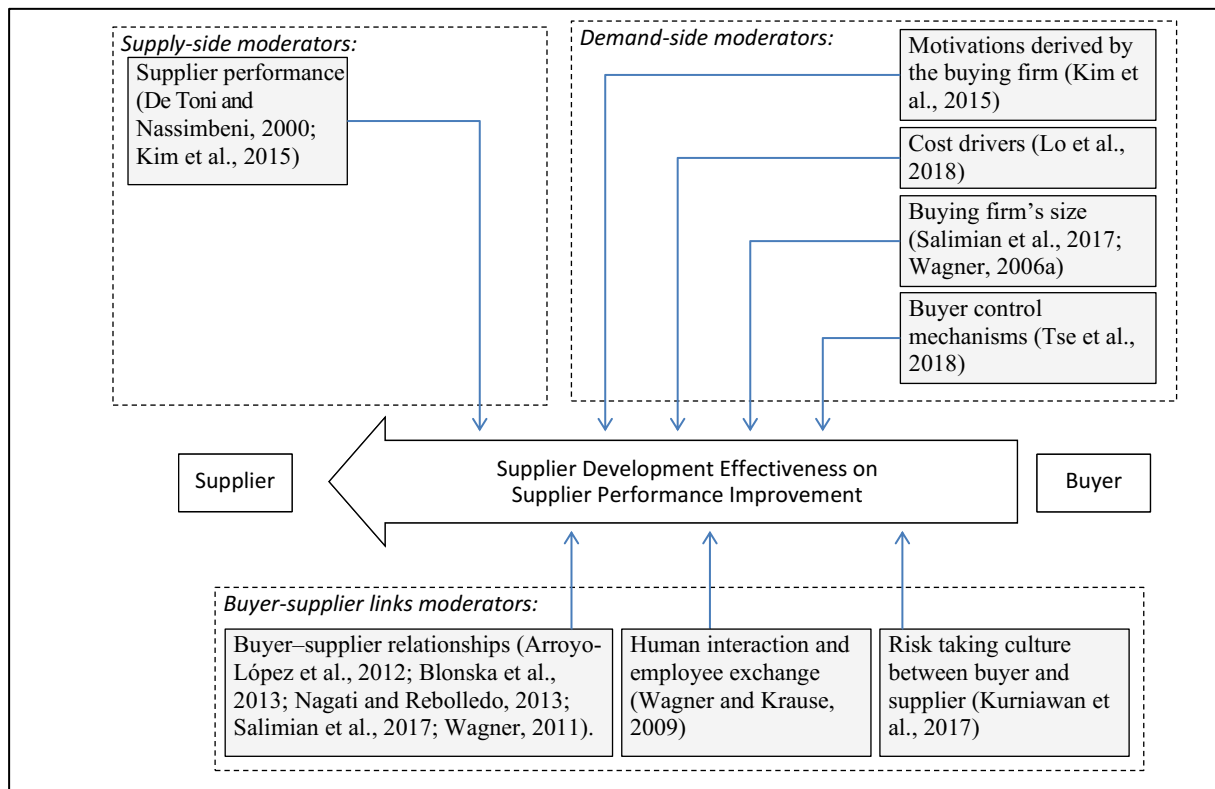


Figure 1. The existing literature on supplier development moderators and their deriving areas.

This synthesis of the literature shows that supply-side moderators have been mostly overlooked, despite the fact that supplier is the main stakeholder and actor of any supply chain development program. Consistent with our literature review findings, Wagner (2006b and 2011) advise future research to study the supplier's perspective and moderating effect in the supplier development programs. Andersen and Drejer (2009) and Aoki and Staebelin (2018) also emphasize the critical role of suppliers in supply development activities. Humphreys et al. (2011) and Li et al. (2012) recommend further research on moderating factors such as technical complexity of the purchased item and the purchase amount in supplier development programs, which are mainly handled by suppliers. Accordingly, this paper focuses on the effectiveness of supplier development programs and examines the moderating role of a wider range of supply-side moderating factors in the relationship between supplier development and supplier performance improvement.

1.3 The missing moderators

To identify which specific supply-side moderators to be focused on, we consider three essential questions: WHO the supplier is (i.e. its main features and role in the supply base); WHAT the supplier supplies (i.e. characteristics of the product), and HOW it is supplied (i.e. how the product is made and delivered). Then, taking ideas from Tsinoopoulos and Mena (2015) about supply chain configurations and factors, supplier size and supply share are selected to answer the WHO question, product complexity is identified to answer the WHAT question, and integration with buyer and the supplier's management system are picked to answer the HOW question and reflect the key supply-side moderators for supplier development. Although these five selected moderators cannot be claimed to form an exhaustive list, they indicate moderating effects that are derived from or related to the supplier, which are mainly missing in the literature. Larger supplier size and more supply share (i.e. higher share of a supplier of the total demand

for a particular product) are expected to attract more resources for and more attention to the supplier development program. Better integration with supplier and well-established management systems in the supplier's site are also supposed to facilitate joint programs like supplier development. Finally, complexity of the purchased products reflects the potential difficulties of the supplier development program to achieve its performance improvement targets.

1.4 The paper contribution and structure

In view of the above grounding reviews, this paper contributes to the literature by investigating the moderating role of supply-side factors in the relationships between supplier development and supplier performance improvement. This is proven to be an important and novel research since those factors are mainly missing in the previous research, despite the fact that suppliers have been recognized as the core element of any supplier development program. The moderators, focused upon in this research (i.e. supplier size, supply share, product complexity, buyer-supplier integration, and the supplier's management systems), mainly address the three key attributes of any sourcing and supply management decisions: WHAT to buy (i.e. the purchased product), WHO to buy from (i.e. the supplier), and HOW to buy (i.e. buyer-supplier relationship), which their moderating role in supplier development programs have not been studied yet. This research also contributes to the literature by highlighting the role of buyers and buyer-led supplier development programs - an outcome which interestingly contradicts some new ideas around the weakening role of buyers in supplier relationship management (e.g. Wu and Choi 2005)

Considering the strategic effect and capital intensiveness of supplier development programs, the outcomes of this research contribute to supplier development programs in practice too. With a better understanding of the scale and scope of the supply-side moderators' effects, supplier development programs can run more efficiently and effectively - by focusing on relevant

moderators to achieve the most out of the supplier development programs, in particular, and supplier relationship management, in general.

This paper is organized as follows. Further justification for the choice of moderators, alongside the detailed formulation of the research hypotheses, are provided in the following section. In view of that, a structural model is presented that tests for relationships between the supplier development and performance improvement factors, and the impact of moderating factors. Supplier development, supplier performance improvement, and the moderating factors form a number of research constructs, which are introduced and operationalized in Section 2 and 3 respectively. The structural model is tested through a large-scale survey. The research method, data collection, and analysis technique are explained in Section 3. The findings of the data analysis are presented in Section 4 and their implications are discussed in Section 5. Finally, the paper finishes with conclusions and recommendations for future research in Section 6.

2. Hypotheses development

Supplier development can run in different ways such as problem solving/improvement projects, regular audits and assessments, competitive pressures and incentives, and contractual requirements for higher performance (Chen et al. 2016; Krause et al. 1998). However, what is usually recognized as direct supplier development programs includes (i) assessment /certification programs and (ii) buyer direct involvement/investment (Glock et al. 2017; Humphreys et al. 2011; Krause et al. 2000; Modi and Mabet 2007, Wagner 2010), which are considered later as the major supplier development constructs in this paper - for the sake of simplicity in reading the text henceforth, we abbreviate them to ACSD and DISD respectively. ACSD programs try to ensure that the supply base is aware of the buyer's requirements and expectations via regular audits and appraisals. During the ACSD process, the audit team, from the buying firm or a third party, identifies the suppliers' non-compliances with the buyer's requirements, and recommends opportunities for improvement (McGovern and Hicks 2006;

Prahinski and Benton 2004). The big scope of ACSD programs, to include all or the majority of the firm's suppliers, usually make them very influential.

In the DISD approach, the buying firm has a proactive role and allocates resources to the supplier development program to enhance hardware, software and knowledge capacity of suppliers (Giannakis 2008). Cost reduction (Fontana 1998; Handfield et al. 2006; Wouters et al. 2007), quality and performance development (Zuckerman 1998; Noshad and Awasthi 2014), and improving the workplace (Smith and Greenwood 1998) are some examples of DISD programs. DISD may include investments in tangible and/or non-tangible assets, training programs or technical supports, knowledge transfer projects, consultancy services or joint product development (Humphreys et al. 2004; Modi and Mabert 2007; Pero et al. 2010). Such activities often extend the impact of supplier development and expand its implications for the supply chain (Sanchez-Rodriguez et al. 2005).

Beside its technical scope, supplier development research is also well-connected with the broader organizational theories (Chen and Paulraj 2004; Rogers et al. 2007). The current study on supplier development is particularly supported by the resource-based view of the firm – RBV (Grant 1992, Penrose 1959, Wernerfelt 1984) and dynamic capability theory (Teece et al., 1997, Wang and Ahmed 2007, Zollo and Winter, 2002). Consistent with the RBV, which defines resources as imperfectly mobile and heterogeneously distributed across competing firms and their supply chains, the supplier's capabilities are recognized as valuable resources for the buying firm. Hence, to achieve and maintain its competitive advantages, the buyer needs to carefully monitor its external resources (i.e. its suppliers' activities), which is achievable through ACSD. ACSD not only monitors the supplier's capacities and capabilities, but also provides the supplier with a set of improvement guidelines and action plans. This initiates the development plan and leads to the improved supplier's performance. Hence, ACSD forms a basis for improvement in supplier capabilities (Theodorakioglou et al. 2006; Araz and

Ozkarahan 2007). This is also in-line with the dynamic capability theory that urges the firm's supply-base to possess distinctive capabilities to make a better use of its resources. Above and beyond ACSD, dynamic capability theory needs a firm to enhance its external resources via knowledge transfer, technology diffusion, information sharing, performance appraisal, and capacity building, which are typically included in DISD approach to supplier development. Therefore, two grounding hypotheses of this research, which underline the impact of supplier development on supplier performance (Humphreys et al. 2011; Lawson et al. 2015; Lee et al. 2018; Yadlapalli et al. 2018) are stated as:

H0a. ACSD positively affects supplier performance improvement.

H0b. DISD positively affects supplier performance improvement.

As mentioned earlier, this research considers supplier performance in terms of quality and delivery. Section 3 provides more justification on this choice and explains the supplier performance measured items.

Supplier Size (SS) – Hypothesis 1a&b.

Considering the competitions among supply chains for securing rare and non-substitutable resources, as accentuated by RBV, it has been evident that supply chains with larger firms can attract more resources and talents (Koufteros et al. 2012). Sanchez and Perez1 (2003), and Wagner (2006b) show the positive effect of buyer size in supplier development programs. The positive effect of supplier size on programs such as TQM, lean, and sustainability have been indicated by previous studies too (Demeter and Matyusz 2011; Jayaram et al. 2010; Pagell and Wu 2009). Therefore, considering the resources and commitment, required by the supplier development program, it can be stated that the success or failure of supplier development programs is affected by supplier size. In the case of ACSD, Gnome (1995) argues that costly certification programs, such as ISO 9000, are less helpful for small/medium-sized firms. Laframboise and Reyes (2005) propose that supplier size in general has impact on the influence

of quality management and certification programs over suppliers. González-Benito et al. (2003) also contend that larger firms need greater quality assurance practices. Hence, it can be posited that:

H1a. Supplier size has a positive moderating impact on the ACSD effect on supplier performance improvement.

The moderating impact of supplier size in DISD can be viewed from the lens of supplier engagement and commitment to its relationship with the buying firm, which in turn encourages more involvement of the buyer in supplier development programs. A number of studies have underlined the significance of the firm's size in buyer-supplier relationship (e.g. Duffy and Fearné 2004; Redondo and Fierro 2007). Duffy and Fearné (2004) discuss that larger firms are more likely to make investment in relationships with their buyers. This can have a direct impact on the buyer involvement in the development program and its success. Leenders (1989) believes that supplier size is an important factor in determining the supplier development program. Wagner et al. (2005) shows that larger suppliers usually attract more attention and involvement of buying firms in projects such as quality or productivity improvement. Thus, it can be stated that:

H1b. Supplier size has a positive moderating impact on the DISD effect on supplier performance improvement.

Supply Share (SH) – Hypothesis 2a&b.

With the RBV lens, purchased items from suppliers, for a specific need of the buying firm, contribute to the buyer's competitive advantages. Hence, suppliers with higher share of the buyer's order are more influential on the buyer's competitive advantages – by the way they fulfil the buyer's orders/needs. This influence can be reflected in supplier development programs. The larger business share and transaction with a supplier need the buying firm to keep closer eye on the supplier's performance. This leads to allocating wider and superior resources to their ACSD - as Love and Li (2000) show that quality certification programs cost

more in suppliers with larger contracts. An ACSD, supported by more financial and technical resources and highly experienced auditor may lead to a better assessment of the supplier and more effective corrective and preventive actions, which positively affect the supplier's performance.

Having more share of the buyer's demand is motivating for competing suppliers too, encouraging them to provide more support to ACSD and its improvement recommendations and actions, which turn to enhanced supplier performance. Ueki (2016) shows how suppliers adopt and support assessment and audit programs like ISO, when they are under pressure and may lose their market shares to competitors if they do not collaborate (Tao et al., 2020). Therefore, the supply share moderating effect in ACSD can be hypothesized as:

H2a: Supply share has a positive moderating impact on the ACSD effect on supplier performance improvement.

Similarly, a higher supply share encourages the buying firm to care more about the supplier, and allocated more resources to their DISD program(s) with that supplier. This can be the case for the high-share supplier too, where it sees itself rewarded by a bigger orders, hence supports the DISD by allocating more resources and commitment to it. These can have an impact on the success of the development program and ultimately the performance measures of the supplier. Bai and Sarkis (2016) analytically show that motivations for investments in supplier development is derived by supply volume. With a different view to the supply share, Bahinipati and Deshmukh (2012) show how supply contribution can be a negotiation parameter between the buyer and supplier, which may have impact on the buyer-supplier collaboration and the supplier development program. Hence, supply share is expected to have a positive moderating role in the effect of supplier development programs with direct supplier involvement on supplier performance. Thus, Hypothesis 2b can be formulated as:

H2b: Supply share has a positive moderating impact on the DISD effect on supplier performance improvement.

Product Complexity (PC) – Hypothesis 3a&b.

To be more effective, ACSD programs might have different requirements for different types of purchased products of the firm and their suppliers. Complexity is a product key differentiating factor which brings greater probability of nonconformity to quality and specifications (Hinckley and Barkan 1995; González-Benito et al. 2003) as well as the delivery fulfilment (Closs et al. 2010). Hence, technical complexity of the product may largely affect the purchasing process and demand more preventive actions and assessment/certification plans (Kaynak 2005; Lo and Power 2010). Taking the dynamic capability view, it can be argued that to enhance external resources and to achieve the same level of supplier improvement, suppliers of more complex products need more sophisticated ACSD program(s). In other words, ACSD improves supplier performance more when the supplying product is less complex:

H3a: Product complexity has a negative moderating impact on the ACSD effect on supplier performance improvement.

DISD programs may be also influenced by the supply chain's product and its technical features. Wuang et al. (2010) underline more crucial role of closer supplier relationship during the design process of complex products. Complex products, due to their complication, usually do not have several or easily available suppliers. Those available suppliers need further collaboration with, and more frequent information sharing and buyer involvement in their development programs (Hvolby et al. 2007). Moreover, complexity of the product may introduce new complexities and uncertainties to the supply process, which might need further integration and involvement of the buying firm (Redondo and Fierro 2007; Gimenez et al. 2012). Product complexity has impacts on supplier performance factors including delivery reliability (Mapes et al. 1997) and service levels (Alfaro and Corbett 2003) too. Therefore, this research posits that supplier improvement via DISD is more achievable for less complex products. In other words, the same DISD has less effect for suppliers with more complex products, compared to the suppliers with

less complex products. Consistent with this argument, van der Vaart et al. (2012) ask for research on the moderating effect of product complexity on the relationship between direct supplier development and performance. In that sense, we can hypothesize that:

H3b: Product complexity has a negative moderating impact on the DISD effect on supplier performance improvement.

Buyer-Supplier Integration (SI) – Hypothesis 4a&b.

Implementation of supplier development programs typically involves more complications than simple improvement projects that a firm run internally, due to the attachment of several external factors, including suppliers. Better supplier involvement, relationship, collaboration or as Squire et al. (2009) synonymize them, “supplier integration”, can be an important dynamic capability to mitigate those complications (Zhang et al. 2018). Frohlich and Westbrook (2001) define supplier integration as coordination of physical and information flows with suppliers. When supplier development program’s tasks are coordinated together by both buyer and supplier, the success of the program (i.e. enhanced supplier performance) will be eventually more likely. Likewise, in view of RBV, the main motive for supplier integration is derived from the leveraged scarce resources and knowledge, achieved and maintained with suppliers.

For ACSD, this coordination can be achieved via proper sharing of supplier performance information with the buying firm before and during the assessment and certification program, joint planning of the assessment and certification activities, and a proper commitment to the corrective actions raised after the assessment. The necessity of coordination and integration is widely recommended by the assessment/certification reviews and guidelines (see, inter alia, Prajogo et al. 2012). Boiral (2011) underlines sufficient resource allocation and managerial conviction, both achieved via supplier integration, as the critical success factors for certification programs. Looking at assessment/certification programs (particularly ISO 9000) from the supplier’s perspective, Boiral and Roy (2007) also emphasize the importance of buyer-supplier

integration for the success of such programs. Hence, the moderating role of supplier integration in ACSD can be formulated as:

H4a: Supplier integration has a positive moderating impact on the ACSD effect on supplier performance improvement.

For the case of DISD, the abovementioned coordination may include mutual understanding of the expected outcomes of the development project, joint-planning of the activities, and agreement on deadlines and resource allocations. The well-established project management body of knowledge strongly recommends these coordination/integration activities as the key success factors of projects too (Belassi and Tukel 1996). For example, the project management literature accentuates that the benefits of a project are not eventually realized by the project's manager, client or sponsor, but by operations management. This necessitates a close co-operations between the managers/sponsors and the operational team (Cooke-Davies 2002). In the context of DISD, this means a proper integration between the buying firm, as the manager/sponsor, and the supplier. The significance of buyer-supplier integration is highlighted in similar joint projects contexts such as product development too (Pero et al. 2010). Therefore, the moderating role of supplier integration in DISD can be formulated as:

H4b: Supplier integration has a positive moderating impact on the DISD effect on supplier performance improvement.

Existing Management Systems (MS) - Hypothesis 5a&b.

The platforms and/or procedures that are typically established by the operations/quality management systems of suppliers can be very good supports for supplier improvement programs. The literature indicates a wide impact of management systems on internal and external activities. Prajogo et al. (2012) show that allocating enough resources to proper implementation of ISO 9000 together with other management systems such as total quality management (TQM), six-sigma or ISO 14000 significantly facilitate internal and customer

process management. Li et al. (2002) indicate that higher maturity in quality management (e.g. via well-established quality management systems) enhances the effectiveness of customer relationship – which include various joint programs such as buyer-led supplier development. Hence, it is reasonable to expect from the supplier's management system(s) to moderate the buyer-led programs such as supplier development.

Operations/quality management systems usually form planning, control and assurance mechanisms to boost operations process and performance (Levine and Toffel 2010). They may include internal and external audits, management reviews, and business process mapping and documentation. These clearly facilitate ACSD, since the buying firm can use the existing documentations and procedures, maintained by the supplier's operations/quality management systems for its assessments. Particular procedures for audits, reviews and action plans assist the certification process and help it to achieve its performance improvement objectives. Therefore, it is sensible to propose the hypothesis below:

H5a. The impact of ACSD on supplier performance is greater in suppliers with established management systems.

The supplier's operations/quality management systems and their relevant mechanisms can similarly support DISD, where the buying firm can find an existing platform to define and run the development project upon it. In this condition, planning and implementation of improvement activities are much easier, since they can be defined on the basis of an ongoing system which has (or can have) mechanisms to manage customers relationship and run joint projects with them. Hence, the earlier *H5a* can be followed by:

H5b. The impact of DISD on supplier performance is greater in suppliers with established management systems.

Figure 2 summarizes this section and the research hypotheses in a conceptual model.

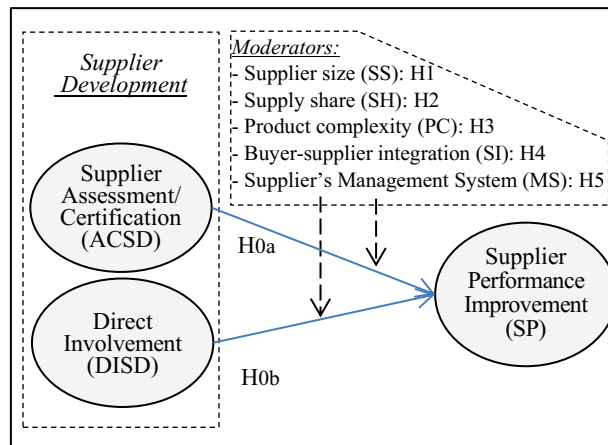


Figure 2. The research conceptual model.

3. Research design

3.1 Research constructs and measures

As Figure 2 shows, the research hypotheses are defined based on three main constructs and five moderators. Multiple measured items are extracted from the literature to identify and estimate the constructs.

Measured items for ACSD and DISD are borrowed from Krause et al. (2000) and Modi and Mabert (2007) as follows.

ACSD:

AC1– assessment of the supplier’s performance through formal audit using established procedures and guidelines.

AC2– providing the supplier with the audit feedback along with recommendations to improve capabilities.

DISD:

DI1 – Site visit by the buyer to the supplier’s premises to help supplier improve its capabilities.

DI2 – Providing training services to the supplier’s personnel.

DI3 – Supplier personnel visit to the buying firm to increase the awareness about the product used (*note: this item is dropped later in the pilot study of this research – see sub-Section 3.2*).

The ACSD and DISD items are measured based on a 10-point scale, where 10 represents the maximum and 1 represents the minimum levels of development activities (see Table 1). It is important to recall that supplier development impacts are not expected to be immediate. Thus,

ACSD and DISD are viewed in the last three years time-window, to make sure their impacts are realized in the recent (i.e. last 12 months) measures of supplier performance.

Supplier performance improvement (SP) is typically measured based on various indicators such as cost, quality, delivery, and flexibility (Chavez et al. 2013; Chavez et al. 2016; Narasimhan et al. 2008b; Quesada et al. 2006; Salimian et al. 2017), among them quality and delivery have been common and core factors in supplier development projects (Kim et al. 2015). They are also expected to be improved more straight and more visibly by direct supplier development programs (Aksoy and Öztürk 2011; Hald and Ellegaard 2011). In addition to the relevance and significance of quality and delivery, their data is available more thoroughly than other supplier performance indicators in the sample frame of this research (see sub-Section 3.3). Therefore, quality and delivery are taken to measure the supplier performance improvement construct. In this research, the delivery and quality (of those products of the firm which are included in the supplier development program, led by the supplying firm's main client) are measured based on a 0-100 scale (see Table 1), where the respondents are asked to provide their assessment about the performance improvement based on objective evidences such as reject rate, deficiency rate, poor quality reports, and customer complaints.

The moderating factors are rated by various measures as follows:

- For ***supplier size***, suppliers are divided according to the number of their employees (Nijssen and Frambach 2000; Leal-Rodríguez et al. 2015) into four groups: micro (<10), small (10-49), medium (50-249), large (≥ 250). This classification of the firms is compatible with EU definition of enterprise categories (European Commission 2009), and is similar to the firm size scales employed by similar studies (e.g. Andries et al. 2014; Antonelli and Scellato 2015).
- ***Supply share*** is divided into three categories, based on the share of the firm in fulfilling the client total demand: "1"- if the firm supplies less than a third of its client's need (i.e. minor supply share); "2"- if the firm supplies around half of its client's need (i.e. average supply

share); “3”- if the firm supplies all or most (more than two third) of its client’s need (dominant supply share). When, a supplier provides more than one product to the main client (which has initiated a supplier development program), the main product is taken into account. This scale for supply share is consistent with primitive sourcing and order allocation theories (Monczka et al. 2015). Heese (2015) also analytically recommends a similar three-level scale, where the supply share is ranging from single-sourcing to multiple-sourcing.

■ **Product complexity** is measured by various metrics in the literature. Kristensen et al. (1999) define product complexity as the difficulty to evaluate the product’s quality due to the product technicality, lack of objective quality measures, and non-tangibility of the product. Hofer and Knemeyer (2009) address the product complexity in the context of delivery, where special considerations are required due to product features, client expectations of the product or environment requirements. Consistent with the product complexity literature, we take two measured items for product complexity: complexity in terms quality assessment, and complexity in terms of delivery. For each measured items, a 3-point scale are used, where “1” and “3” represented the lowest and highest levels of complexity respectively. When, a supplier provides more than one product to the main client, complexity of the main product is taken into account.

■ **Buyer-supplier integration** has been measured in various ways and there is a substantial literature around them (e.g. Cheng et al. 2016; Faraz et al. 2018; Mandal and Jha 2018; Peng et al. 2013). Among them, there are two measured items which are shared by almost all studies in this field: “information sharing” and “joint decision making and planning”, which typically refer to joint planning and share of information about the inventories, production, demand forecasts, and capacities. They are usually measured based on the level of implementations of information sharing and joint decision making and planning (e.g. see Cheng et al. 2016), and this research follows the same measurement scale (see Table 1).

■ For operations/quality **management systems**, based on the introduction provided earlier, this

research measures this item in the scale of 1 to 3, where “1” means “no operations/quality management system is established in the supplier”, “2” means “one operations/quality management system has been established in the supplier”, and “3” means “two or more operations/quality management systems have been established in the supplier”.

3.2 Pilot test

Face validity and content validity of the research constructs are tested through a pilot study. The pilot study involves three supply chain managers and four academics, all are experts in supplier development and supply chain management. Definitions of the constructs and their items have been reviewed during the pilot study, ambiguous or redundant items are clarified and wordings are changed where necessary. Full descriptions of the validated measured items and their associated scales are provided in Table 1. The constructs and their measured items then form a basis for the research questionnaire (sub-Section 3.3). Section 4 also run further tests on the validity and reliability of the constructs and the research measurement model through the confirmatory factor analysis, which is suitable when the measured variable of the constructs are already known.

It should be noted that unlike the supplier development and supplier performance constructs, which are measured in the last three years and last 12 months time-windows respectively, the moderator constructs, by nature, are stable (at least for 2-3 years), therefore responses to them should reflect their recent status - valid and relevant for the structural model of this research.

3.3 Source of data and data collection

To test the research hypotheses, quantitative data are collected through a web-based survey on UK-based firms. The sample frame consists of 1329 firms (whose information is available from the public domain) from a wide range of industries – covering many categories of Standard Industrial Classification - SIC2007 (Prosser 2009). The survey is recognized as a suitable

method for deductive studies, which can collect large amount of quantitative data. For the current study, survey method can provide the required empirical data to test the research hypotheses adequately, and it is adopted accordingly.

Table 1. Research constructs, measured items and their description.

Construct	Item	Item Description	Measure
Supplier Assessment/ Certification (ACSD)	AC1	Assessment of the supplier's performance through formal audit using established procedures and guidelines.	Scale: ① ← ② = ③ = ④ = ⑤ = ⑥ = ⑦ = ⑧ = ⑨ ⇒ ⑩ (1): limited number of audits (less than two audits in the last three years). (10): very frequent audits (four or more audits each year).
	AC2	Providing the supplier with the audit feedback along with recommendations to improve capabilities.	Scale: ① ← ② = ③ = ④ = ⑤ = ⑥ = ⑦ = ⑧ = ⑨ ⇒ ⑩ (1): short audit report on major non-conformities. (10): detailed audit report with major and minor non-conformities and recommendations for reactive and proactive action plans.
Direct Involvement of the buying firm (DISD)	DI1	Site visit by the buyer to the supplier's premises to help supplier improve its capabilities.	Scale: ① ← ② = ③ = ④ = ⑤ = ⑥ = ⑦ = ⑧ = ⑨ ⇒ ⑩ (1): limited number of visits (less than two visits in the last three years). (10): very frequent visits (four or more visits each year).
	DI2	Providing training services to the supplier's personnel.	Scale: ① ← ② = ③ = ④ = ⑤ = ⑥ = ⑦ = ⑧ = ⑨ ⇒ ⑩ (1) No training, or just general purchase requirements and guidelines provided annually. (10) very high level and extensive training service, including frequent on-site training, updated learning material, and available helpline.
Supplier Performance improvement	SQ	Supplier performance in terms of product quality.	Scale: 0 ← ===== ⇒ 100 This item is measured based on a 0-100 scale. Elements which collectively form this score can include improvement (in last 12 months) in reject rate, deficiency rate, poor quality reports, and customer complaints. "0" means no improvement; "100" means total improvement.
	SD	Supplier performance in terms of delivery performance.	Scale: 0 ← ===== ⇒ 100 This item is measured based on a 0-100 scale. Elements which collectively form this score can include improvements in delay rate, delivery reliability, delivery inaccuracy rate, and delivery flexibility (in last 12 months). "0" means no improvement*; "100" means total improvement.
Supplier Size	SS	Number of employees	Scale: Micro (1) Small (2) Medium (3) Large (4) (<10) (10-49) (50-249) (≥250)
Supply Share	SH	Share of the buyer's need, fulfilled by the supplier	Scale: Minor supply contribution (1) Average supply contribution (2) Dominant supply contribution (3) (<1/3) (≥1/3 and <2/3) (≥2/3)
Product Complexity	QC	Product complexity in terms of quality assessment	Scale: Low (1) Average (2) High (3) Very few quality parameters are tested ← ===== ⇒ Many quality parameters are tested
	DC	Product complexity in terms of delivery	Scale: Low (1) Average (2) High (3) On product delivery, simple/ few controls are needed ← ===== ⇒ On product delivery, many controls are needed
Buyer-Supplier Integration	IS	Information sharing (e.g. demand forecast, production plans, order tracks, delivery status)	Scale: ① ② ③ ④ ⑤ None High
	JD	Joint decision making and planning (about product design/modifications, process design/modifications, quality improvement and cost control)	Scale: ① ② ③ ④ ⑤ None High
Supplier's Management System	MS	Existing operations/quality management system	Scale: ① ② ③ no operations/quality management system is established in the supplier One operations/quality management system has been established in the supplier More than one operations/quality management systems have been established in the supplier

* Including performance deterioration, if any.

The survey questionnaire is designed based on the measured items, which are identified in sub-Section 3.1 and preliminary validated through the pilot study (sub-Section 3.2). The unit of study is at the organizational level, and the target firms are suppliers who have been involved in a supplier development program by their key buyer. The contact points in the firms are mainly key people such as account managers, internal managers, or supply managers. After three rounds of contacts, with a three-week gap between every two consecutive contacts, the data has been collected via online questionnaire for 393 firms. Out of them, 142 usable responses have been achieved. Non-usable responses include those firms which are not involved in any direct supplier development plan, and those with more than 5% missing data. The 5% (or fewer) missing values are replaced by the average score for the question (Tsikriktsis 2005).

This sample includes a wide range of manufacturing and service industries - with different sizes, supply shares, products, integration levels with buyers, and management systems. Overall, due to their business nature and products, they have relevant data for the research questionnaire of Table 1. The sample size is comparable with studies using a similar data analysis method, such as: Enkel et al. (2017): 104, Jugend et al. (2018): 116. The sample size also meets the recommended rule of thumb by Hair et al. (2017), and is capable of explaining medium to small population effects very well – according to G*Power3.1.9.2 power analysis (Faul et al. 2008): for $f^2=0.15$, $n=142$, $\alpha=0.05 \rightarrow 1-\beta=0.92$; for $f^2=0.10$, $n=142$, $\alpha=0.05 \rightarrow 1-\beta=0.80$. A basic demographic of the responding firms is provided in Table 2.

Table 2. The sample basic demographic.

<i>Industry Category</i>		<i>%</i>
		<i>(of n=142)</i>
<u>CIS code / Description</u>		
C10	Manufacture of food products	5
C13/14	Manufacture of textiles/ wearing apparel	10
C16/31	Manufacture of wood and of products of wood/ furniture	7
C20	Manufacture of chemicals and chemical products	6
C22/23	Manufacture of rubber/plastic/ other non-metallic mineral products	11
C32	Other manufacturing	23
J58	Publishing activities	5
J62	Computer programming, consultancy & related activities	5
	Not-specified	28
<i>Firm size</i>		<i>%</i>
<u>Number of employees</u>		
	Micro (<10)	20
	Small (10-49)	56
	Medium (50-249)	17
	Large (≥ 250)	7

Non-response bias is tested via the widely-used method of wave analysis. The first 30 responses are compared to the last 30 responses, which are received after two reminders (as representatives of non-respondents). No statistically significant difference is found among the means of the two samples (i.e. no evidence of non-response biasness). Moreover, following Wagner and Kemmerling (2010) method for non-response bias test, the characteristics of the firms in the sample are compared with the ones in the population, and the results prove that the sample represent the population well and non-response bias is not an issue in this survey.

3.4 Data analysis method

Considering the research's model complexity, sample size, and the requirements for the interaction effect (moderation) test, Partial Least Square (PLS) method using Smart-PLS 3 software package (Ringle et al. 2015) is employed to test the research hypotheses. Capacity and suitability of PLS for structural hypothesis test and predictive analysis have been widely recognized for years and re-emphasized in the recent literature (Akter et al. 2017). PLS, which is based on variance maximization, allows for the examination of latent variables, path loading, path significance, and moderating effects simultaneously (Hair et al. 2017). It does not have the same distributional assumptions of normality for data and is able to handle small- to medium-sized samples - compared to other methods such as LISREL (Hair et al. 2011; Tenenhaus et al. 2005). Details of the paths estimations and further analysis of the model are discussed in Section 4.

4. Data analysis findings

The survey data (see sub-Section 3.3) is used in this section first to test the validity and reliability of the research structural model (Figure 2), and then to test the research hypotheses using the PLS method (as explained in sub-Section 3.4).

4.1 Measurement model: validity and reliability tests

This sub-section tests the convergent validity, discriminant validity, nomological validity, and reliability of the research structural model and its constructs, through the confirmatory factor analysis. These rigorous tests ensure that only very strong, relevant items remain in the models. Convergent validity is assessed by checking the sign and magnitude of the loadings of the measured items onto their respective constructs. Item loadings to their relevant construct are very high (all ≥ 0.87 , except JD = 0.55, which is still higher than the acceptable threshold: Hair

et al. 2011), as shown in Table 3. Convergent validity is also supported by the very high levels of average variance extracted (AVE), ranging from 0.63 to 1, well in excess of Fornell and Larcker's (1981) suggested level of 0.50. Table 3 also indicates that all t-values of the measured items are significant at 0.1% level (except JD=1.67, significant at 10% level), which approves nomological validities (Anderson and Gerbing 1988).

Table 3. Constructs' means, standard deviations, loadings and AVE.

Constructs	Item	Loading	t-value	Mean (STD)	AVE*
Supplier Assessment/ Certification (ACSD)	<i>AC1</i>	0.91	61.20	6.79(1.27)	0.82
	<i>AC2</i>	0.89	38.96	6.64(1.39)	
Direct Involvement of the buying firm (DISD)	<i>DI1</i>	0.91	57.23	7.07(1.28)	0.80
	<i>DI2</i>	0.88	30.14	6.91(1.22)	
Supplier Performance Improvement (SP)	<i>PQ</i>	0.96	166.12	73.01(14.16)	0.93
	<i>PD</i>	0.97	174.20	71.41(13.29)	
Supplier Size (SS)	<i>SS</i>	\$	n/a	2.11(0.80)	n/a
Supply Share (SH)	<i>SH</i>	\$	n/a	1.94(0.75)	n/a
Product Complexity (PC)	<i>QC</i>	0.89	64.76	1.95(0.75)	0.78
	<i>DC</i>	0.87	160.05	2.04(0.71)	
Buyer-Supplier Integration (SI)	<i>IS</i>	0.98	2.83	3.56(0.88)	0.63
	<i>JD</i>	0.55	1.67	3.45(0.90)	
Supplier's Management System (MS)	<i>MS</i>	\$	n/a	1.75(0.75)	n/a

* Average Variance Extracted; \$: Single Item Construct

The reliability of the constructs in structural models is tested using composite reliability measure and Cronbach's α (Nunnally 1978; Hair et al. 2006). As shown by Table 4, the levels of composite reliability are very high (≥ 0.76) for constructs in all models. Cronbach's α s are all also very high (≥ 0.71), exceeding the standard thresholds recommended by Fornell and Larcker's (1981) and Nunnally (1978). High Cronbach's α values also tend to indicate construct unidimensionality (Tenenhaus et al. 2005).

The square-roots of AVEs (italic figures on diagonal of Table 5) are also higher than the intercorrelations of the constructs (on non-diagonal cells of Table 5) in every case, which

confirms discriminant validity (Fornell and Larcker 1981).

Table 4. Construct reliabilities

Constructs	Cronbach's Alpha	Composite Reliability
Supplier Assessment/ Certification (ACSD)	0.78	0.90
Direct Involvement of the buying firm (DISD)	0.75	0.89
Supplier Performance Improvement (SP)	0.92	0.96
Product Complexity (PC)	0.72	0.88
Buyer-Supplier Integration (SI)	0.71	0.76

Table 5. Correlations among constructs and square-root of AVE (in italic on diagonal).

Constructs	ACSD	DISD	SP	SS	SH	PC	SI	MS
Supplier Assessment/ Certification (ACSD)	<i>0.90</i>							
Direct Involvement of the buying firm (DISD)	0.69	<i>0.89</i>						
Supplier Performance Improvement (SP)	0.59	0.61	<i>0.96</i>					
Supplier Size (SS)	0.42	0.45	0.44	<i>\$</i>				
Supply Share (SH)	0.40	0.49	0.48	0.60	<i>\$</i>			
Product Complexity (PC)	0.39	0.42	0.48	0.52	0.65	<i>0.88</i>		
Buyer-Supplier Integration (SI)	0.09	0.15	0.13	0.13	0.01	0.02	<i>0.79</i>	
Supplier's Management System (MS)	0.21	0.33	0.32	0.39	0.42	0.54	0.07	<i>\$</i>

\$. Single Item Construct

In addition to the key tests above, the common method bias, which might happen in self-administered and single-respondent surveys, is tested to analyze how much of the measured items' variances is associated with the method factor alongside their assigned constructs (Podsakoff et al. 2003). The results confirm that the data analysis of this research is not affected by the common method bias, as all loadings on substantive constructs are significant, while none of them is significant for the method factor (details are available from the authors). Therefore, this research comes up with a set of valid, reliable constructs to be subsequently used

for hypotheses tests.

4.2 Hypotheses and structural model assessment

In the structural model analysis, estimations of all paths and the calculation of corresponding t-values are done via the PLS algorithm calculation and the application of bootstrapping respectively, using the Smart-PLS 3 software package (Ringle et al. 2015). Table 6 illustrates the results. As recommended by Hair et al. (2017), the direct effects are tested separately first. Both $ACSD \rightarrow SP$ and $DISD \rightarrow SP$ are found significant at 5% and 0.1% significant levels respectively. The coefficient of determination R^2 is 0.66, which indicates a moderate (according to Hair et al. 2017) to high (according to Carr and Pearson 1999; and Chen et al. 2004) level of supplier performance improvement variance explained by ACSD and DISD.

The moderation impacts (i.e. research hypotheses) are tested by formulating the research conceptual model (Figure 2) as: endogenous variable = direct effect of exogenous variable + direct effect of moderator variable + interaction term (Hair et al. 2017). The formulation for ACSD, SS and SP, as an example, is presented below:

$$\begin{array}{cccc} \textit{endogenous} & \textit{direct effect of} & \textit{direct effect of} & \textit{interaction} \\ \textit{variable} & \textit{exogenous variable} & \textit{moderator variable} & \textit{term} \\ \hline SP = ACSD \times (ACSD \rightarrow SP) + SS \times (SS \rightarrow SP) + (ACSD \times SS) \times ((ACSD \times SS) \rightarrow SP) \end{array}$$

The moderation impact is tested by assessment of the significance of the interaction term. Table 6 provides details of the moderators' paths coefficients and their significance. Among them $(DISD \times SS) \rightarrow SP$ (i.e. $H1b$), $(DISD \times PC) \rightarrow SP$ (i.e. $H3b$) and $(DISD \times SI) \rightarrow SP$ (i.e. $H4b$) are found significant at 5%, and $(ACSD \times SI) \rightarrow SP$ (i.e. $H4a$) and $(DISD \times MS) \rightarrow SP$ (i.e. $H5b$) are found significant at 6% significance level. The signs of the path coefficients also support all of the above hypotheses (i.e. positive for $H1b, H4b, H4a, H5b$, and negative for $H3b$).

The results indicate that larger suppliers, better integration with them, their existing

management system(s) and less complexity of the purchased product(s) from them moderate the impact of DISD on supplier performance. The studied moderators have much more limited effect on the effectiveness of ACSD, and only supplier integration demonstrates a significant moderating impact on the link between ACSD and supplier performance.

The results also reveal that supply share does not have a significant moderating effect on the impact of development programs on supplier performance improvement.

Table 6. Results of PLS path analysis and hypotheses tests.

	Impact on SP	
	Path coefficient	t-value
Direct effects		
ACSD	0.17	2.03*
DISD	0.68	9.02**
(R ² : 0.66)		
Moderation effects		
<i>H1a</i> : ACSD X SS	0.84	1.18
<i>H1b</i> : DISD X SS	1.34	2.13*
<i>H2a</i> : ACSD X SH	0.72	0.85
<i>H2b</i> : DISD X SH	0.45	0.55
<i>H3a</i> : ACSD X PC	0.62	0.82
<i>H3b</i> : DISD X PC	-1.92	2.05*
<i>H4a</i> : ACSD X SI	0.92	1.91 [◇]
<i>H4b</i> : DISD X SI	1.10	1.97*
<i>H5a</i> : ACSD X MS	0.75	1.61
<i>H5b</i> : DISD X MS	1.29	1.91 [◇]
[◇] Significant at 6% * Significant at 5% ** Significant at 0.1%		

The results can be further analyzed by mapping the two-way interactions (Dawson 2014) between the dependent and independent variables in the presence of the moderators. Figure 3 shows the changes in supplier performance based on different levels of DISD (low vs. high) and different levels of moderators (low vs. high). All diagrams in Figure 3 illustrate the effective role of moderators and support the earlier statistical results. For the effects of SS, SI and MS,

slopes of the lines are significantly higher for the higher level of each moderator, which depict the positive and significant role of the moderators in DISD→SP relationship. For PC, as expected, the slope of the line is higher for the lower level of the moderator, favoring the negative moderating role of product complexity in DISD.

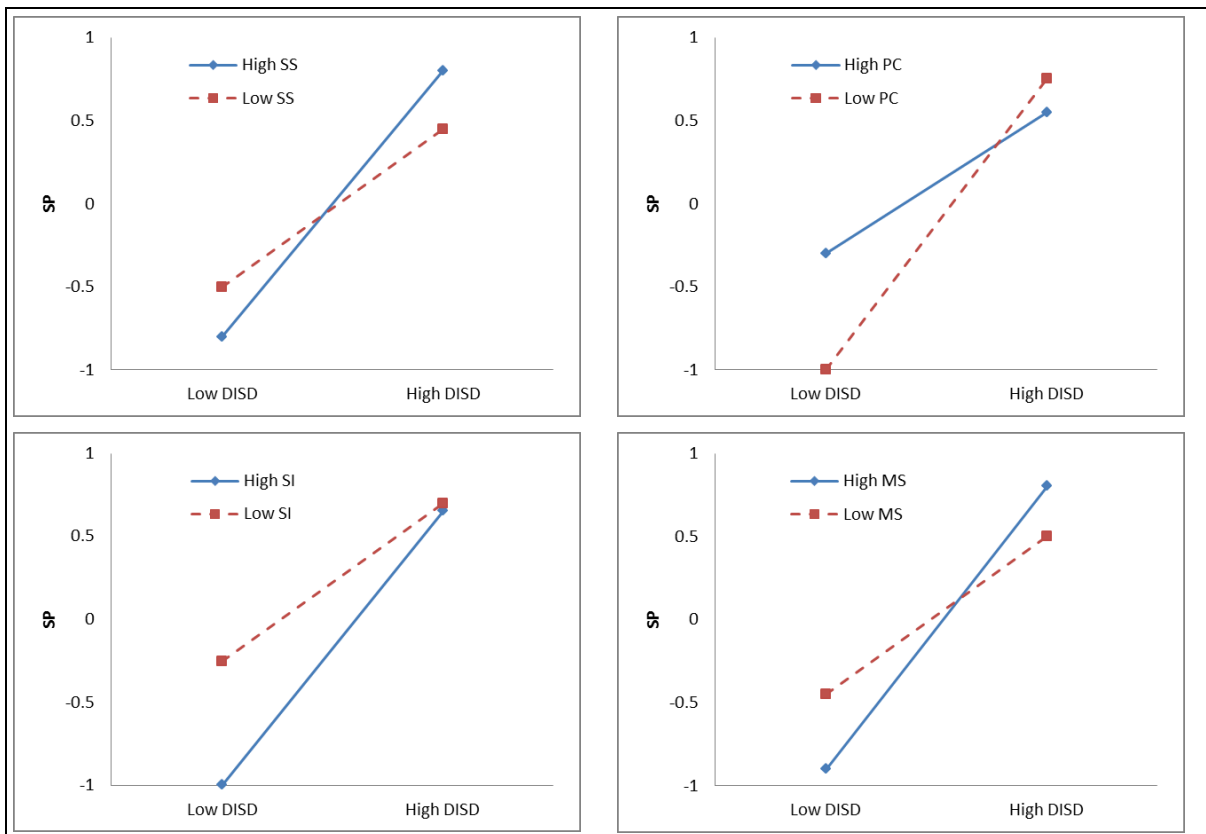


Figure 3. Two-way interaction analysis of the significant effects of the moderators.

5. Discussion

5.1 Theoretical implications

The positive impacts of direct supplier development programs (i.e. ACSD and DISD) on supplier performance, as supported by this paper, re-emphasize the value of supplier development programs, corresponding with extant literature (e.g. Hahn et al. 1990; Humphreys et al. 2004). According to the coefficient of determination of the model ($R^2 = 0.66$), direct

supplier development constructs significantly contribute to the variation of supplier performance improvement and positively influence it. The findings reconfirm that direct supplier development can improve the key areas of supplier performance (i.e. delivery and quality). Given the recent claims on weakening the dominant role of buyers in some industries, and new structures for supply chain and supplier relationship management (e.g. Wu and Choi 2005), this is an important and contradicting finding, which re-escalate the role of buyers in supply chain development practices. The higher coefficient and strength of the DISD→SP path, compared to ACSD→SP, implies that DISD programs are more effective, and/or have more immediate impact on supplier performance.

Apart from the positive impacts of supplier development programs, the more important part of this research is to investigate the role of moderators. Four key supply-side moderators (i.e. supplier size, product complexity, supplier integration and the supplier's management systems) have been found significant in the impact of DISD on supplier performance improvement, and one moderator (i.e. supplier integration) presents a considerable effect on the link between ACSD and supplier performance improvement.

Supply-side factors are well-recognized in supplier relationship management and its wider implications for network dynamic capabilities, supply governance and power-dependencies (Aitken and Harrison 2013; Kim 2000). With a more specific focus, this paper underlines the role of those factors in supplier development programs. Our results show that buyers, directly involved in the supplier development, usually have more resources committed by larger suppliers to the improvement program. This is in line with Duffy and Fearné (2004) view on more investment of larger firms in relationships with their buyers. The supported positive moderating effect of supplier size is expected on the ground of RBV and dynamic capability too, as elaborated earlier in Section 2.

The results also highlight the effect of product complexity in the buyer's direct involvement in

supplier development. Building upon our findings and the relevant literature (Gimenez et al. 2012; Hvolby et al. 2007; Redondo and Fierro 2007), we discuss that since more complex products need more attention and resources of supplier development programs, while technically there are limited supply sources available for them (i.e. due to their complexities, not many supplier can produce them easily), they need more integration and involvement of the buying firm, and supplier development programs are very vital for them. Therefore, it can be stated that complex products are crucially in need of resources and capabilities, which are expected to be expanded through supplier development, as envisaged by RBV and dynamic capability theories).

The empirical results of this study show that further enhancement in supplier performance is expected from those supplier development programs which are run directly by buyers and supported by the existing supplier's management systems. The literature views the management system as a supporting platform for capability enhancement (Levine and Toffel 2010; Prajogo et al. 2012), and our findings expand its role and underline its moderating effect in supplier development programs.

The moderating role of supplier integration, as theorized earlier, has been also found significant for both DISD and ACSD. This re-emphasizes the importance of integration. In this research, the results particularly underline the importance of information sharing and joint-decision and planning in running supplier development programs.

This paper did not find ACSD affected by supplier size, supply share, product complexity, or the supplier's management systems. This can be due to the standardized procedures developed for supplier assessment and certification. The certification procedures are virtually universal these days (Rebelo et al. 2014), and the type or size of the suppliers or their products do not change them. Although this is the reality of the assessment and certification programs these days, this research cannot recommend that this is the best way to run them.

Moreover, supply share has not been found significantly important for the success of supplier development programs. This underlines the fact that the supply share effect should be viewed in the context of buyer-supplier relationship and their relational power. While, our earlier hypotheses are defined around competing suppliers, dominant or independent suppliers may not be motivated by a high supply share (Cox, 2001; Tangpong et al., 2015). This can imply that buying firms do not necessarily need different development programs for those suppliers with bigger shares of supply, and relationship type should be considered first.

In sum, this research adds supplier size, product complexity, supplier integration and the supplier's management systems (i.e. supply-side factors) to the current list of supplier development programs' moderators including environmental dynamism – e.g. competition and technological change (Krause et al. 1998), organization performance (De Toni and Nassimbeni 2000), the buying firm size (Wagner 2006b), and buyer–supplier relationships (Wagner 2011; Nagati and Rebolledo 2013). Moreover, it can be discussed that some of the supply-side moderators, assessed by this research, might be adjustable to enhance the outcomes of the supplier development program.

The reverse pyramid of Figure 4 shows that although there are less opportunity to do much about supplier size and product complexity, supplier management systems and supplier integration can be positively affected by the buying firm, which consequently boost the supplier development outcomes. Despite the fact that the current study focuses on supplier performance in terms of quality and delivery as the key outcomes of DISD, supplier development programs usually have much wider impact on the relationship with suppliers and enhancement of their capacities and capabilities (e.g. management systems). Therefore, a closed loop can be built between supplier development in one hand, and supplier integration and supplier management systems on the other hand, where they can positively affect each other.

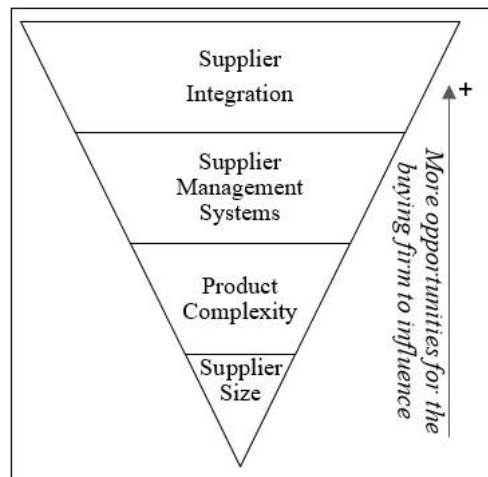


Figure 1. Possible buyer impacts on supplier development moderators.

5.2 Managerial implications

In addition to its theoretical implications, this paper has key findings for supplier development and management practitioners, and can influence their priorities in sourcing and supply base development decisions.

The moderating effects on DISD may have various implications for supplier managers. Our results on supplier size are in line with the general expectation from larger suppliers to allocate more resources to improvement programs. Similarly, they show that the full resource commitment of small suppliers, for example due to power-dependency, is not guaranteed. Hence the expected performance improvement in smaller supplier may have a slower pace. The results also necessitate a special attention to smaller companies, involved in development programs. Supplier size may influence the order assignment decisions too (Chen and Pundoor 2006). Finding the smaller suppliers less responsive to development programs, a buyer may decide to form a consortium of small suppliers (of the same or similar products) which need development, and allocate its aggregated orders to the consortium, as a bigger supplier which have the capacity to handle and succeed direct development programs. The moderating effect of supplier size can be also influential in sourcing and supplier selection decisions. Knowing

that the direct involvement in supplier development programs for smaller suppliers is less likely to succeed, many buyers may switch to new suppliers, rather than developing the existing ones. In the supply base management, if smaller suppliers are found riskier for supplier development programs, then the small size supplier will have a negative weight in selection and evaluation of suppliers (De Boer et al. 2001). If small firms remain favorable in the supplier selection list, then those with well-established management system(s) or more integration with the buying firm, as two other proven moderators of this study, will be more preferred.

Considering the supplier development as a resource acquirement and capability development platform (recall Section 2), then supplier integration and the supplier's management system can effectively support development programs and the empirical results have found their role significant too. The research results encourage firms to expand their supplier integration toward supply-base development programs. Those firms who are not very comfortable with (or do not believe in) supplier integration need to re-consider the benefits of ACSD and DISD, which are more attainable via supplier integration. Additionally, while DISD needs intense commitment and collaboration of suppliers, the results show that the existing management system can considerably facilitate them.

The outcomes of this research also underline the difficulties in DISD for more complex products. Given that more complex products have typically less supply availability, the results obviously do not recommend dropping development programs (due to their difficulties) for complex products – given that finding a new supplier here is even more complicated. Therefore, it can be suggested that development of the supplier's performance for complex products needs further commitment and resource allocation by both buyer and supplier. Insourcing the complex products is not usually doable (probably it was the main motive for outsourcing in the first place), and if the supplier has a difficulty in meeting the buyer's requirement, the improvement ideas, knowledge, and/or resource should come from third parties. This expands the scope of

supplier development programs toward wider connections, and need them to learn from an extensive literature on triad relationships and supply networks (Andersen and Drejer 2009; Friedl and Wagner 2016).

The findings of this research on supplier development moderators are much more converged around DISD than ACSD. The results do not lessen the importance of ACSD, but may indicate the capacity of each of those programs. This will need expectations from ACSD to be managed more carefully. In effect, companies cannot expect an ACSD to sort out all of their suppliers' problems fundamentally and very quickly.

The research outcomes can also imply that buying firms may run the development programs in form of assessment/certification generically, while buyer direct involvement programs should be operated in a more specific and customized way.

6. Conclusions

This research tests the moderating role of supplier size, supply share, product complexity, buyer-supplier integration, and the supplier's management systems in the relationship between supplier development and supplier performance improvement. A structural model, developed to test the research hypotheses, consists of two exogenous constructs: supplier development constructs: supplier assessment/certification (ACSD) and direct involvement of the buying firm (DISD); one endogenous construct: supplier performance improvement (SP), and five moderators. The theoretical foundations of the research constructs are developed in line with the literature, and the constructs are validated using empirical data.

The findings support the positive impact of supplier development on supplier performance improvement, which is consistent with the literature (e.g. Humphreys et al. 2004; Carr and Kaynak 2007; Krause et al. 2007; Narasimhan et al. 2008a). But, the main contribution of the paper is in examining the role of five key moderators in the relationship between supplier

development program and supplier performance improvement. The results indicate the significant moderating role of supplier size, product complexity, buyer-supplier integration, and the supplier's management systems in supplier development programs, in form of buyer direct involvement (DISD), and the positive moderating role of buyer-supplier integration in assessment/certification supplier (ACSD) development programs.

This research builds its contribution upon the relevant literature (e.g. Krause et al. 1998; De Toni and Nassimbeni 2000; Krause et al. 2000, Handfield et al. 2006; Wagner 2006b; and Wagner 2011), which address other moderators for the success of supplier development programs, but mainly lacks the supply-side moderators (i.e. the one studied in this paper).

Empirically, this paper increases the understanding of supply chain development programs by comparing their outcomes for different types of supply networks and conditions. The findings of this research can greatly support supply chain development decisions. Supplier development is a costly program (Araz and Ozkarahan 2007), which requires the buying firm to employ or prioritize it for a right set of suppliers. Supply managers should design or employ a suitable supplier development program which is compatible with each supplier/supply type too. By understanding how effective a supplier development program is for different types of supply arrangement (in terms of supplier size, product complexity, buyer-supplier integration, and the supplier's management systems), it can be employed in different ways to help both supplier and buyer benefit most out of it. The effectiveness of the development program can be then measured more accurately.

This research has some limitations too. Only two constructs are used for supplier development and two measures are used for supplier performance. Depending on the supplier development programs in other supply chains, a wider range of constructs and measures can be explored and used. Moreover, a 2-3 year time lag between the supplier development programs and improved supplier performance is considered by this research. This is open for further research to

investigate different time windows and their associated moderators' effects, in different industries. Finally, more advanced topics such as management of technological innovation should be focused on further in the future supplier development research.

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