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Demand-driven supply chain operations management strategies – a literature review and conceptual model

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ABSTRACT

The literature on demand-driven supply chain operations management strategies (DDSCOMSs) is excellent in describing when, where and how the strategies can be used. However, managers of manufacturing companies usually employ more than one DDSCOMS when designing and operating their supply chains, thus needing to understand when, how and why two or more DDSCOMSs can be used in combination. The answers to these questions are not stated well in the literature. The purpose of this study is therefore *to explore the relations among the DDSCOMSs*, using a combination of a structured literature review and analytical conceptual research. The study identifies and establishes both direct and indirect relations among the five studied DDSCOMSs. These results assist in nuancing the complex and dynamic relations between the DDSCOMSs, by showing the effects different decisions have on operational performance. The study also points out further research directions, such as the DDSCOMS relations that are under-studied.

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1. Introduction

Manufacturing companies' supply chains comprise the end-to-end flow of information, material and money. How manufacturing companies design and operate their supply chains is thus paramount for their ability to compete, with implications for their customization abilities, delivery lead time offerings, product costs and working capital, among others (Perez, 2013). Arguably, it is important to match demand and product characteristics with supply chain design to be competitive. In his seminal paper, Fisher (1997) argues for just that, that is, 'supply chain fit' (Gligor, 2016, 2017). Since then, a steady stream of research has emphasized the importance of achieving supply chain fit (see, e.g., Esper et al., 2010; Gligor, 2016, 2017; Hallavo, 2015; Rahman & Rahman, 2019; Y. Y. Sabri, 2019; Stock et al., 1998; Wagner et al., 2012). In practice, this means that supply chain operations managers of manufacturing companies should consider not only the flow of material and information when designing their supply chains but also the types of products and the market demands (Aitken et al., 2005; Alicke & Forsting, 2017; Esper et al., 2010; Fisher, 1997; Lovell et al., 2005; Thomas, 2012). Adding to this

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complexity, as business conditions and market requirements are dynamic and change over time, so will the characteristics of an appropriate supply chain design (Aitken et al., 2005; Childerhouse et al., 2002; Christopher & Towill, 2000; Gligor, 2017; Tony Hines, 2013; Sebastiao & Golicic, 2008). Supply chain fit is thus not only a state but also a process, adding a dynamic problem to its alignment and maintenance (Gligor, 2017; Miles & Snow, 1984; Zimmermann et al., 2020). The concept of supply chain fit can thus be a daunting and significant challenge for most managers (Gligor, 2017; Miles & Snow, 1984; Van de Ven et al., 2013; Wagner et al., 2012), perhaps more so for managers of demand-driven manufacturing companies. Such companies' business strategies are aimed at competing in the market by acting and adapting to customer needs. The demand-driven concept is, however, one of a degree, where some demand-driven manufacturing companies are event customer order driven, that is, they produce products based on actual customer orders, having the ability to adapt the product based on individual customers' demand. This can be seen as what Ayers and Malmberg (2002, p. 23) and Mendes (2011, p. 8) terms '*100 percent demand-driven*'. These demand-driven manufacturing companies tend to want their processes to be efficient (also referred to as cost-efficient) yet simultaneously responsive (Perez, 2013) to customers' dynamic needs. In this context, a set of demand-driven supply chain operations management strategies (DDSCOMSs) is used as a plan for how demand-driven manufacturing companies will allocate their resources to support this balancing act of ensuring efficiency and responsiveness. The DDSCOMSs should further support a manufacturing company's business strategy, acting as a bridge between customers and the operations that deliver the products and fulfil the customer requirements (Tony Hines, 2013). Some DDSCOMSs that specifically address and support this balancing act of ensuring efficiency and responsiveness and/or the ability to create variants and customizations include *segmentation, leagility, customization, transparency* and *postponement*. These five DDSCOMSs can each be used to aid supply chain operations managers of demand-driven manufacturing companies in designing and operating their supply chains.

However, it is fairly common for demand-driven manufacturing companies to operate a portfolio of products and markets, both using and being members of several supply chains (Aitken et al., 2005; Godsell et al., 2011; Hilletofth, 2009; Pagh & Cooper, 1998). In this way, demand-driven manufacturing companies tend to employ more than one DDSCOMS (Tony Hines, 2013). Consequently, these managers have the difficult task of designing and maintaining supply chain fit using not only one DDSCOMS but more probably two or more in combination. In such a situation, it is important that the DDSCOMSs do not conflict with one another but be compatible and coherent, supporting the demand-driven manufacturing companies' business strategies and competitiveness, as well as generation of profits (Tony Hines, 2013; Melnyk et al., 2010). The probability of achieving the said supply chain fit, combining two or more DDSCOMSs, is thus highly related to managers' understanding of DDSCOMSs. First, what are DDSCOMSs, and when should they be used? Second, if they have to be combined, what are the relations among them? For the first set of challenges, a vast number of publications address what each DDSCOMS is and when it is applicable to use (see, e.g., Alderson, 1950; Fuller et al., 1993; Lamming et al., 2001; Naylor et al., 1999; Pine, 1993a); some even deal with two or more DDSCOMSs in combination (see, e.g., Christopher & Towill, 2000; Feitzinger & Lee, 1997; Fogliatto & da Silveira, 2008). For the second challenge, to the author's knowledge, only one publication addresses the relations among all five DDSCOMSs, see Wikner (2014b). Nonetheless, Wikner (2014b) only presents a short overview of some key similarities among these DDSCOMSs while acknowledging that other aspects of these relations are not covered. Hence, further research and a more thorough investigation of the relations among the five DDSCOMSs are desirable in order to substantiate the understanding of such relations. The purpose of this study is therefore *to explore the relations among the DDSCOMSs*. This purpose is further broken down into three research questions (RQs).

The demand-driven concept is important for this study and its context. However, for the concept to be useful, its meaning should first be understood. The first RQ, therefore, aims to provide an understanding of what the demand-driven concept actually means, as well as how it can be comprehensible and useful when establishing the relations among the DDSCOMSs. The first RQ is thus stated as follows:

1. What constructs could be used to operationalize the demand-driven concept?

Operationalization is here perceived as the act of dividing a concept into concrete constructs. In other words, the identified constructs are the constituents of the demand-driven concept. These constructs can then be used to study each of the five DDSCOMSs, thereby establishing the relations among them. The second RQ is therefore formulated as follows:

2. What are the relations between the constructs and the DDSCOMSs?

Using transitivity and the established relations between the constructs and the DDSCOMSs, it is then possible to establish the relations among the DDSCOMSs. Transitivity means that if a relation exists between one DDSCOMS and a construct, as well as between the same construct and a second DDSCOMS, then a relation between the first and the second DDSCOMS is also possible to establish. In this regard, the third RQ is as follows:

3. What are the transitive relations between the DDSCOMSs based on the constructs?

The rest of the paper is organized as follows: Section 2 operationalizes the demand-driven concept, identifying nine constructs of demand driven. The section thus answers RQ1. Section 3 starts by describing the research design and how a rather extensive structured literature review was conducted to identify relevant publications on the DDSCOMSs and the constructs. The section also presents how the relations were identified or established using analytical conceptual research. Section 4 then addresses the relations between the nine constructs and the five DDSCOMSs, answering RQ2. Section 5 draws from these relations when establishing the transitive relations between the DDSCOMSs, thus answering RQ3. The answers to the RQs present both direct and transitive (indirect) relations among the DDSCOMSs. These relations and the purpose fulfilment are further discussed in Section 6. Based on these findings, a conceptual transitive DDSCOMS relations model is proposed in Section 7. Section 8 then ends the paper by presenting the theoretical and managerial contributions, discussing the study's limitations and proposing further research, addressing the DDSCOMS relations that are found to be under-studied, for instance.

2. Operationalizing the demand-driven concept

This section starts by operationalizing the demand-driven concept, dividing it into its constituent elements, that is, identifying the concept's fundamental characteristics and the constructs that can be used to operationalize it. The nine identified constructs are then elaborated on and summarized in Table 1, presenting the answers to RQ1. Note that the presentation contains several abbreviations and acronyms. Appendix 1 therefore presents a list of the key abbreviations and acronyms used throughout this paper.

2.1. The demand-driven concept

The demand-driven concept consists of two words, *demand* and *driven*. In this study, demand is either based on, or can be related to, actual customers. However, since the demand-driven concept is of a degree, how and when this demand is used by the demand-driven manufacturing company can differ. Some demand-driven manufacturing companies develop products based on perceived market needs in terms of what to produce and its quality, or produce products based on historical market demand data (Chase, 2013; Neves, 2013). As such, all production and distribution-related activities are based on speculation. However, it could also be that demand is incorporated before production is initiated, giving the ability to adapt products based on actual customer demand, that is, to customize. The driver in this case can be perceived as the impulse or the signal that the customer sends, such as a specific requirement (i.e., customer order). Hence, the demand-driven concept as used here entails that a customer order can drive the flow of material and information, as well as can have some form of uniqueness in terms of variants and customizations. The idea that a customer order can drive the flow begs the question of *when* (i.e., point in time) a customer order penetrates the flow. This implies that a customer order either drives or does not drive the flow of material and information. Meaning that there must be a point in time when a customer order comes into the system and decoupling the flow into two subflows. Complementing the question of when, the answers to the questions of *where* (i.e., place) and *what* (i.e., form) is of interest. These two questions specifically address the level of uniqueness in terms of variants and customizations. In one way or another, all of the five DDSCOMSs address these three questions when aiding supply chain operations managers in designing their flow of material and information.

A theory that is frequently used in studying these three questions, for instance, in terms of the driver and the uniqueness of the material and the information, is decoupling thinking (see, e.g., Hoekstra & Romme, 1992; Sharman, 1984; Wikner, 2014a, 2018). This theory consists of different decoupling points and lead times (i.e., constructs) that specifically address the questions of when a customer order drives the flow of material and information, as well as where and what type of variant or customization that can be made, for instance. This theory also includes various practical managerial tools for analyzing flows, such as a time-phased bill-of-materials (BOM; see, e.g., Bäckstrand, 2012; Wikner, 2014a, 2018). Hence, decoupling thinking and its constructs can possibly be used to operationalize the demand-driven concept and are therefore further discussed hereafter.

2.2. Decoupling thinking

As used in this paper, decoupling thinking concerns two different types of constructs, that is, strategic lead times and strategic decoupling points. A lead time commonly represents '*a span of time required to perform a process*' (Blackstone, 2013, p. 90). The subset of lead times that is of particular interest from a demand or a supply perspective, with significant implications for financial performance, is here referred to as strategic lead times. A key characteristic is that a strategic lead time is based on the boundary of the system and related to the positioning of a strategic decoupling point (Wikner, 2014a, 2018). A strategic decoupling point is then a point where materials are given a unique identifier (e.g., item number or part number), and/or a point that plays a role of critical importance to the interface of the supply system and its context (Wikner & Johansson, 2015).

Decoupling thinking consists of several different constructs. However, for the purpose of this study, only constructs related to driver (forecast vs. customer order) and uniqueness (standardized vs. customized) of flows as well as information transparency (flow observability) is of interest. These constructs are elaborated on hereafter and classified as risk-based, variant-based and information-based. A summary of the constructs are also given in Table 1. For more information on the remaining constructs of decoupling thinking, see Wikner (2014a, 2018).

Moreover, throughout the presentation, the constructs are also exemplified using a time-phased BOM, see Figure 1. The right side of the figure illustrates a fictitious time-phased BOM, based on a traditional BOM (presented on the left side of the figure), which is rotated ninety degrees clockwise (presented horizontally) and where L_i represents the number of time units it takes to perform segment *i*.

2.2.1. Risk-based constructs

The two risk-based strategic lead times are related to the demand-based risk and the amount of speculation required (Wikner, 2015, 2018). The *delivery lead time* (*D*) corresponds to the time from the receipt of a customer order to the time when the customer requested the delivery of the product. The *system lead time* (*S*) is then the cumulative lead time of the complete supply system (Wikner, 2018). *S* can thus be seen as the critical path from the flow source, which is the upstream end of the studied system, to the flow sink, which is the downstream end of the studied system (Sun et al., 2008), see Figure 1. The ratio between these two lead times, called the *D:S* ratio (Wikner, 2014a, 2018), is most critical when $D < S$, that is, the *D:S* ratio is less than one (<1). This means that *D* is shorter than the cumulative lead time of producing the said product. As shown in the example in Figure 1, *S* and *D* equal 12 time units and 6 time units, respectively, for a *D:S* ratio of 1:2. This means that the cumulative lead time for supplying the product is twofold the length of time that the customer requested.

Since *D* corresponds to the customer's requested *D*, the upstream end of *D* is also where a customer order is received and hence where the customer order decoupling point (CODP) is positioned (Bäckstrand & Wikner, 2013; Hoekstra & Romme, 1992; Wikner, 2014a). The CODP is the point that '*separates decisions about initiating flow*

Table 1. The nine constructs of demand driven used in this study.

Constructs	Definitions
Risk-based	
Delivery lead time (*D*)	The time from the receipt of a customer order to the time when the customer requested the delivery of the product
System lead time (*S*)	The cumulative lead time of the complete supply system
Customer order decoupling point (CODP)	Separates decisions about initiating flow based on speculation for future customer orders from commitment against actual customer orders
Variant-based	
Adapt lead time – supply-based (A_S)	The lead time downstream from the point where it is possible to make variants
Adapt lead time – demand-based (A_D)	The lead time downstream from the point where the delivery-unique offering is made
Customer adaptation decoupling point (CADP)	Separates decisions about differentiating flow based on standardization for a market of different customers from adaptation against actual customer orders
Information-based	
Demand information decoupling point (DIDP)	The upstream point from where demand information is constrained
Upstream supply information decoupling point (USIDP)	The point from where supply information is constrained upstream
Downstream supply information decoupling point (DSIDP)	The point from where supply information is constrained downstream

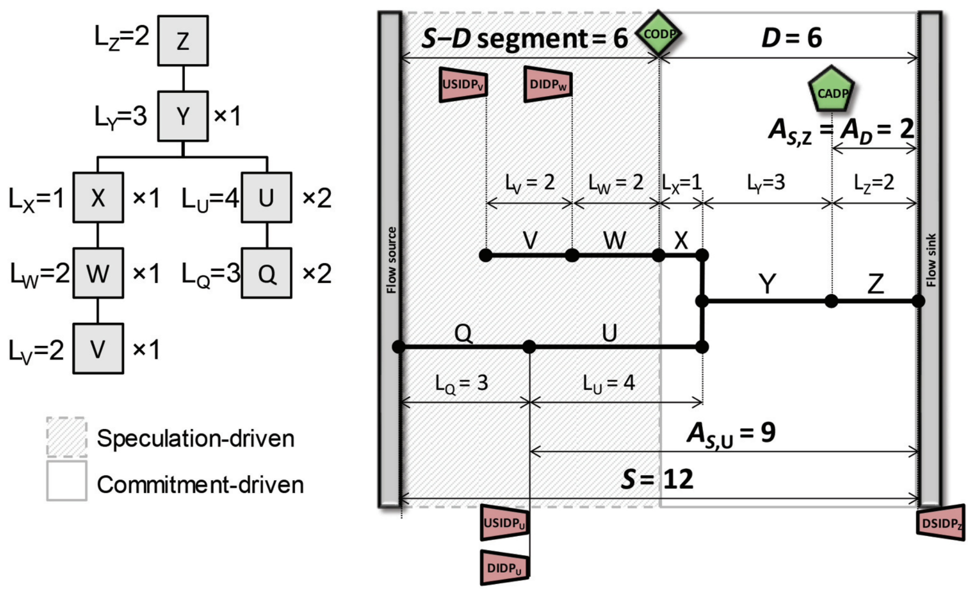

Figure 1. Material-based and time-phased BOM (adapted from Wikner, 2014a, p. 206; 2018, p. 462).

based on speculation for future customer orders from commitment against actual customer orders' (Wikner, 2014a, p. 194). In Figure 1, the CODP is hence positioned at 6 time units, illustrated as a diamond, in line with Wikner's (2014a) representation. This also means that the activities conducted upstream of the CODP (i.e., the *S*–*D* segment) are performed based on forecast, also known as speculation-driven (Wikner, 2015, 2018). Downstream of the CODP (during *D*), the activities are instead performed based on the commitment to customer orders, also known as commitment-driven (Mather, 1988; Wikner, 2015, 2018). The speculation-driven part of the supply system is indicated with a grey dashed outline and light upward diagonal lines in Figure 1, whereas the commitment-driven part is indicated with a grey solid outline.

Furthermore, generally, the CODP coincides with the main buffer point in the flow from which customers are served (Hoekstra & Romme, 1992; Olhager, 2010; Olhager & Wikner, 2000; Sharman, 1984). The activities carried out upstream of the CODP should thus focus on maintaining an optimal mix and inventory levels at the CODP. Since these activities are speculation-driven, they do not need to focus on delivery speed but on efficiency (Olhager, 2003, 2010). Nevertheless, if a customer can accept a D that is as long as or even longer than S, it becomes possible for the supply actor to perform all provisioning activities after its receipt of a customer order (Wikner, 2014a), that is, the S–D segment ≤ 0. From the discussion, the positioning of the CODP is obviously a strategic choice (Olhager, 2003; Wikner & Rudberg, 2005b) and should be based on (1) *customer/market characteristics* (e.g., D requirements, demand volatility, product volumes, product range, customization requirements, customer order size and frequency), (2) *product characteristics* (e.g., modular product design, customization opportunities, product structure, complexity of the BOM, risk of obsolescence or proliferation) and (3) *process/supply chain characteristics* (e.g., length of S, number of planning points, bottleneck position, sequence-dependent resources, supply chain approach, process and equipment flexibility) (see, e.g., Aitken et al., 2005; Hoekstra & Romme, 1992; Olhager, 2003; Sharman, 1984; Van Donk, 2000). As such, the CODP may differ in various contexts, for instance, among different industries, as well as among different products and supply chains in the same company (Hoekstra & Romme, 1992; Olhager, 2003; Sharman, 1984). This is also related to the manufacturing strategy employed (Hallgren & Olhager, 2006; Olhager, 2003, 2010; Vollmann et al., 2005). One of the more known and applied classifications of manufacturing strategies consists of the following four types (Wikner & Rudberg, 2005a, 2005b), as illustrated in Figure 2: make-to-stock (MTS), assemble-to-order (ATO), make-to-order (MTO) and engineer-to-order (ETO; see, e.g., Bozarth & Chapman, 1996; Marucheck & McClelland, 1986; Olhager, 2003; Wikner & Rudberg, 2005a; John Charles Wortmann, 1992). The distinction among these four strategies is the timing of the receipt of a customer order (Marucheck & McClelland,

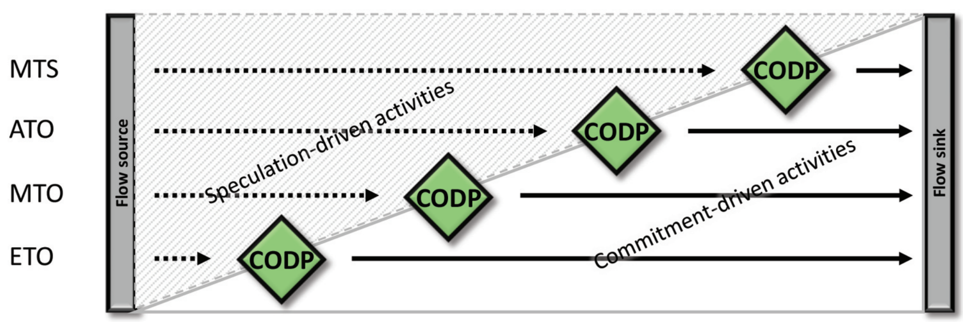

Figure 2. Typical CODP positions within four types of manufacturing strategies (adapted from Hoekstra & Romme, 1992, p. 7; Olhager, Selldin, 2003, p. 320).

1986), that is, the positioning of the CODP. These four types of manufacturing strategies offer a continuum of CODP positionings. MTS and MTO are pure production strategies in the sense that within MTS, the products are produced based on speculation (speculation-driven) and kept in finished stock, awaiting customer orders. Within MTO, the products are in general fully designed, where production starts after a customer order is received (Marucheck & McClelland, 1986; Wemmerlöv, 1984). The ATO strategy can then be described as a compromise or a combination of MTS and MTO (Wikner, 2014a), where the MTS and the MTO strategies are, respectively, applied upstream and downstream of the CODP. As such, ATO can be regarded as a hybrid manufacturing strategy, also known as MTS/MTO (see, e.g., Hemmati & Rabbani, 2010; Rajagopalan, 2002), where major components, subassemblies and/or materials are acquired or manufactured according to the forecast and held in stock, only to be assembled after the receipt of a customer order (Kingsman et al., 1993; Wemmerlöv, 1984). Last but not least, ETO entails that products are designed or engineered according to customer requirements to some degree (Meredith & Akinc, 2007).

However, it is fairly common for a company to apply more than one manufacturing strategy (Sharman, 1984; Soman et al., 2004). Additionally, a product usually consists of many items (Hoekstra & Romme, 1992; Sun et al., 2008), so when looking into the BOM of a product, the CODP may penetrate the physical material flow at different locations. This results in what Sun et al. (2008) call multiple CODPs, for instance, when an individual product or product–market combination generates multiple CODPs (see, e.g., Shidpour et al., 2014; Verdouw et al., 2008).

2.2.2. *Variant-based constructs*

The two variant-based strategic lead times are then related to when demand or supply provides a basis for creating variants based on customer requirements (Wikner, 2015, 2018). *Adapt lead time – supply-based* (A_S) corresponds to the lead time downstream from the point where it is possible to make variants. Thus, there could be multiple A_S in a BOM (Wikner, 2014a), as shown in Figure 1 (see $A_{S,\mathrm{U}}$ and $A_{S,\mathrm{Z}}$). When comparing these A_S with D, it is possible to identify the subset that can be used for delivery-unique offerings. The point of customization that is finally selected is then referred to as the *adapt lead time – demand-based* (A_D), which is the A_S finally selected for the delivery-unique offering (Wikner, 2014a, 2018). This is illustrated in Figure 1, where two potential A_Ss are identified (i.e., $A_{S,\mathrm{U}}$ and $A_{S,\mathrm{Z}}$). However, only $A_{S,\mathrm{Z}}$ is possible for delivery-unique offerings since it is within D; hence, $A_{S,\mathrm{Z}}$ is selected as A_D.

The upstream end of A_D is also where the customer adaptation decoupling point (CADP) is positioned, being the point that '*separates decisions about differentiating flow based on standardization for a market of different customers from adaptation against actual customer orders*' (Wikner, 2014a, p. 196). The properties of the offering upstream of the CADP are hence standardized and downstream delivery unique (Wikner, 2018). Since customizations are made according to customer requirements and the CODP represents the stage where customers may influence the design (Fogliatto et al., 2012), the CADP should coincide with or be located downstream of the CODP for the provider to know what the customer requirements are (Bäckstrand, 2012; Olhager & Östlund, 1990; Squire et al., 2006; Wikner, 2014a, 2018). For the fictitious lead-time-phased BOM presented in Figure 1, two potential points for customizations can be identified – item U and end product Z. This was previously discussed in terms of A_S, were two A_Ss were identified (i.e., $A_{S,U}$ and $A_{S,Z}$). However, as the CADP has to be within D, simply the end product Z is possible to make delivery unique. Thus, the CADP is positioned at 2 time units, where the upstream end of A_D coincides with the CADP (Wikner, 2014a, 2018; Wikner & Bäckstrand, 2018). Nevertheless, if it would be possible to move the CODP upstream, more activities could be commitment-driven (Rudberg & Wikner, 2004; Wikner & Rudberg, 2005a). Hence, by moving the CODP and the CADP upstream simultaneously, the ability to follow the specifications of individual customers increases (Mikkola & Skjøtt-Larsen, 2004; Sharman, 1984). In terms of Figure 1, if D could be extended to 9 time units or more, item U could also be offered as a delivery unique solution, that is, D would be equal to or longer than $A_{S,U}$ and $A_{S;Z}$ (i.e., $D \geq A_{S,U}$ and $A_{S;Z}$). Moving the CODP farther downstream will have the opposite effect, reducing the ability to fulfil individual customers' requests (Yao & Liu, 2009). Similar to the CODP, there may be multiple CADPs, for instance, where a product family can have several CADPs (Garg & Tang, 1997).

2.2.3. Information-based constructs

A key question in supply chain operations management is, according to Van Hoek (2000), how far into the supply chain customer order information is shared, that is, the flow of information is usually decoupled and disconnected at different points in the supply chains, such as between different functions and companies involved. This is related to what Mason-Jones and Towill (1999b) calls the information decoupling point, which is '*the point in the information pipeline to which the marketplace order data penetrates without modification. It is here where market driven and forecast driven information flows meet*' (p. 17). This point can further be seen as the so-called demand mediation decoupling point (Hallgren & Olhager, 2006; Wikner & Wong, 2007), later relabelled as the demand information decoupling point (DIDP) by Wikner (2014a, 2018)) and defined as the point that '*constrains the transparency upstream of demand information*' (Wikner, 2014a, p. 204). The DIDP is thus related to the sharing of available external demand information upstream of the supply chain. Note that the term *information* here only concerns observable information that can be used for decision-making, such as point-of-sale data, customer orders, direct sales, delivery schedules and call-offs (Wikner, 2014a). Such information as real demand (i.e., customer orders) must be available downstream of the CODP; otherwise, it would be impossible to act on customer orders (Hallgren & Olhager, 2006; Wikner, 2014a, 2018). Hence, the DIDP must be positioned at or upstream of the CODP, where the decision domain upstream of the DIDP is estimated demand (i.e., forecast) and where the decision domain downstream is real demand (i.e., customer orders; Wikner, 2018). The farther upstream the flow of the DIDP is positioned, the more pure (undistorted, unbiased and up-to-date) point-of-sale data can be used to improve the speculation-driven part of the flow (Christopher, 2000; Mason-Jones & Towill, 1997, 1999b; Van der Vorst et al., 2001; Wikner et al., 2017). In Figure 1, items V and Q are purchased from one or more suppliers. However, items W and U are internally produced. The positioning of the two DIDPs ($DIDP_W$ and $DIDP_U$) thus indicate that the company has full demand information on product Z, such as point-of-sale data, but does not share the data with its upstream suppliers.

However, demand information is only one type of information, where information related to available capacity and/or usage of capacity is also important (Wikner, 2014a). This is covered by the upstream supply information decoupling point (USIDP) and the downstream supply information decoupling point (DSIDP), both concerning the availability of supply information about available and required capacity. The USIDP and the DSIDP thus represent the points from where real supply information is constrained, either upstream (USIDP) or downstream (DSIDP). As such, the decision domain upstream of the USIDP is estimated supply, and the decision domain downstream is real supply. For the DSIDP, the opposite relation applies, where the decision domain upstream of the DSIDP is real supply, and the decision domain downstream is estimated supply (Wikner, 2018). In Figure 1, all information on available and required capacity is available to the company in focus (i.e., the focal actor), except the supply of item Q. Hence, the DSIDP is positioned at the end of the supply system, at the flow sink in Figure 1, where one of the USIDPs is positioned upstream of item V ($USIDP_V$). However, the second USIDP is positioned downstream of item Q ($USIDP_Q$), in the interface between the supplier and the focal actor.

3. Research design

This study was conducted using a combination of a structured literature review and analytical conceptual research (cf. Wacker, 1998) to identify or logically develop and build relations among the five DDSCOMSs and the constructs of demand driven. Although to some extent, the analytical work was performed in parallel to the literature search, as well as iteratively, this study can be divided into two main parts: the structured literature review part, followed by the analytical conceptual part. Both parts are elaborated on hereafter.

3.1. The structured literature review part

Using the study's purpose as a starting point, the structured literature review was designed around the idea of identifying seminal publications on each DDSCOMS, to understand what they are and how they are used, as well as how these areas of literature have progressed and even been used in combination to understand the relations among them. Published literature reviews, usually condensed overviews of relevant literature (Seuring & Gold, 2012), are excellent in addressing these questions, such as where the DDSCOMSs stem from, what their definitions are, how they have evolved and how they have been used in relation to other research areas or bodies of literature. Based on this logic, the structured literature review was designed as firstly using a protocol-driven method (see Greenhalgh & Peacock, 2005), identifying literature reviews on the DDSCOMSs. This was followed by a reference search method (also known as snowballing), using the identified published literature reviews to find both earlier and more recent publications. In comparison to the process described by Greenhalgh and Peacock (2005), this study neither intends nor claims to be systematic (cf. Tranfield et al., 2003) but structured, that is, arranged and carried out using a predefined procedure, as well as documented in parallel to being conducted.

In the protocol-driven part, published literature reviews on segmentation, leagility, customization, transparency and postponement were sought separately, using the two electronic databases *Thomson Reuters Web of Science* and *Elsevier Scopus*. All the search strings were structured using the same Boolean logic, that is ((<the name of the DDSCOMS> OR <alternative spellings/synonyms>) AND (*review*)). The search strings used in each database can be found in Appendix 2.

The inclusion criteria were as follows: (1) Both 'review' and the name of the DDSCOMS should be mentioned in the abstract, not only as keywords to position the work in a broader research area. (2) The literature review should focus on the DDSCOMS itself, that is, not marginal referenced. (3) The full publication should be retrievable through a download, a purchase or a loan from other universities worldwide, for instance. The abstracts of the literature reviews found through the queries were first screened, and the publications deemed interesting based on the inclusion criteria were read in full. The number of and the specific publications that were finally selected after duplicates were dropped are also presented in Appendix 2. The selected published literature reviews for each DDSCOMS were then summarized in an Excel document, one spreadsheet per DDSCOMS, totalling five spreadsheets. Each spreadsheet included the following codes in this order: 'title of the publication', 'name of the journal/conference/book', 'publication year', 'author(s)', 'definition(s)', 'retrieved from which database', 'type of document', 'date of search', 'interesting publications cited or have been cited by', 'print screens of tables and figures', 'text clippings related to the nine constructs, such as lead time(s) or decoupling point(s)' and relations to decoupling thinking or other DDSCOMSs.

The second part of the structured literature review followed, namely the reference search method. The published literature reviews were then used as starting points for each DDSCOMS, conducting backward reference searches by analyzing and identifying publications in the list of references within the published literature reviews. This course of action, suggested by Greenhalgh and Peacock (2005) and Thomé et al. (2016), enabled seminal publications to be identified. The identified publications and the bibliographic search engine *Google Scholar* also made it possible to conduct forward reference searches, analyzing and identifying publications that cited the seminal publications and as such, how the literature on each DDSCOMS has progressed.

This technique of backward and forward reference searches ensured that books and other types of publications than just journal publications could be included for each DDSCOMS, as books can often be the seminal publications. For these reference searches, the third inclusion criterion was employed once again, that is, the full publication should be retrievable through a download, a purchase or a loan from other universities worldwide, for instance. The reference searches concluded when new publications added nothing or little to existing findings, that is, saturation was reached (Levy & Ellis, 2006; Rumsey, 2008; Thomé et al., 2016). Nevertheless, in seeing that some publications on the DDSCOMSs were highly interlinked, these publications were revisited frequently, underscoring the iterative nature of the process. The different publications on each DDSCOMS that were found using the backward and forward reference search method are summarized in the last column of the table in Appendix 2. Note that several publications have been used for more than just one DDSCOMS, for instance, where publications on postponement can also include customization and vice versa. Hence, some publications listed in Appendix 2 can be found for more than one DDSCOMS (e.g., Aitken et al., 2005; Naylor et al., 1999).

To ensure that the publications were found using backward and forward citation searches, a citation network of the publication sample was established (see Appendix 3). In the network, each publication in the sample is represented by a node, and citations are represented by arcs between nodes. The size of a node is relative to the number of direct citations to the publications in the sample, where larger nodes signify highly cited publications. Showing that each reference has an arc, the figure supports the statement that backward and forward reference searches was used. Similar to the process outlined above, a literature review on the constructs of demand driven (i.e., decoupling thinking) was then conducted (see Appendix 4). This was done to substantiate the relations when answering RQ2 and RQ3, as well as fulfilling the purpose. For these publications, another citation network was established to ensure that these references were also found using backward and forward citation searches (see Appendix 5). A third citation network was also developed by combining all publications in the sample, including the publications on both the five DDSCOMSs and the constructs (see Figure 3 in Section 6). All three citation networks were developed using VOSviewer software, version 1.6.11.0 (van Eck & Waltman, 2019). The publications in the citation network were also clustered based on what they addressed (see the colour legend in Figure 3 in Section 6). The publications addressing more than one DDSCOMS were clustered according to what the publications mainly addressed or contributed to. Books with different editions and volumes were merged and seen as the same references. The same was applied to work-in-progress papers that were later published, where it was possible to discern that the papers in fact were one and the same. However, conference papers that were later published in journals were not treated as the same publication, since these usually are extended versions of the conference paper, including new findings, for instance. The author acknowledges that the citation networks as such are rather subjective but still provide representations of the relations among the DDSCOMSs, as well as decoupling thinking.

3.2. The analytical conceptual part

Parallel to the later parts of the structure literature review, the analytical conceptual work commenced. Here, the Excel spreadsheets, including the codes, were used to identify or establish relations between the constructs and each DDSCOMS. Identifying relations refers to those that are explicitly presented within the publications in the sample, where even the exact or similar wording for the construct is used. In terms of the relations that do not use the same or similar terms for the constructs, the relations had to be built or established through analytical conceptual reasoning (cf. Wacker, 1998). Each DDSCOMS was therefore analyzed and divided into constituent building blocks to understand their underlying meaning. Second, these building blocks or the underlying meanings could be used to logically develop and build the relations. Both the identified and the logically developed relations were then synthesized into narrative summaries. These summaries are presented in Section 5 and used to logically develop the transitive DDSCOMSs' relations, presented in Section 6. The relations presented in Section 4 are also summarised into Table 2, and classified as weak, fair or strong using the following classification criteria:

- Strong = Direct relations are explicitly presented within the publications, where even the exact or similar wording for the construct is used.
- Fair = A mix of direct and indirect relations are somewhat explicitly presented within the publications but does not use the exact or similar wording for the constructs.
- Weak = Relations are not explicitly presented within the publications and does not use exact or similar wording for constructs, indirect relations had to be established.

4. Relations between the constructs and demand-driven supply chain operations management strategies

This section aims to answer RQ 2 by establishing the relations between the constructs and the DDSCOMSs. This is done one DDSCOMS at a time and summarized in Table 2, where each relation is also classified as *weak*, fair or **strong**, using a typographical emphasis, where *italic* font is used for a weak relation, regular font for a fair or intermediate relation and **bold** font for a strong relation.

4.1. Relation between the constructs and segmentation

Segmenting markets based on the similarity of customer preferences was introduced in Smith's (1956) seminal paper (Chatrathi & Zhengyuan, 1995; Godsell et al., 2011; D. D. Harrison & Kjellberg, 2010; Jenkins & McDonald, 1997; Johansen et al., 2012; Kumar et al., 2007; Xu & Coatney, 2015). Smith (1956) states that product differentiation and segmentation are two closely related concepts, meaning that increased product differentiation gives way to segmentation and disaggregation, that is, '*to bring about recognition of several demand schedules where only one was recognized before*' (p. 5). Since then, many different segmentation models have been proposed, where Fisher's (1997) is one of the more well-known (Alicke & Forsting, 2017; Roscoe & Baker, 2014; E. H. E. H. Sabri, 2015). Based on their approaches, most models can be roughly categorized into one of the following three (Alicke & Forsting, 2017): (1) market-driven segmentation, (2) product-driven segmentation or (3) hybrid segmentation (i.e., a combination of market – and product-driven segmentation), for instance, where '*the product-driven segmentation frameworks seek to segment the product range according to different product, demand, and supply characteristics*' (p. 8). Whichever segmentation approach is employed, the supply chain should be designed and aligned with the resulting product segment and/or market segment (Christopher & Towill, 2002; Fisher, 1997; Lee, 2002; Lovell et al., 2005). Here, Aitken et al. (2005), Roscoe and Baker (2014), E. H. E. H. Sabri (2015) and Shaikh et al. (2017) offer segmentation classifications, stating that the segmentation in fact should be based not only on customer and product profiles but also on the channel (i. e., process/supply chain) in order to generate segments with similar requirements, patterns and characteristics, such as service level, product type, inventory cost, demand type and *D* requirements.

The segmentation categories presented above are similar to those given by Hoekstra and Romme (1992) and Olhager (2003) in the decoupling thinking literature. They argue that depending on the market (i.e., customers), product and process/supply chain

Table 2. Relations between the five DDSCOMSs and the constructs of demand driven.

	Decoupling thinking		
	Risk-based constructs *S*, *D* and CODP	Variant-based constructs A_S, A_D and CADP	Information-based constructs DIDP, USIDP and DSIDP
Segmentation	**Segmenting in terms of market, product and process characteristics results in multiple CODPs, where each segment is offered a different *D*, and as such, a different *D:S*ratio. This has implications for the applied manufacturing strategy, where different strategies can be employed for different product/market segments, such as MTS or MTO.**	**The segmentation and the positioning of the CADP will have implications for the CODP and vice versa. As such, the segments may be offered different solutions, resulting in multiple CADPs and different A_Ds.**	*Segmentation results in multiple CODPs and CADPs; thus, when and what type of demand or supply information that is needed may differ among the segments and among the suppliers. As such, there may be multiple DIDPs, USIDPs and DSIDPs when looking into different segments.*
Leagility	**In a leagile flow, the CODP is a pivotal point for combining leanness and agility. The *S–D* segment (lean/efficient flow) should be streamlined to reduce waste and focus on efficiency, where *D* (agile/responsive flow) should be minimized to respond faster to customer demands. The employed manufacturing strategy (e.g., MTS or MTO) will have implications for the need for efficiency and responsiveness, respectively.**	In leagility the CODP combines the lean and agile flows. Since the CODP acts as an upstream boundary for the CADP, as well as the agile flow, the CADP will most likely be situated in the agile flow.	*Demand information is needed at or upstream of the CODP, in order to act on customer requests. The sharing of demand related information upstream of the CODP (preferable throughout the total leagile flow), enables forecasts to be improved, also enabling an efficient flow. Similar, moving the USIDP and the DSIDP farther upstream and downstream, respectively, enables a leagile supply system. In other words, sharing information on available and acquired capacity throughout the supply chain enables actors to produce and distribute their products in a manner that is appropriate for them, that is, either an efficient or a responsive way.*
Customization	The positioning of the CODP will constrain the possible customizations offered. A relatively longer *D* usually implies that a higher degree or level of customization can be offered. This is similar to the idea that an ETO context implies a higher degree of customization abilities compared to an ATO environment.	**The CADP is the point where customization can be offered (similar to a point of differentiation downstream of the CODP), and as such, there could be multiple CADPs in a product family. The positioning of the CADP, and thus the length of the A_D, have implications for the degree of possible customizations offered.**	*Demand information, and thus the DIDP, should be located at or upstream of the CODP, and thus also the CADP, in order for the company to make customizations based on customer orders. Moreover, moving the USIDP upstream and/or the DSIDP downstream may enable other actors of the supply system to make more informed and feasible production and distribution plans, knowing more about the available and needed capacity to carry out customization activities.*

(*Continued*)

Table 2. (Continued).

	Decoupling thinking		
	Risk-based constructs *S*, *D* and CODP	Variant-based constructs A_S, A_D and CADP	Information-based constructs DIDP, USIDP and DSIDP
Transparency	Transparency in terms of real demand needs to be shared at, or preferably, upstream of the CODP and thus, also *D*. Moving the DIDP to the upstream end of the supply system enables better forecast throughout the supply system. The same applies to the USIDP and the DSIDP, where moving them respectively to the upstream end and the downstream end of the supply system enables the whole supply system to make more informed and feasible production and distribution plans, as well as achieve said plans, knowing more about needed and available capacity.	Real demand needs to be shared at, or preferably, upstream of the CODP and thus the CADP. Instead of moving the CADP downstream, the CODP and thus the DIDP can be moved upstream. As such, the transparency in terms of real demand may improve. The same applies to the USIDP and the DSIDP, where moving them respectively to the upstream end and the downstream end of the supply system enables the whole supply system to make more informed and feasible production and distribution plans, knowing more about the available and needed capacity to carry out customization activities.	**The point where demand related information is constrained can be seen as the DIDP, whereas the point where supply-related information is constrained can be seen as the USIDP and the DSIDP, respectively. The DIDP and the USIDP should be moved as far upstream the supply chain as possible, whereas the DSIDP should be moved downstream, as to improve transparency and enable decision making based on real demand or supply information.**
Postponement	**Time postponement is about reducing the *S*—*D* segment to reduce the risk of conducting activities based on speculation, especially the activities related to variants. This can be achieved by (1) prolonging *D* by moving the CODP upstream; (2) reducing *S* without affecting *D*, thus reducing the *S*—*D* segment; (3) repositioning activities, entailing a higher supply risk downstream of the CODP; or (4) even employing a combination of the three.**	**Particularly, activities related to product differentiation entail a higher risk and should therefore be postponed. Form and place postponement thus involve delaying both A_D and A_S, generating new potential CADPs (i.e., potential customization offerings if repositioned downstream of *D*), as well as the downstream movement of the CADPs.**	Postponement is based on the idea of reducing supply risk of carrying out activities on speculation, but also about improving decision making and reduced need for reversibility. Moving the DIDP upstream enabling better decision support and can even reduce need for safety lead times, enabling activities to be postponed. Similar, moving the USIDP upstream and/or the DSIDP downstream may enable the actors in the supply system to make more informed and feasible production and distribution plans. Repositioning the USIDP or the DSIDP can thus reduce the need for safety lead times and enable activities to be postponed, that is, performed later in time, relative to the CODP.

Legend: *weak relation*, fair relation or **strong relation** characteristics, a company needs to determine where the CODP should be positioned for each product–market combination or product group. Hence, by segmenting the market and differentiating and customizing the offerings, the positioning of the optimum CODP may differ among different product-market combinations and/or products (Godsell et al., 2011; Hilletofth, 2009; Hoekstra & Romme, 1992; Shidpour et al., 2014; Thomas, 2012). This established phenomenon is also known as multiple CODPs (see, e.g., Shidpour et al., 2014; Verdouw et al., 2008). The CODP is hence directly related to segmentation, where the positioning of the CODP(s) has an impact on the D that may be offered to the customers (Olhager, 2003). For instance, Aitken et al. (2005) present a practical example of a company that divided its supply chain into different pipelines and grouped its products into different segments, based on the product, market and production characteristics. This resulted in four different pipelines, with different manufacturing strategies: (1) MTS, (2) ATO, (3) MTO/ATO and (4) ETO/MTO approaches. The choice of the manufacturing strategy thus has implications for the positioning of the CODP and thereby the length of D, as well as the D:S ratio, which will differ for different segments (Wikner, 2014a).

Furthermore, as Smith (1956) states, product differentiation and segmentation are two closely related concepts. As product differentiation increases, so does the need for segmentation (Smith, 1956; Su et al., 2005). Hence, the segmentation strategy is also closely related to the CADP, for instance, where the positioning of the CODP constrains the ability to offer customizations (Daaboul et al., 2015; Olhager & Östlund, 1990; Squire et al., 2006) and as such, the length of A_D. Moreover, as segmentation brings about different ways of achieving customizations, this results not only in multiple CODPs but also multiple CADPs and thus, multiple A_Ds.

Finally, depending on where the CODP and/or the CADP are/is positioned, the need for demand information and capacity-related information will differ. In other words, the farther upstream of the supply system the CODP and the CADP are positioned, the farther upstream the DIDP needs to be positioned. As such, the DIDP may vary among different product and market segments. This means that the USIDP and the DSIDP may also differ among various product/supplier and product/market combinations, respectively. Depending on the product or the market segment, suppliers and/or customers may be segmented based on arms-length relations or joint ventures, for instance (Bäckstrand, 2012). For collaborative relations and major customers/suppliers, more information in terms of both demand information and supply-related information may be shared. Suggesting that more demand and supply-related information is shared with suppliers and customers, respectively, results in the DIDP and the USIDP being positioned farther upstream and the DSIDP farther downstream of the supply system. In relation to the discussion on multiple CODPs (Sun et al., 2008), this possibility of the DIDP, USIDP and DSIDP being positioned differently between segments can be seen as multiple DIDPs, USIDPs and DSIDPs, respectively.

4.2. Relation between the constructs and leagility

In the late 1990s and the early 2000s, lean and agile were combined in different ways (Goldsby et al., 2006; Nieuwenhuis & Katsifou, 2015). The most referenced combination is the leagile strategy (Banerjee et al., 2012), introduced by Naylor et al. (1999) as a combination of lean and agile in a total supply chain (also known as end-to-end). Within this DDSCOMS, the CODP has to be positioned to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream (Agarwal et al., 2006; Mason-Jones et al., 2000a; Naylor et al., 1999). As such, Naylor et al. (1999) and most scholars (e.g., Christopher & Towill, 2000; Mason-Jones et al., 2000a, 2000b; Naylor et al., 1999; Prince & Kay, 2003; Van der Vorst et al., 2001; Van Hoek, 2000) use the CODP to define or describe the leagility strategy, emphasizing the CODP importance for the strategy. Hence, the CODP is a pivotal point for the leagility strategy (Virmani et al., 2018), used to create a hybrid flow by linking an efficient flow with a responsive one (Mason-Jones et al., 2000a). Thus, the total flow could even be perceived as a hybrid MTS/MTO supply chain strategy, as described by Hemmati and Rabbani (2010), Rafiei and Rabbani (2011), and Rajagopalan (2002), among others.

Additionally, lead time is important for both an efficient flow and a responsive flow but for two different reasons (Childerhouse & Towill, 2000; Jonsson, 2008; Mason-Jones et al., 2000a). A lean or efficient flow should be used when demand is stable in both volume and variety, volume is high, variety is low and/or efficiency is required (Mason-Jones et al., 2000a; Naylor et al., 1999). Here, *S*, especially the *S*–*D* segment (see Figure 1), should be minimized to reduce waste and excessive time, focusing on efficiency (Childerhouse & Towill, 2000; Christopher & Towill, 2000, 2002; Naylor et al., 1999; Ohno, 1988; Olhager, 2003, 2010), which in turn often leads to better productivity and reduced manufacturing costs (Roscoe & Baker, 2014; Towill, 1996). On the contrary, an agile or responsive flow is more favourable when demand is volatile in both volume and variety, volume is low, variety is high and/or flexibility and availability are required (Christopher & Towill, 2002; Narasimhan et al., 2006; Naylor et al., 1999). Here, in particular, *D* must be minimized to enable a quick response and the exploitation of market demands (Christopher & Towill, 2000, 2001, 2002; S. H. Huang et al., 2002; Mason-Jones et al., 2000a; Olhager, 2003). As such, the CODP acts as a buffer (Childerhouse & Towill, 2000; Naylor et al., 1999) and in terms of position, should correspond to the longest lead time that a customer is willing to wait (Naylor et al., 1999), or the point at which variability in product demand dominates, that is, the point of differentiation (Childerhouse & Towill, 2000; Mason-Jones et al., 2000a; Naylor et al., 1999). The point of differentiation can then be conceptualized as the CADP, as long as it is downstream of *D* (Wikner & Bäckstrand, 2018). Thus, if a CADP is present, this will mostly likely be positioned in the responsive agile part of the flow, at or downstream of the CODP (Bäckstrand, 2012; Naylor et al., 1999; Olhager & Östlund, 1990; Squire et al., 2006; Wikner, 2014a, 2018).

Furthermore, the positioning of the CODP in terms of the need for a efficient flow (lean) versus a responsive one (agile) will also result in the DIDP being positioned accordingly. In other words, since customer orders must be available downstream of the CODP (Hallgren & Olhager, 2006; Wikner, 2014a, 2018), the CODP positioning will either be hampered by the timing of shared demand information, in terms of real demand, or result in real demand having to be shared earlier and farther upstream in the supply system. Whether the first or the second scenario occurs, the farther upstream of the flow the DIDP is positioned, the more pure point-of-sale data can be used to improve the speculation-driven part of the flow (Hedenstierna & Ng, 2011; Mason-Jones & Towill, 1997, 1999b; Van der Vorst et al., 2001; Wikner et al., 2017). Thus, by sharing demand-related information farther upstream of the CODP (within the *S*–*D* segment), preferably throughout the total supply chain, forecasts can be improved, enabling efficient flows (Childerhouse & Towill, 2000; Christopher & Towill, 2000, 2002; Naylor et al., 1999; Ohno, 1988; Olhager, 2003, 2010). The sharing of supply information, such as available and required capacity, with suppliers upstream and customers downstream, will then enable the supply system to adhere to the need for efficiency or responsiveness. In other words, by knowing in advance what is required by the different actors in the supply system, necessary plans and procedures can be set up to ensure that materials and products are produced and distributed in an appropriate manner, either efficient or responsive. As such, the positioning of the USIDP and the DSIDP farther upstream and downstream, respectively, will enable a leagile supply system.

4.3. Relation between the constructs and customization

The word *customize* means *'to build, fit, or alter according to individual specifications'* (Merriam-Webster Dictionary, 2020). Consequently, customization could vary, ranging from a simple modification of a standard product all the way to a complete delivery unique and bespoke (one of a kind) product (see, e.g., Alford et al., 2000; Coronado et al., 2004; Davis, 1989; Gilmore & Pine, 1997; Lampel & Mintzberg, 1996; Ross, 1996; Sharma, 1987; Da Silveira et al., 2001). Whether a modification or a complete bespoke product, the point where the customization is made has been referred to as the *point of differentiation* (e.g., Childerhouse & Towill, 2000; Garg & Tang, 1997; Tang, 2006), *differentiation point* (Wikner & Wong, 2007; Wong et al., 2009), *point of product differentiation* (e.g., Childerhouse & Towill, 2000; García-Dastugue & Lambert, 2007; Mason-Jones & Towill, 1999b; Naylor et al., 1999; Nieuwenhuis & Katsifou, 2015) and *product differentiation point* (Daaboul & Da Cunha, 2014; Daaboul et al., 2015). To keep the discussion general, not only to focus on products, the term used in this paper is *point of differentiation.*

The point of differentiation can, according to Wikner and Bäckstrand (2018), be conceptualized as the CADP, as long as it is positioned at or downstream of the CODP. The CADP will therefore be used interchangeably with the point of differentiation if positioned downstream of the CODP. Since products can be differentiated in diverse ways, multiple CADPs can exist in a product family (Daaboul & Da Cunha, 2014; Daaboul et al., 2015; Garg & Tang, 1997; Yang & Burns, 2003). Deciding on the point of customer involvement (the CODP position) is crucial because of its constraints on the ability to make customizations (Daaboul et al., 2015; Mikkola & Skjøtt-Larsen, 2004; Olhager & Östlund, 1990; Squire et al., 2006; Wikner, 2014a, 2018). The farther downstream the CODP is positioned, the shorter *D* is and the less possible CADP positionings there are. As such, it could be said that the location of the CADP is a key indicator of the degree or the type of customization provided (Duray et al., 2000; Ogawa & Piller, 2006). The farther downstream the CADP is positioned in the production process or the supply chain, the more constrained the customization options become (Wikner, 2014a, 2018; Yao & Liu, 2009). For example, if positioned at the design and fabrication stage, similar to an ETO context, a product can be highly customized. However, if positioned at the assembly stage, similar to an ATO context, the customization ability is constrained by the product's component sizes and interfaces, for instance

(Squire et al., 2006). In other words, using Lampel and Mintzberg (1996) typology, *pure standardization* leaves no room for customization, whereas *pure customization* means that delivery-unique requirements can be met (Dekkers, 2006; Duray, 2002; Mikkola & Skjøtt-Larsen, 2004). Pure customization involves significant competitive benefits through the ability to produce delivery-unique products but at high operational costs. On the contrary, pure standardization allows shorter *D* and large economies of scale but offers customers no scope for customization (Coronado et al., 2004; Da Silveira et al., 2001; Squire et al., 2006). According to Da Silveira et al. (2001) and Ramdas (2003), the right degree or level of customization, and thus the positioning of the CADP, depend on customer requirements and a company's existing operational capabilities. Daaboul et al. (2015) then state that the best customization strategy is one where both the CODP and the CADP are considered simultaneously. Furthermore, McCarthy (2004) states that firms' contextual factors have implications for the customization strategy and the CADP positioning, such as the product volume/variety ratio, the complexity and the value of the product complexity, the point or the degree of customer involvement (the CODP) and the type of product modularity offered. These factors can be condensed into market, product and process characteristics, similar to the characteristics that should be considered when positioning the CODP (see Hoekstra & Romme, 1992; Olhager, 2003; Sharman, 1984).

As discussed beforehand, the CADP also needs to be positioned at or downstream of the CODP, whereas the DIDP and real demand need to be at or upstream of the CODP (Bäckstrand, 2012; Olhager & Östlund, 1990; Squire et al., 2006; Wikner, 2014a, 2018). Hence, the point where a customization is made (the CADP) also constrains the positioning of the CODP, acting as a downstream end point for feasible CODP positioning, as well as DIDP positioning. In other words, to know what customization to make, the information must first be mediated to the one making the customization. However, to ensure that customization can be made on time, the transparency of supply-related information is also important (Barratt & Barratt, 2011; Barratt & Oke, 2007; Kaipia & Hartiala, 2006; Lee & Whang, 2000). Moving the USIDP upstream and/or the DSIDP downstream may enable other actors of the supply system to make more informed and feasible production and distribution plans, knowing more about the available and needed capacity for carrying out the customization activities, as well as increasing the possibility of keeping established production and distribution plans.

4.4. Relation between the constructs and transparency

The idea behind the transparency strategy is that delivery performance and supply chain efficiency, among others, can be improved if better decision support can be obtained. This should be achieved through the sharing of high-quality demand and supply-related information among actors in the supply chain (Barratt & Barratt, 2011; Barratt & Oke, 2007; Christopher & Lee, 2004; Lee & Whang, 2000; A. N. Zhang et al., 2011). However, throughout the supply chain, it is fairly common for one member to lack detailed demand and supply-related information on other parts of the supply chain (Christopher & Lee, 2004). As such, the flow of supply and demand information is decoupled among different functions and actors in the supply chain. The decoupling of demand information could be perceived as what Wikner (2014a, 2018) labels the DIDP, that is, the point at which demand information transparency is constrained. Demand-related information could include point-of-sale data, actual sales data, demand forecasts, customer inventory levels and customer promotional plans (Christopher & Lee, 2004; Williams et al., 2013). By means of acting on customer orders downstream of the CODP, the DIDP is required to be positioned at or upstream of the CODP (Hallgren & Olhager, 2006; Wikner, 2014a, 2018). Preferably, the DIDP should be positioned as far upstream of the supply chain as possible, enabling decision-makers to improve the speculation-driven part of the flow (Christopher, 2000; Mason-Jones & Towill, 1997, 1999b; Van der Vorst et al., 2001; Wikner et al., 2017). For instance, the farther upstream of the supply system that point-of-sale data (one type of demand information) is distributed, the more actors can act on 'real' demand (Kiely, 1998; Mason-Jones & Towill, 1997, 1999b; Somapa et al., 2018; Towill et al., 1992; A. N. Zhang et al., 2011). In turn, this could aid in moderating the bullwhip effect (Forrester, 1958; Lee et al., 1997a, 1997b, 2004), for instance.

However, to improve the match between supply and demand, the transparency of supply-related information is also important (Barratt & Barratt, 2011; Barratt & Oke, 2007; Kaipia & Hartiala, 2006; Lee & Whang, 2000). This information could contain supplier inventory levels, work-in-process, supplier lead times, delivery dates, available capacity, required capacity, production plans, order status and distribution network inventory levels (Christopher & Lee, 2004; Williams et al., 2013). This type of information is related to the USIDP and the DSIDP. At the USIDP, estimated supply is transitioned into information on real supply. The opposite then applies to the DSIDP, where information on real supply is decoupled and transitioned into estimated supply (Wikner, 2018).

4.5. Relation between the constructs and postponement

Most authors define postponement as a strategy to intentionally delay activities, such as logistics, production, purchasing and design, until customer orders are received (Bowersox & Closs, 1996; Pagh & Cooper, 1998; Van Hoek, 1998a, 2000; Yang & Burns, 2003; Yang et al., 2005a; Zinn & Bowersox, 1988). In other words, some activities should not be initiated based on speculation and incomplete information but delayed until a customer order is received (Van Hoek, 2001; H.-J. H.-J. Wang et al., 2003; Yang et al., 2005a), leading to improved decision-making and reduced need for reversibility. This is also called time postponement, where the time at which a company commits to a decision can be delayed (Aitken et al., 2005; Van Hoek et al., 1998). Hence, time postponement is about reducing the S–D segment, which is related to the risk of performing activities based on speculation. In fact, according to Bucklin (1965), García-Dastugue and Lambert (2007), and Pagh and Cooper (1998), postponement is only half a concept, with speculation being the other half or its converse. Speculation is thus about conducting activities as early as possible to gain economies of scale, that is, based on forecast rather than on commitment to a customer. As such, the CODP plays a vital role in the postponement and speculation strategy.

However, time postponement is only one type of postponement, whereas form postponement is about delaying the final configuration, manufacturing, assembly or packaging of the product, and place postponement is the delay in the geographical dispersal of the product (Aitken et al., 2005; Van Hoek et al., 1998). As such, postponement is arguably also related to the CADP, where form and place postponement are about delaying the point of differentiation in terms of variety, mix and movement. In fact, one of the more acknowledged form postponement typologies was developed by Forza et al. (2008). This typology uses the customer order entry point (also known as the CODP) as the base for describing how form postponement can be achieved. One way to do so is by extending *D* and thus repositioning the CODP upstream of a point of differentiation, rendering it a potential CADP. Another means of achieving the said form postponement is to delay the CADP or even to employ a combination of moving the CODP upstream and the CADP downstream.

Postponement is also known as *delayed product differentiation* (Aviv & Federgruen, 1999, 2001; Blackburn et al., 2004; Garg & Lee, 1999; Gupta & Benjaafar, 2004; Lee & Tang, 1997; Swaminathan & Lee, 2003), *delayed differentiation* (Christopher, 1998a) and *late customization* (Garg & Lee, 1999; Swaminathan & Lee, 2003), where some definitions of postponement even include the words 'delay in configuration' and/or 'customization' (Christopher, 2000; Christopher & Towill, 2000; Kim, 2014; Van Hoek, 2001). These authors argue that the point of differentiation should be delayed until or after the CODP. In doing so, the point of differentiation renders itself a possible customization option, that is, a possible CADP, where A_S becomes a possible A_D. Some authors even state that the point of differentiation should be delayed as long as possible (Alderson, 1950; Aviv & Federgruen, 2001; Lee & Tang, 1997; Yang et al., 2004a, 2004b). From this perspective, the CADP should be postponed as far downstream as possible, thus increasing customer responsiveness. In other words, if A_D can be reduced, it is also possible that the CODP can be shifted downstream, resulting in reduced *D* (Daaboul et al., 2015; Olhager & Östlund, 1990; Squire et al., 2006). However, note that in reality, there is a likelihood of having more than one point of differentiation in a BOM or a flow (Aviv & Federgruen, 1999; Garg & Tang, 1997; Swaminathan & Lee, 2003), similar to multiple CODPs (see, e.g., Shidpour et al., 2014; Sun et al., 2008). This could be regarded as multiple CADPs if positioned downstream of the CODP.

Postponement is also highly related to demand information and the DIDP, where the idea behind postponing different activities in the supply chain is to improve decision-making and reduce the need for reversibility (Yang et al., 2005a). Thus, postponement is not only about reducing the *S*–*D* segment but also minimizing the supply risk. This can be done by increasing the sharing of demand-related information throughout the supply system. As such, the demand information can enable better decision support by moving the DIDP upstream, for instance. Postponement or the postponing of an activity can also be done by reducing the safety lead times introduced in the system. The sharing of demand information is one such way of enabling safety lead time reduction. However, supply-related information is also important. Moving the USIDP upstream and/or the DSIDP downstream may enable the actors in the supply system to make more informed and feasible production and distribution plans, reducing the need for safety lead times, for instance. As such, activities can be postponed simply by reducing uncertainties in the supply system (Barratt & Barratt, 2011; Barratt & Oke, 2007; Christopher & Lee, 2004; Lee & Whang, 2000; A. N. Zhang et al., 2011).

5. Transitive relations between the demand-driven supply chain operations management strategies

The established relations between the constructs and the DDSCOMSs in Section 4 are here used to answer RQ3 – *What are the transitive relations between the DDSCOMSs based on the constructs?* With the five DDSCOMSs, ten unique dyadic relations may be identified, not considering their reverse dyadic relation. Table 3 presents these ten dyadic relations, as well as the numbers indicating the order in which the relations are presented.

1. **Segmentation and leagility**: Arguably, the segmentation strategy provides a platform for flow analysis and may be used for segmenting the market based on the type of product (e.g., standard versus customized), customer demand (e.g., order winner and order qualifiers) or the process (e.g., efficient versus responsive; Fuller et al., 1993; Hilletofth, 2009). Segmenting based on market, product and process characteristics thus results in multiple CODPs and CADPs being positioned accordingly (Sun et al., 2008; Verdouw et al., 2008), where each segment is offered different Ds and A_Ds. The need for and combination of efficient (lean) and responsive (agile) flows will then differ among segments. The leagility strategy specifically addresses this need and the balancing act by properly combining efficient and responsive flows, that is, combining lean and agile flows in a total supply chain using the CODP (Mason-Jones et al., 2000a; Naylor et al., 1999). Leagility thus supports the segmentation strategy in balancing each segment's need for efficiency and responsiveness based on the market needs and the product characteristics (Hilletofth, 2012).

2. **Segmentation and customization**: Segmentation and product differentiation are two closely related concepts where increased product differentiation gives way to segmentation (Smith, 1956; Su et al., 2005). However, only the product differentiations that are conducted based on actual customer orders (commitment-driven) can by definition, be customizations (Squire et al., 2006; Wikner, 2014a). As discussed earlier, segmentation is said to result in multiple CODPs and CADPs, where each segment is offered different Ds and A_Ds based on the market needs and the product characteristics. Each product–market combination and CODP positioning will thus have implications for the positioning of potential CADPs and the length of the A_D. Using the segmentation and customization strategy in combination thus enables companies to differentiate their customization offerings for heterogeneous customer–market segments, providing various types of customizations and levels of uniqueness (Akinc & Meredith, 2015; Spring & Dalrymple, 2000).

3. **Segmentation and transparency**: The need for and the level of transparency within the different segments may differ. The different CODP positions mean that demand-related information, for instance, in terms of real demand, needs to be known at or upstream of the respective CODPs and thus the CADP (Hallgren & Olhager, 2006;

Table 3. Dyadic relations between the five DDSCOMSs.

	Segmentation	Leagility	Customization	Transparency	Postponement
Segmentation					
Leagility	1				
Customization	2	5			
Transparency	3	6	8		
Postponement	4	7	9	10	

Wikner, 2014a, 2018). In other words, the DIDP may differ among the segments. The same applies to supply-related information, where a higher form of transparency may be needed for different types of market and product combinations, resulting in multiple USIDPs and DSIDPs. The transparency strategy thus supports the segmentation strategy, enabling better decision support, by answering the questions of when and what type of information should be shared in different segments and with different suppliers (i.e., positioning of DIDPs, USIDPs and DSIDPs), as well as what benefits are provided by doing so.

4. **Segmentation and postponement**: Segmenting in terms of market, product and process characteristics results in multiple CODPs and CADPs, where each segment is offered different Ds and A_Ds. Time postponement is then about reducing the risk of conducting activities based on speculation, where form and place postponement are especially related to the delay in activities concerning variants and customizations. Through postponement, activities that entail a higher supply risk can thus be repositioned farther downstream of the supply system, for instance. Postponement can thus be used to delay when a variant or customization is obtained in time, giving the ability to offer more of standardized D and A_D for more segments. Postponement may thus be used to reduce the number of segments and the complexity entailed by more segments.

5. **Leagility and customization**: The CODP is used in leagility to balance the need for an efficient flow (lean) with a responsive one (agile). Since the CODP acts as an upstream boundary for the CADP, it needs to be in the agile part of the flow. Thus, the farther downstream the CODP is positioned, the farther downstream the CADP needs to be positioned, constraining the customization options that may be offered (Wikner, 2014a, 2018; Yao & Liu, 2009).

6. **Leagility and transparency**: Transparency enables a leagile flow, where demand-related information is needed at or upstream of the CODP. The sharing of demand-related information upstream of the CODP enables forecasts to be improved, supporting an efficient flow upstream of the CODP. Furthermore, being transparent and sharing supply-related information on available and required capacity throughout the supply system enable actors to produce and distribute their products in an appropriate manner for them, either efficiently or responsively.

7. **Leagility and postponement**: In a leagile flow, the point that separates lean and agile flows is the CODP. This is also the point where the speculation-driven flow transitions to being commitment-driven. Time postponement is then mostly viewed as a strategy for delaying activities until customer orders are received (see, e.g., Bowersox & Closs, 1996; Pagh & Cooper, 1998; Van Hoek, 2001; Yang & Burns, 2003; Zinn & Bowersox, 1988; etc.). Thus, postponement can be used to reduce the lean part of the leagile flow (the S–D segment). However, form and place postponement are also known as late customization (Garg & Lee, 1999; Swaminathan & Lee, 2003), where the point of differentiation should be delayed until or during the agile part of the flow, rendering it a possible CADP.

8. **Customization and transparency**: In sharing more demand and supply-related information, actors within the supply system can make more informed and feasible production and distribution plans. Transparency thus helps in knowing more when and what type of customizations are demanded and what capacity is available and needed for carrying out these customization activities, for instance. Transparency consequently

supports the customization strategy, where the DIDP should preferably be positioned as far upstream as possible (Mason-Jones & Towill, 1997, 1999b; Van der Vorst et al., 2001). The USIDP and the DSIDP should then preferably be, respectively, positioned as far upstream and downstream of the supply system as possible, enabling decision-making based on real supply information.

9. **Customization and postponement**: The point at which customization is made is called the CADP, similar to the point of differentiation if positioned downstream of the CODP. Time postponement is then about reducing the risk of conducting activities based on speculation, upstream of the CODP, where form and place postponement are especially related to the delay in the activities associated with variants and customizations. By postponing the CODP and/or reducing the length of A_S, more customization offerings may be possible, that is, if the upstream end of an A_S is repositioned downstream of the CODP, it renders itself a possible CADP. For instance, see Figure 1, where it is also possible to offer item U as a customization if $A_{S,\mathrm{U}}$ is reduced by 3 time units or the CODP is repositioned 3 time units upstream.

10. **Transparency and postponement**: Similar to the transparency strategy, the postponement strategy also involves improving decision-making (Van Hoek, 2001; Yang et al., 2005a) by reducing the risk of carrying out activities based on speculation (Pagh & Cooper, 1998; Van Hoek, 2000, 2001; Yang & Yang, 2010; Zinn, 2019), particularly activities related to differentiation (Aviv & Federgruen, 1999, 2001). As such, the different types of postponement are about reducing the S–D segment and/or delaying the CADP in the supply chain. In achieving postponement by moving the CODP farther upstream, the DIDP may also need to be moved, resulting in a higher level of transparency and allowing better decision support. Furthermore, moving the USIDP upstream and/or the DSIDP downstream may enable the actors within the supply system to make more informed and feasible production and distribution plans, thus reducing the need for safety lead times and enabling activities to be postponed. Both strategies thus emphasize the need for improved decision support although focusing on different types of flows, that is, the flow of material and the flow of information.

6. Discussion

The purpose of this study is *'to explore the relations among the DDSCOMSs'*. In fulfilling this purpose, the study has both identified direct relations among the DDSCOMSs and established transitive relations. Here, direct relations refer to relations between or among two or more DDSCOMSs that are explicitly presented in the publications identified in the structured literature review. The transitive relations have been established using the constructs and their relations to the DDSCOMSs. In other words, if a relation exists between one DDSCOMS (e.g., segmentation) and a construct (e.g., the CODP), as well as between the same construct and a second DDSCOMS (e.g., the CODP and leagility), then a relation also exists between the first and the second DDSCOMSs (e.g., between segmentation and leagility). It means that through the constructs, transitive relations between the DDSCOMSs could be established. These direct and transitive relations are discussed hereafter, starting with the direct relations.

In the literature, leagility is sometimes referred to as a segmentation model in itself, where products are segmented in terms of their need for a lean or an agile supply chain

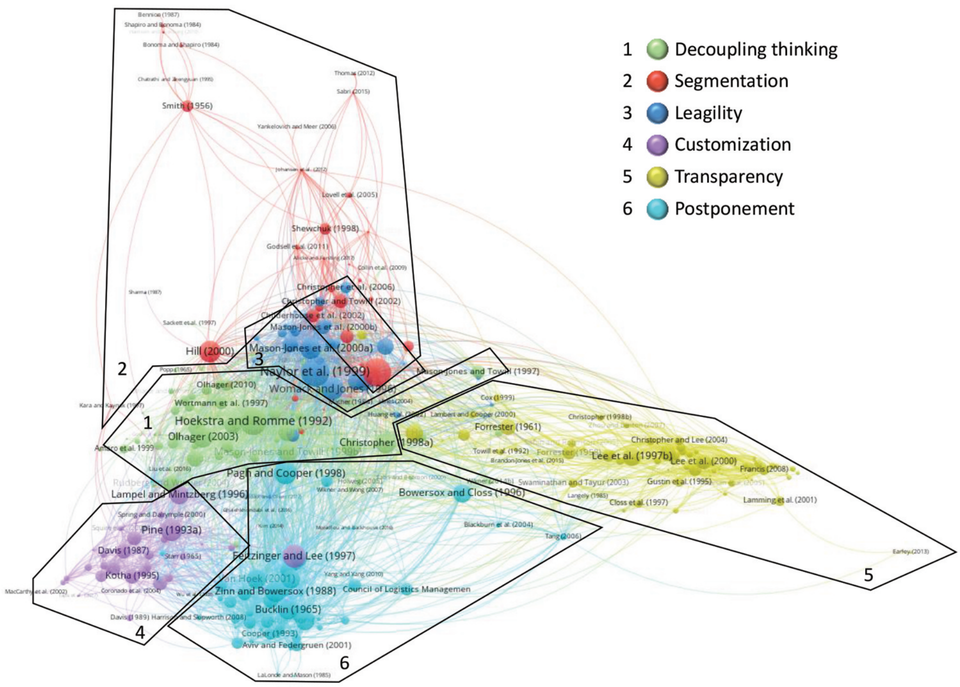

Figure 3. Citation network on the 339 publications in the sample.

(see, e.g., Hilletoft, 2012). The publications on segmentation and leagility are even closely related in terms of how they cite each other. By studying the citation networks in Figure 3, it is possible to see that segmentation and leagility publication clusters in the sample are probably the two closest ones, adjacent or even overlapping (Note that Figure 3 offers the reader lines around the six cluster centres, containing the majority of references within each cluster. For the same figure without the lines, please see Appendix 6). However, note that the terms efficiency and responsiveness are sometimes used in this discussion, instead of lean and agile. In fact, leagility, postponement and customization, especially mass customization, all appear to combine the two fundamental and mutually exclusive concepts of efficiency/leanness and responsiveness/agility (Mahdavi & Olsen, 2017). Further, leagility and postponement is also found to have a direct relation, where postponement is a way of realising leagility, postponing certain activities until customer orders are received (Christopher & Towill, 2001; Stavrulaki & Davis, 2010).

Another direct relation is found between segmentation and customization, where people's demands to express their individuality have resulted in companies customizing their products for smaller customer groups or segments (MacCarthy et al., 2002; McCarthy, 2004; Su et al., 2005). This relation can also be seen in Table 4, which offers a summary of publications (1) on the direct relation between two DDSCOMSs (the intersections between them) or (2) on the DDSCOMSs themselves (the diagonal intersections where each DDSCOMS intersects itself). Note that the number of publications on each DDSCOMS or the dyadic relation between them are presented in each

Table 4. Seminal and progressive publications on the DDSCOMSs and their relations.

Segmentation	86 – (Fisher, 1997; Fuller et al., 1993; Smith, 1956)				
Leagility	5 – (Aitken et al., 2003; Hilletofth, 2012; Johansen et al., 2012)	67 – (Mason-Jones et al., 2000a; Naim & Gosling, 2011; Naylor et al., 1999)			
Customization	28 – (Fogliatto & da Silveira, 2008; Kara & Kaynak, 1997; McCarthy, 2004)	12 – (Childerhouse & Towill, 2000; Christopher & Towill, 2000; Naylor et al., 1999)	194 – (Davis, 1987; Lampel & Mintzberg, 1996; Pine, 1993a)		
Transparency	**2 –(Aitken et al., 2005; Roscoe & Baker, 2014)**	**2 – (Mason-Jones et al., 2000a; Naylor et al., 1999)**	7 – (Christopher & Towill, 2000; Mason-Jones & Towill, 1999b; Tang, 2006)	147 – (Barratt & Oke, 2007; Caridi et al., 2010a; Lamming et al., 2001)	
Postponement	7 – (Alderson, 1950; Alicke & Forsting, 2017; Yang & Burns, 2003)	15 – (Christopher & Towill, 2001; Hilletofth, 2012; Stavrulaki & Davis, 2010)	79 – (Feitzinger & Lee, 1997; Garg & Tang, 1997; Mikkola & Skjøtt-Larsen, 2004)	8 – (Lee & Whang, 2000; Mason-Jones & Towill, 1999b; Van Hoek, 1998a)	139 – (Alderson, 1950; Bucklin, 1965; Zinn & Bowersox, 1988)

intersection, followed by up to three publications. These publications are either perceived as seminal or those that have contributed to the progression of the DDSCOMSs. Most of the publications on the DDSCOMSs themselves can also be found in the citation network as the larger nodes (see Figure 3).

Returning to the relation between segmentation and customization, 28 out of 339 publications in the sample discuss the relation between the two DDSCOMSs (see Table 4). A relation between postponement and transparency can also be found. Although the first strategy is more related to physical flows and the delay in speculation-driven activities, both strategies are about reducing supply risk and based on the logic that decision-making can be improved by utilizing real demand information. However, the most discussed direct relation between the DDSCOMSs is probably the one between postponement and customization, particularly mass customization (see Christopher & Towill, 2000; Feitzinger & Lee, 1997; Ferreira et al., 2018; Holweg, 2005; Lee, 1998; Pine, 1993a; Van Hoek, 2001; H.-J. H.-J. Wang et al., 2003; Yang et al., 2004b). Different authors argue that postponement is a way of offering mass customization, where activities related to product differentiation are postponed so that it is possible to conduct the activities when customer orders are received. This close relation between customization and postponement can also be observed in the citation networks in Figure 3, where the two clusters are adjacent, even overlapping in some references (e.g., Feitzinger & Lee, 1997; Salvador et al., 2002; Swaminathan, 2001). This relation can also be found in Table 4, being the most well-documented relation within the sample, where 79 publications out of the 139 publications on postponement and 194 publications on customization addressed the relation between the two DDSCOMSs.

However, two of the intersections do only include two publications (Table 4); these are (1) transparency and segmentation, and (2) transparency and leagility. Since these findings are not based on a systematic literature review, the lack of publications in these intersections does not necessarily mean that there are no more publications. Nevertheless, this still gives an indication that the relation is not that strong and/or that it is an under-researched area. For instance, both intersections where only two publications can be found in the sample are on the transparency strategy. In fact, four of the six intersections where ten or less publication is presented are on relations to the transparency strategy (see Table 4).

One probable cause for this phenomenon is that the segmentation, leagility, customization and postponement strategies are more related to physical material flows, whereas the transparency strategy is more related to the flow of information. This phenomenon is also acknowledged in Figure 3, where it is possible to observe that the transparency publication cluster is more fragmented and separate from the other DDSCOMSs and decoupling thinking. The predominant transparency references in Figure 3, and the ones closest to the other DDSCOMSs and decoupling thinking clusters, are the publications on the bullwhip effect (see, e.g., Forrester, 1961; Lee et al., 1997b). This physical material flow-related phenomenon, caused by the lack of demand-related information, further illustrates that the main relation between transparency and the other DDSCOMSs exists when a phenomenon in the material flow is caused by either adequate or inadequate information sharing, for instance. This is also noticeable in Table 2, where the relations between the three information-related decoupling points (DIDP, USIDP and DSIDP) and the DDSCOMSs are considered weak or fair, except for the transparency strategy, which is considered strong. Obviously, demand information is needed at or upstream of the CODP and the CADP in order for demand-driven manufacturing companies to act on customer orders and cater to any potential customer need for uniqueness. However, the DIDP, the USIDP and the DSIDP are about the availability of information, whereas the actual use of information is related to the CODP and the CADP. As such, the relations between the transparency strategy and the other four DDSCOMSs are rather established through their transitive relations, through their relations to the DIDP, the CODP and the CADP.

Returning to Table 4, three of the six intersections where ten or less publications can be found in the sample are related to the segmentation strategy. These are (1) leagility and segmentation, (2) transparency and segmentation, and (3) postponement and segmentation. Here as well, the constructs helped in establishing transitive relations to the DDSCOMSs, not found through the direct relations. For instance, in Figure 3, it is possible to discern a pattern related to the authors of the more predominant publications on the segmentation strategy that are also closest to the other DDSCOMSs and decoupling thinking. For instance, the authors of the publications Aitken et al. (2005), Childerhouse et al. (2002), Christopher and Towill (2000, 2002), Godsell et al. (2011) and some of their frequent recurring co-authors have also written publications on the information decoupling point (also known as the DIDP), the CODP (constructs within decoupling thinking), the bullwhip effect (presented in the transparency strategy) and the leagility strategy, among others (see, e.g., Childerhouse & Towill, 2000; Christopher & Lee, 2004; Disney & Towill, 2003a, 2003b; Mason-Jones et al., 2000a, 2000b; Mason-Jones & Towill, 1997, 1998, 1999a, 1999b; Naylor et al., 1999; Towill & Christopher, 2002, 2007; Wikner et al., 1991). As such, two sub-clusters are noticeable within the segmentation cluster, partially explaining the scattered and extracted segmentation cluster shown in Figure 3. The first sub-cluster consists of publications in the business and marketing management literature. The second sub-cluster of publications is closely related to the decoupling thinking, leagility and transparency clusters. Using the CODP and the DIDP, the publications in the latter sub-cluster strengthen the relations between the segmentation strategy, on one hand, and the transparency strategy and the leagility strategy, on the other hand. Both addressing the two intersections in Table 4 where only to publications were found. In other words, in discussing segmentation from the perspective of multiple CODPs, a transitive relation to leagility is established, where the CODP is the point that combines the lean and the agile flows into a leagile flow (Naylor et al., 1999). Likewise, through the relation between the CODP and the DIDP, it is possible to discern the relations between the segmentation and the transparency strategies, as well as between the leagility and transparency strategy, such as when and what demand-related information is needed within each segment or within the lean or agile part of the leagile flow. The

Table 5. Seminal and progressive publications on decoupling thinking and its relations to the DDSCOMSs.

	Decoupling thinking
Decoupling thinking	179 – (Hoekstra & Romme, 1992; Sharman, 1984; Wikner, 2018)
Segmentation	17 – (Hallgren & Olhager, 2006; Hilletofth, 2009, Hilletofth, 2012)
Leagility	54 – (Naylor et al., 1999; Nieuwenhuis & Katsifou, 2015; Towill & Christopher, 2007)
Customization	78 – (Dekkers, 2006; Mikkola & Skjøtt-Larsen, 2004; Rudberg & Wikner, 2004)
Transparency	27 – (Mason-Jones & Towill, 1997, Mason-Jones & Towill, 1999b; Hallgren & Olhager, 2006)
Postponement	64 – (Forza et al., 2008; Van Hoek, 2001; Yang & Burns, 2003)

transparency strategy thus supports the segmentation strategy, and leagility strategy in enabling better decision support (Barratt & Barratt, 2011; Barratt & Oke, 2007; Christopher & Lee, 2004; Lee & Whang, 2000; A. N. Zhang et al., 2011). Moreover, in comparing Table 4 with Table 5, it is obvious that the transitive relation between segmentation and transparency also offers more publications. Specifically, there are less publications on the direct relation between segmentation and transparency than on the relations between decoupling thinking and segmentation and between decoupling thinking and transparency. Note that Table 5, similar to Table 4, presents the number of publications on decoupling thinking or the dyadic relation between it and each DDSCOMS, followed by three publications perceived as seminal or progressive publications.

7. Proposing a conceptual model

Overall, the decoupling thinking constructs have proven to be useful for enhancing the relations among the different DDSCOMSs and as such, have also helped in increasing the understanding of how they can be combined. The idea of using decoupling thinking and its constructs for operationalizing the term demand-driven and establishing the relations with the DDSCOMSs is also somewhat supported by Figure 3. In this figure, the decoupling thinking cluster is positioned as a midpoint, surrounded by the other DDSCOMS publication clusters. In removing the decoupling thinking publications, a void between the other DDSCOMSs is somewhat formed (Compare Figure 3 with Appendix 3).

As stated before, the structured literature review only offers a limited number of direct relations among the DDSCOMSs. However, using the nine constructs and transitivity, the relations between all DDSCOMSs and the nine constructs and thus between DDSCOMS pairs could be established, although some are considered weak. This approach further facilitates the ability to include more DDSCOMSs if identified in the future. In such a case, exploring the relation between each DDSCOMS pair is not required. Instead, each identified DDSCOMS may be incorporated into the already established relations simply by establishing a relation between the constructs and the additional DDSCOMS. Figure 4 presents a conceptual model, illustrating these transitive relations between the DDSCOMS pair, where the set of constructs

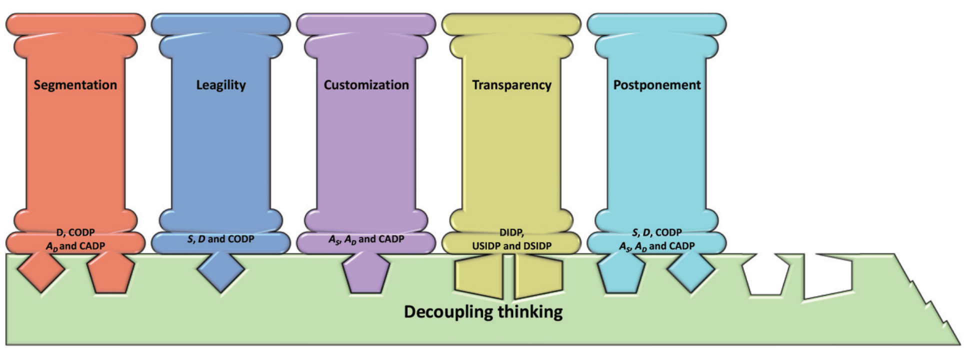

Figure 4. The conceptual transitive DDSCOMS relations model.

(found within decoupling thinking) acts as a foundation on which it is possible to combine or 'piece in' the DDSCOMS relations. The 'missing' column on the extreme right of Figure 4 and the jagged end of the foundation are meant to illustrate the idea that it is possible to 'piece in' other DDSCOMSs if identified in the future. However, note that the model does not include the direct relations between the DDSCOMSs but focuses on the transitive relations.

The existing columns in Figure 4 represent the literature on each DDSCOMS. Within each column, the constructs that are found to have a strong relation to that DDSCOMS (see Table 2) are also presented. Furthermore, the element (elements) fixing the column to the foundation correspond (corresponds) to the strategic decoupling point (points) to which the DDSCOMS has a strong relation and use (uses) the shape (shapes) in which the strategic decoupling point (points) is (are) illustrated in Figure 1. For instance, the leagility strategy specifically addresses the balancing of efficiency and responsiveness through the positioning of the CODP, where the efficient part and the responsive part correspond to the *S*–*D* segment and *D*, respectively. Hence, in the leagility column in Figure 4, the three constructs *S*, *D* and CODP are presented, and the fixing element is shaped as a diamond, representing the CODP. The literature on each DDSCOMS then offers support in terms of describing what the strategy is, as well as when, where and how it should be used. Despite being good in describing the effects of using each DDSCOMS, the literature does not necessarily present the DDSCOMSs' ramifications for one another, that is, a change made to the supply system, based on one DDSCOMS, will in many circumstances have implications for one or more of the other DDSCOMSs. Here, the constructs and the existing relations between them can assist in nuancing this complex and dynamic relation, for instance, by displaying the effects of different decisions on operational performance. For example, the customization strategy is excellent in describing where and how customizations can be made. In turn, the postponement strategy is outstanding in presenting how and what activities should be postponed. Using the time-phased BOM tool (see, e.g., Figure 1), the customization and the postponement strategies can be combined with the constructs, especially A_S, A_D and CADP. This offers the possibility to see the effects of a postponed customization option on the other strategic decoupling points and strategic lead times, such as the CODP and *D*. For example, does delaying an activity result in (1) a reduced *S*–*D* segment and thus less activities being speculation-driven, (2) a new customization option offered (a new potential CADP) and/or (3) the ability to offer customers shorter *D* by repositioning the CODP farther downstream? As such, it could be argued that this study supports supply chain operations managers in understanding not only the strength of each DDSCOMS but also how they can be combined when establishing supply chain fit.

8. Theoretical and managerial contributions, limitations and further research

This study has explored the relations among DDSCOMSs, identifying direct relations, as well as developed transitive relations through the operationalization of the demand-driven concept. In doing so, the study combines and extends existing knowledge on

DDSCOMSs and constructs within decoupling thinking in several important ways. The three main theoretical contributions are primarily related to the RQs and the study's purpose:

First, the study operationalizes the term demand-driven using recognized constructs within decoupling thinking (e.g., Hoekstra & Romme, 1992; Olhager, 2003; Wikner, 2014a). In establishing the relations between the constructs and five commonly used DDSCOMSs, this research contributes to the knowledge on decoupling thinking by clarifying the relations between decoupling thinking and the DDSCOMSs, substantiating the work of Wikner (2014b), among others.

Second, a rather extensive structured literature review was conducted to answer RQ2. The answer and the discussion, including the citation network of 339 publications, offer other researchers a summary of seminal and progressive publications about each DDSCOMS, as well as decoupling thinking.

Third, the study identifies a limited number of direct relations among the DDSCOMSs. However, in using the operationalized constructs of demand driven and transitivity, the relations between all DDSCOMS pairs could be established. The study thus enriches the existing literature by reinforcing and clarifying both direct and transitive relations among and between the DDSCOMSs.

The main managerial contributions are then related to the two questions stated in the problematization in the introduction section: (1) What are DDSCOMSs, and when should they be used? (2) What are the relations among them? This study first offers managers a descriptive summary of DDSCOMSs and how they are meant to be used. Second, this study clarifies the relations among and between the DDSCOMSs. By utilizing the established relations between the constructs and the DDSCOMSs, a time-phased BOM can be used as a practical tool for illustrating and nuancing the complexity of when, how and why the DDSCOMSs can be combined, displaying the effects of different decisions on operational performance.

The results of the structured literature review have some limitations, but also offer opportunities for further research. The identified direct relations and the transitive DDSCOMS relations model offers a plethora of leads for further research. First, the relations between the five DDSCOMSs and the constructs merely outline a common ground or building blocks. To increase the managerial contribution, the knowledge from this study could be operationalized into a practical method for operations and supply chain managers to use in establishing and maintaining supply chain fit.

Second, this study has focused on demand and supply transparency. However, during the structured literature review, the concept of 'traceability visibility' emerged, that is, transparency in terms of the origins of raw materials and working conditions, such as human and environment-related conditions. This type of transparency would be interesting to study using other constructs, such as the moral decoupling point (see Eriksson & Svensson, 2016). Where in the supply chain do firms decouple their moral responsibility? Furthermore, Lamming et al. (2001) discuss transparency as more of a continuum, where information can be translucent and only partial information is shared. As such, transparency could be studied using the decoupling zone construct, introduced by Wikner and Rudberg (2005b), for instance, in terms of a demand information decoupling zone or upstream and downstream supply information decoupling zone (see, e.g., Wikner, 2018, pp. 452–453).

Third, it could be worthwhile to follow up and explicitly research on the two DDSCOMS relations that are found to be under-studied, that is, the intersections where only two publications can be found in the sample (bold font in Table 4).

Last but not least, although purposely designed this way, the structured literature review offers little in terms of replicability. The search terms used are by no means exhaustive, where a different set could have yielded a different sample. However, the use of backward and forward reference searches somewhat mitigates the risk of excluding important work on each DDSCOMS and decoupling thinking. This approach has facilitated the inclusion of seminal and progressive publications on the DDSCOMSs and decoupling thinking. Nevertheless, the chosen DDSCOMSs and the constructs are not claimed to be exhaustive. Further research could identify other DDSCOMSs, as well as include more constructs. In fact, the approach used in this study and the design of the transitive DDSCOMS relations model facilitate the ability to include or 'piece in' more DDSCOMSs in the future. This is illustrated by the 'missing' column and the jagged end of the foundation in Figure 4.

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Appendix 1. Some key abbreviations and acronyms used in the text

A_D	Adapt lead time – demand based
A_S	Adapt lead time – supply-based
ATO	Assemble-to-order
BOM	Bill-of-materials
CADP	Customer adaptation decoupling point
CODP	Customer order decoupling point
D	Delivery lead time
DDSCOMS	Demand-driven supply chain operations management strategies
DIDP	Demand information decoupling point
DSIDP	Downstream supply information decoupling point
ETO	Engineer-to-order
MTO	Make-to-order
MTS	Make-to-stock
RQ	Research question
S	System lead time
USIDP	Upstream supply information decoupling point

Appendix 2. Search strings and resulting publications on the DDSCOMSs

DDSCOMS	Database	Search string	Resulting literature reviews	Duplicates	Results from backward and forward reference searches
Segmentation	Scopus Web of Science	TITLE-ABS-KEY (segmentation AND *review* AND 'supply chain') AND (LIMIT-TO (LANGUAGE, 'English')) TOPIC: (segmentation AND *review* AND 'supply chain') AND LANGUAGE: (ENGLISH)	30 results, 4 selected (Hilletofth, 2012; Rezaei & Ortt, 2012; Roscoe & Baker, 2014; E. H. E. H. Sabri, 2015) 20 results, 2 selected (Hilletofth, 2012; Rezaei & Ortt, 2012)	2 duplicates (Hilletofth, 2012; Rezaei & Ortt, 2012) = 4 in total	(Aitken et al., 2005; Aitken et al., 2003; Alicke & Forsting, 2017; Bennion, 1987; Berry et al., 1995; Bonoma & Shapiro, 1984; Chatrathi & Zhengyuan, 1995; Childerhouse et al., 2002; Christopher & Towill, 2000, Childerhouse et al., 2002; D'Alessandro & Baveja, 2000; Fisher, 1997; Fuller et al., 1993; Godsell et al., 2011; Hallgren & Olhager, 2006; D. D. Harrison & Kjellberg, 2010; A. Hill & Hill, 2009; T. Hill, 2000; Hilletofth, 2009; Huiskonen et al., 2003; Jenkins & McDonald, 1997; Johansen et al., 2012; Kara & Kaynak, 1997; Kraljic, 1983; Kumar et al., 2007; Lee, 2002; Lovell et al., 2005; MacCarthy et al., 2002; McCarthy, 2004; Naylor et al., 1999; Ogawa & Piller, 2006; Olsen & Ellram, 1997; Perez, 2013; Sebastiao & Golicic, 2008; Shaikh et al., 2017; Shapiro & Bonoma, 1984; Shewchuk, 1998; Smith, 1956; Su et al., 2005; Thomas, 2012; Towill & Christopher, 2002; Van der Veeken & Rutten, 1998; Xu & Coatney, 2015; Yang & Burns, 2003; Yankelovich & Meer, 2006)
Leagility	Scopus Web of Science	TITLE-ABS-KEY (leagile OR leagility) AND *review*) AND (LIMIT-TO (LANGUAGE, 'English')) TOPIC: ((leagile OR leagility) AND *review*) AND LANGUAGE: (ENGLISH)	17 results, 5 selected (Banerjee et al., 2012; Mahdavi & Olsen, 2017; Naim & Gosling, 2011; Nieuwenhuis & Katsifou, 2015; Virmani et al., 2018) 69 results, 5 selected (Ambe & Badenhorst-Weiss, 2011; Banerjee et al., 2012; Naim & Gosling, 2011; Nieuwenhuis & Katsifou, 2015; Stavrulaki & Davis, 2010)	3 duplicates (Banerjee et al., 2012; Naim & Gosling, 2011; Nieuwenhuis & Katsifou, 2015) = 7 in total	(Agarwal et al., 2006; Aitken et al., 2002; Aravind et al., 2018; Bruce et al., 2004; Childerhouse & Towill, 2000; Chopra & Meindl, 2013; Christopher, 2000; Christopher et al., 2006; Christopher & Towill, 2000, Christopher & Towill, 2001, Christopher & Towill, 2002; Dekkers, 2006; Droge et al., 2004; Goldsby et al., 2006; Hallgren & Olhager, 2009; Tony. Hines, 2004; S. H. Huang et al., 2002; Hull, 2005; Jonsson, 2008; Krishnamurthy & Yauch, 2007; Mason-Jones et al., 2000a, Mason-Jones et al., 2000b; Naim & Barlow, 2003; Narasimhan et al., 2006; Naylor et al., 1999; Ohno, 1988; Ponticelli et al., 2013; Prince & Kay, 2003; Purvis et al., 2014; Stratton & Warburton, 2003; Towill & Christopher, 2002, Towill & Christopher, 2007; Van der Vorst et al., 2001; Van Hoek, 2000; Womack & Jones, 1996)

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DDSCOMS	Database	Search string	Resulting literature reviews	Duplicates	Results from backward and forward reference searches
Customization	Scopus Web of Science	TITLE-ABS-KEY ((customization OR customisation) AND *review*) AND (LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, 'SOCI')) AND (LIMIT-TO (LANGUAGE, 'English')) TOPIC: ((customization OR customisation) AND *review*) Refined by: WEB OF SCIENCE CATEGORIES: (ENGINEERING MANUFACTURING OR ENGINEERING INDUSTRIAL OR MANAGEMENT OR OPERATIONS RESEARCH MANAGEMENT SCIENCE) AND LANGUAGE: (ENGLISH)	595 results, 9 selected (Akinc & Meredith, 2015; Coronado et al., 2004; Da Silveira et al., 2001; Dekkers, 2006; Fogliatto et al., 2012; Kumar et al., 2007; MacCarthy et al., 2003; McCarthy, 2004; Spring & Dalrymple, 2000) 242 results, 7 selected (Buffington, 2011; Da Silveira et al., 2001; Dekkers, 2006; Fogliatto et al., 2012; Kumar et al., 2007; McCarthy, 2004; Taps et al., 2017)	5 duplicates (Da Silveira et al., 2001; Dekkers, 2006; Fogliatto et al., 2012; Kumar et al., 2007; McCarthy, 2004) = 11 in total	(Alford et al., 2000; Childerhouse & Towill, 2000; Daaboul et al., 2015; Daaboul & Da Cunha, 2014; Davis, 1987, Davis, 1989; Duray, 2002; Duray et al., 2000; Ernst & Kamrad, 2000; Feitzinger & Lee, 1997; Fogliatto & da Silveira, 2008; García-Dastugue & Lambert, 2007; Garg & Tang, 1997; Gilmore & Pine, 1997; Haug et al., 2009; Kara & Kaynak, 1997; Kotha, 1995; Lampel & Mintzberg, 1996; MacCarthy et al., 2002; Mahdavi & Olsen, 2017; Mason-Jones & Towill, 1999b; Mason & Lalwani, 2008; Mikkola & Skjøtt-Larsen, 2004; Naylor et al., 1999; Nieuwenhuis & Katsifou, 2015; Ogawa & Piller, 2006; Pine, 1993a, Pine, 1993b; Pine et al., 1993; Ramdas, 2003; Ross, 1996; Sharma, 1987; Spira, 1993; Squire et al., 2006; Starr, 1965; Su et al., 2005; Swaminathan, 2001; Tang, 2006; Towill & Christopher, 2007; Tu et al., 2001; Van Hoek, 2001; Van Hoek et al., 1999; Yang & Burns, 2003; Yang et al., 2004b; Yankelovich & Meer, 2006; Åhlström & Westbrook, 1999)
Transparency	Scopus Web of Science	TITLE-ABS-KEY((transparency OR visibility) AND '*review*' AND 'supply chain') AND (LIMIT-TO (LANGUAGE, 'English')) TOPIC: ((transparency OR visibility) AND *review* AND 'supply chain') AND LANGUAGE: (ENGLISH)	39 result, 5 selected (Caridi et al., 2010b; Caridi et al., 2013; Goh et al., 2009; Kaipia & Hartiala, 2006; Somapa et al., 2018) 33 results, 2 selected (Goh et al., 2009; Somapa et al., 2018)	2 duplicates (Goh et al., 2009; Somapa et al., 2018) = 5 in total	(Aitken et al., 2005; Aviv, 2001; Barratt & Barratt, 2011; Barratt & Oke, 2007; Bartlett et al., 2007; Bradley, 2002; Brandon-Jones et al., 2015; Busse et al., 2017; Caridi et al., 2010a; Caridi et al., 2014; Caridi et al., 2017; Carter & Easton, 2011; Carter & Rogers, 2008; Chen et al., 1999; Christopher, 1998a, Christopher, 1998b; Christopher & Lee, 2004; Christopher & Towill, 2000; Closs et al., 1997; Cox, 1999; Croson & Donohue, 2003; Disney & Towill, 2003a, Disney & Towill, 2003b; Earley, 2013; Forrester, 1958, Forrester, 1961, Forrester, 1997; Francis, 2008; Gustin et al., 1995; Hultman & Axelsson, 2007; Introna, 1991; Kiely, 1998; Klueber & O'Keefe,2013 ; Lambert & Cooper, 2000; Lamming et al., 2001; Langley, 1985; Lee et al., 1997a, Lee et al., 1997b, Lee et al., 2004; Lee et al., 2000; Lee & Whang, 2000; Jingquan Li et al., 2001; Mahadevan, 2010; Mason-Jones & Towill, 1997, Mason-Jones & Towill, 1998, Mason-Jones & Towill, 1999a, Mason-Jones & Towill, 1999b; Mentzer et al., 2001; Mohr & Sohi, 1995; Morgan et al., 2018; Ouyang, 2007; Papert et al., 2016; Parry et al., 2016; Petersen et al., 2005; Ringsberg, 2014; Sahin & Robinson, 2005; Småros et al., 2003; Stalk & Hout, 1990; Steinfield et al., 2011; Sterman, 1989, Sterman, 1992; Storey et al., 2006; Swaminathan & Tayur, 2003; Towill, 1991; Towill et al., 1992; Trienekens et al., 2012; Tse & Tan, 2012; Wei & Wang, 2010; Whipple et al., 2002; Wikner et al., 1991; Vilko et al., 2012; Williams et al., 2013; Vitasek, 2013; A. N. Zhang et al., 2011; H. Zhou & Benton, 2007; L. Zhou et al., 2010)

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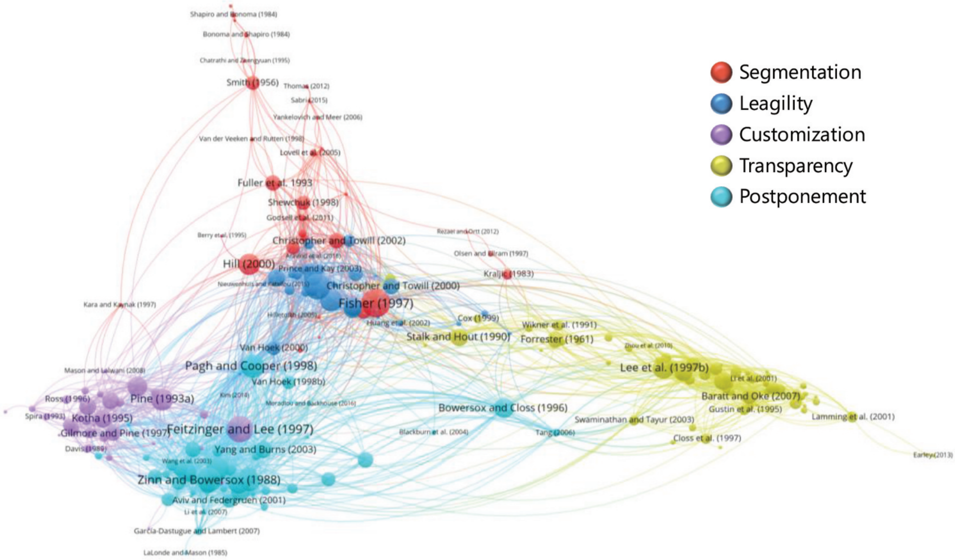
(Continued).

DDSCOMS	Database	Search string	Resulting literature reviews	Duplicates	Results from backward and forward reference searches
Postponement	Scopus	TITLE-ABS-KEY ((postponement) AND *review*) AND (EXCLUDE (SUBJAREA, "MEDI") OR EXCLUDE (SUBJAREA, "BIOC")) AND (LIMIT-TO (LANGUAGE, 'English'))	126 results, 11 selected (Boone et al., 2007; Ferreira et al., 2018; Ferreira et al., 2015; Kim, 2014; Van Hoek, 2001; H.-J. H.-J. Wang et al., 2003; Yang et al., 2004b, Yang et al., 2005a, Yang et al., 2005b; Yang & Yang, 2010; Yang et al., 2007)	7 duplicates (Ferreira et al., 2015; Van Hoek, 2001; Yang et al., 2004b, Yang et al., 2005a, Yang et al., 2005b; Yang & Yang, 2010; Yang et al., 2007) = 12 in total	(Aitken et al., 2005; Alderson, 1950; Aviv & Federgruen, 1999, Aviv & Federgruen, 2001; Blackburn et al., 2004; Bowersox & Closs, 1996; Bucklin, 1965; Can, 2008; Cannas et al., 2018; Childerhouse & Towill, 2000; Christopher, 1998a, Christopher, 2000; Christopher & Towill, 2000, Christopher & Towill, 2001; Cooper, 1993; Council of Logistics Management, 1995; Ernst & Kamrad, 2000; Feitzinger & Lee, 1997; Forza et al., 2008; García-Dastugue & Lambert, 2007; Garg & Lee, 1999; Garg & Tang, 1997; Gonçalves et al., 2007; Gupta & Benjaafar, 2004; A. A. Harrison & Skipworth, 2008; Haug et al., 2009; Holweg, 2005; Y.-Y. Huang & Li, 2008; LaLonde & Mason, 1985; Lampel & Mintzberg, 1996; Lee, 1998; Lee et al., 1993; Lee & Tang, 1997; Jian Li et al., 2007; Mahdavi & Olsen, 2017; Mason-Jones & Towill, 1999b; Mikkola & Skjøtt-Larsen, 2004; Moradlou & Backhouse, 2016; Naylor et al., 1999; Nieuwenhuis & Katsifou, 2015; Ogawa & Piller, 2006; Pagh & Cooper, 1998; Pine, 1993a; Salvador et al., 2002; Stavrulaki & Davis, 2010; Su et al., 2005; Swaminathan & Lee, 2003; Swaminathan & Tayur, 1998; Trentin & Forza, 2010; Waller et al., 2000; Van Hoek, 1998a, Van Hoek, 1998b, Van Hoek, 2000; Van Hoek et al., 1998; Van Hoek et al., 1999; Wikner & Wong, 2007; Wong et al., 2009; Yang & Burns, 2003; Yang et al., 2004a; Yang et al., 2010; C. Zhang & Tan, 2001; Zinn, 2019; Zinn & Bowersox, 1988)
	Web of Science	TOPIC: ((postponement) AND *review*) LANGUAGE: (ENGLISH)	202 results, 8 selected (Ferreira et al., 2015; Tang, 2006; Van Hoek, 2001; Yang et al., 2004b, Yang et al., 2005a, Yang et al., 2005b; Yang & Yang, 2010; Yang et al., 2007)		

Appendix 3.

Citation network on the 246 DDSCOMS publications in the sample

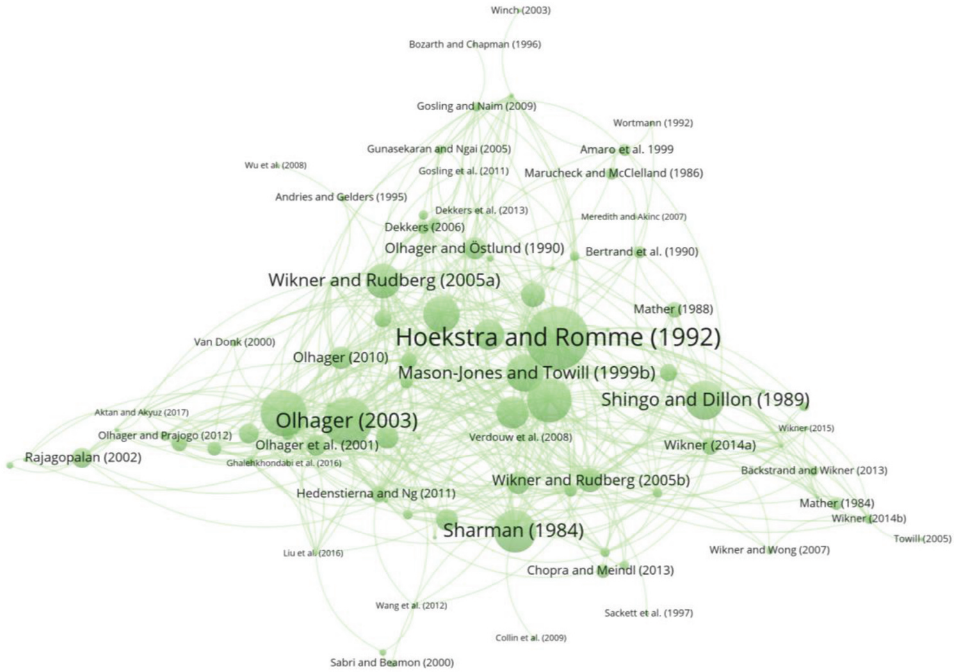


Appendix 4. Search strings and resulting publications on decoupling thinking

DDSCOMS	Database	Search string	Resulting literature reviews	Duplicates	Results from backward and forward reference searches
Decoupling thinking	Scopus	TITLE-ABS-KEY(('order penetration point' OR 'decoupling point') AND *review*) AND (LIMIT-TO (LANGUAGE, 'English'))	15 results, 4 selected (Banerjee et al., 2012; Ceryno et al., 2013; Naim & Gosling, 2011; Serrano et al., 2009)	3 duplicates (Banerjee et al., 2012; Naim & Gosling, 2011; Serrano et al., 2009) = 6 in total	(Aitken et al., 2005; Aktan & Akyuz, 2017; Amaro et al., 1999; Andries & Gelders, 1995; Berry & Hill, 1992; Bertrand et al., 1990; Bozarth & Chapman, 1996; Bäckstrand, 2012; Bäckstrand & Wikner, 2013; Chopra & Meindl, 2013; Christopher, 1998a, Christopher & Towill, 2000; Christopher & Towill, 2000; Collin et al., 2009; Debreu, 1987; Dekkers, 2006; Dekkers & Sopers, 2001; Van der Vlist et al., 1997; Van Donk, 2000, Van Donk, 2001; Van Donk & van Doorne, 2016; Fogliatto et al., 2012; Forza et al., 2008; García-Dastugue & Lambert, 2007; Garg & Tang, 1997; Ghalehkhondabi et al., 2016; Giesberts & van der Tang, 1992; Gosling et al., 2011; Gosling & Naim, 2009; Gosling et al., 2014; Gunasekaran & Ngai, 2005; Gupta & Benjaafar, 2004; Hallgren & Olhager, 2006; Hedenstierna & Ng, 2011; Hemmati & Rabbani, 2010; T. Hill, 2000; Hilletofth, 2009; P. Hines & Rich, 1997; Hoekstra & Romme, 1992; Hofmann & Knébel, 2013; Holweg, 2005; Hvam et al., 2008; Kim et al., 2012; Kingsman et al., 1993; Kisperska-Moroñ, 2003; Liu et al., 2016; Marucheck & McClelland, 1986; Mason-Jones et al., 2000a, Mason-Jones et al., 2000b; Mason-Jones & Towill, 1997, Mason-Jones & Towill, 1999a, Mason-Jones & Towill, 1999b; Mason & Lalwani, 2008; Mather, 1984, Mather, 1988, Mather, 1999; Meredith & Akinc, 2007; Mishra et al., 2017; Naylor et al., 1999; Nieuwenhuis & Katsifou, 2015; Olhager, 2003, Olhager, 2010; Olhager & Prajogo, 2012; Olhager et al., 2001; Olhager et al., 2006; Olhager & Wikner, 2000; Olhager & Östlund, 1990; Pagh & Cooper, 1998; Perez, 2013; Popp, 1965; Porter et al., 1999; Rafiei & Rabbani, 2011; Rajagopalan, 2002; Rudberg & Wikner, 2002, Rudberg & Wikner, 2004; E. H. Sabri & Beamon, 2000; Sackett et al., 1997; Sharman, 1984; Shingo & Dillon, 1989; Soman et al., 2004; Squire et al., 2006; Sun et al., 2008; Towill, 2005; Van der Vorst et al., 2001; Van Hoek, 2000; Y. Y. Wang et al., 2012; Wemmerlöv, 1984; Verdouw et al., 2008; Wikner, 2014a, Wikner, 2014b, 2015, 2018; Wikner & Bäckstrand, 2018; Wikner et al., 2015; Wikner & Johansson, 2015; Wikner et al., 2009; Wikner et al., 2007; Wikner et al., 2017; Wikner & Rudberg, 2005a, Wikner & Rudberg, 2005b; Wikner & Wong, 2007; Winch, 2003; Vollmann et al., 2005; John Charles Wortmann, 1992; Johan Casper Wortmann et al., 1997; Wu et al., 2008; Yang & Burns, 2003; Yao & Liu, 2009; Zaerpour et al., 2009)
	Web of Science	TOPIC: (('order penetration point' OR 'decoupling point') AND *review*) AND LANGUAGE: (ENGLISH)	23 results, 5 selected (Banerjee et al., 2012; Dekkers et al., 2013; Naim & Gosling, 2011; Saeed et al., 2016; Serrano et al., 2009)		

Appendix 5

Citation network on the 93 decoupling thinking publications in the sample



Appendix 6

Citation network on the 339 publications in the sample, without outlining the clusters using lines as markers