Procurement's role in resolving demand–supply imbalances: an information processing theory perspective

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Procurement's role in resolving demand–supply imbalances: an information processing theory perspective

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Abstract

Purpose – Drawing on information processing theory, the linkage between buffering and bridging and the ability on the part of procurement to resolve demand–supply imbalances is investigated, as well as contexts in which these strategies may be particularly useful or detrimental. Buffering may be achieved through demand change or redundancy, while bridging may be achieved by the means of collaboration or monitoring.

Design/methodology/approach – This study employs a hierarchical regression analysis of a survey of 150 Finnish and Swedish procurement and sales and operations planning professionals, each responding from the perspective of their own area of supply responsibility.

Findings – Both the demand change and redundancy varieties of buffering are associated with procurement's ability to resolve demand–supply imbalances without delivery disruptions, but not with cost-efficient resolution. Bridging is associated with the cost-efficient resolution of imbalances: while collaboration offers benefits, monitoring seems to make things worse. Dynamism diminishes, while the co-management of procurement in S&OP improves procurement's ability to resolve demand–supply imbalances. The most potent strategy for tackling problematic contexts appears to be buffering via demand change.

Practical implications – The results highlight the importance of procurement in the S&OP process and suggest tactical measures that can be taken to resolve and reduce the effects of supply and demand imbalances.

Originality/value – The results contribute to the procurement and S&OP literature by increasing knowledge regarding the role and integration of procurement to the crucial process of balancing demand and supply operations.

Keywords Sales and operations planning, Procurement, Information processing theory, Buffering, Bridging

Paper type Research paper

Introduction

In order to deliver value to their customers by the means of operations and supply chains, manufacturing firms seek to balance demand and supply through cross-functional planning (Ivert and Jonsson, 2014). The effectiveness of this *sales and operations planning* (S&OP) process is dependent on how good the quality of the inputs to the process are and the extent to which the decision-making is internally and externally co-managed (Wagner and Eggert,

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2016; Stank *et al.*, 2012). Demand planning contributes with forecasts, whereas operations planning contributes by providing up-to-date capacity information regarding constrained resources. However, the effectiveness of operations planning is very much dependent on the involvement of procurement, which represents the thousands of parts and materials being used in a manufacturing company. These are provided by external suppliers with constraints and uncertainties of their own. The role of procurement in effective S&OP has been further emphasised in the temporal context of this research, in which many manufacturing organisations have been subjected to unprecedented supply chain challenges. These challenges have been, to large extent, driven and aggravated by the COVID-19 pandemic and other major shifts in trade policies and geopolitics (e.g. Handfield *et al.*, 2020). Indeed, there have been reports of significant increases in demand (King *et al.*, 2021) and the persistent scarcity of critical components, such as semiconductor chips (Shepardson, 2022). In such a dynamic environment, a firm, with procurement being a key contributing function, may encounter *demand–supply imbalances*, i.e. situations in which forecasted demand exceeds projected supply capacity or *vice versa* (surplus; e.g. Githens, 2009).

Due to the prominence of shortages in the current operating context and because it is imperative for procurement to support the high-performing corporate dual strategy of revenue expansion and cost reduction (Mittal *et al.*, 2005), imbalances of the shortage type challenge procurement the most, particularly in its typical savings-incentivised environment (Deloitte, 2021). On one hand, the total ramifications of supply shortages may go well beyond the losses in short-term sales (Hendricks *et al.*, 2020), while on the other, providing high service levels is costly and capital intensive in uncertain environments with exponentially rising inventory levels. Thus, in this research the use of the term "imbalance" is focused and limited to the occurrence of a supply shortage. Crucially, procurement may play a part in the *resolution* of this type of imbalance by undertaking operational measures within its own domain of inventory, inbound delivery, outsourcing and supplier management. However, whereas these measures appear quite straightforward, particularly with a well-considered decision framework (Githens, 2009), there are likely to be strategic orientations and practices that contribute to the ability of procurement to respond to and, crucially, resolve imbalances both *efficiently* (controlling cost) and *effectively* (securing delivery). Recognising the significant role on the part of procurement in S&OP, as well as the scarce literature on the topic of integrating procurement into S&OP (Kristensen and Jonsson, 2018), the following research question is posed:

RQ1. How can procurement efficiently and effectively resolve demand–supply imbalances for S&OP?

Furthermore, the contingent nature of the S&OP process has been prominently recognised in the literature (Kristensen and Jonsson, 2018; Kreuter *et al.*, 2021) and procurement contexts vary quite significantly across and within direct spend categories. For example, item variety and supplier capability variation affect the tasks of a procurement manager (Bozarth *et al.*, 2009) and determine the conditions in which demand–supply balance resolution takes place as a response. The second research question is thus as follows:

RQ2. To what degree is the ability of procurement to resolve demand–supply imbalances dependent on the context?

The importance of procurement involvement in the S&OP process is recognised in the literature (e.g. Danese *et al.*, 2018), but S&OP research with explicit procurement and supplier perspectives is almost nonexistent (Kristensen and Jonsson, 2018; Roscoe *et al.*, 2020; Kreuter *et al.*, 2022). The demand and supply integration (Stank *et al.*, 2012) and procurement (Wagner and Eggert, 2016) literatures emphasise the role of supply and procurement in demand and supply balancing but without explicitly focusing on procurement strategies or S&OP as a process. Using survey data and drawing on information processing theory, this paper investigates the relationship between buffering and bridging (independent variable) and the ability of procurement to respond to and resolve demand–supply imbalances (dependent variable), as well as contexts in which these strategies may be particularly useful or detrimental. Addressing these two research questions contributes to both the procurement and S&OP literatures by increasing knowledge regarding the role of procurement and its integration into the crucially important process of balancing demand and supply operations for the sake of value delivery and business success. Furthermore, the dependent constructs are associated with the broad concept of resilience and its part in organisational responses to external threats (Linnenluecke, 2017). More particularly, they relate to the efficiency (cost) and effectiveness (delivery) of resilient responses (Ponomarov and Holcomb, 2009). While response as an element of resilience is a well-researched theme, the efficiency and effectiveness of response to critical situations, such as a demand–supply imbalance, seem to rarely, if ever, feature as dependent variables in quantitatively oriented explanatory studies (see, e.g. Braunscheidel and Suresh, 2009; Hohenstein *et al*., 2015; Han *et al*., 2020; Shekarian and Parast, 2021; Katsaliaki *et al*., 2021). Even though resilience is not the main focus of this study, this study also addresses the gap in the literature regarding efficient and effective response, and sheds light on the antecedent strategies and contexts of efficient and effective responses to imbalance situations from the procurement perspective.

Literature review on demand–supply balancing and procurement

S&OP is a cross-functional process aimed at keeping the demand and supply plans of an organisation in balance at the level of tactical planning. From a procurement perspective, S&OP aims to proactively identify and assess potential future supplier constraints and supply market opportunities and to make procurement decisions with an overall business or supply chain focus and thus contribute to keeping mid- and long-term demand and supply in balance. However, procurement may also contribute to both the proactive and reactive management of risks by responding to demand–supply imbalances identified within the framework of sales and operations planning (Dittfeld *et al*., 2020), as well as complementing established planning processes with quick response activities (Lapide, 2022). Consequently, procurement involvement in S&OP is both about adopting a business-wide perspective on procurement decisions, similar to what Wagner and Eggert (2016) called the internal co-management of procurement, and integrating external supply market resources into supply chain-wide decision-making, i.e. the external co-management of procurement.

S&OP frameworks on maturity (e.g. Grimson and Pyke, 2007; Wagner *et al*., 2014), coordination mechanisms (Tuomikangas and Kaipia, 2014), alignment (Noroozi and Wikner, 2017) and overall syntheses (Thomé *et al*., 2012a) identify horizontal and vertical alignment, supply chain visibility and holistic and proactive decision-making to be fundamental characteristics and design parameters of S&OP. The S&OP literature is almost completely absent from explicit procurement focus, but from this literature we can presume how procurement may be involved. With an *internal co-management* perspective on procurement, horizontally integrated plans and decisions could align the procurement plans with the production and demand plans and make adjustments when there are deviations. Vertically integrated plans and decisions could compare monetarised procurement plans to the business plan and make adjustments if necessary. Visibility requires the full transparency of the data and assumptions between the procurement function and other functions and processes in the supply chain. Alignment also requires using metrics in the procurement function that are defined so as to measure integrated supply chain performance.

To manage the role of procurement in S&OP, at least three *external co-management* adaptations are discussed in the literature (Noroozi and Wikner, 2017; Roscoe *et al.*, 2020): sharing the supply plan with suppliers gives suppliers more accurate forecasts. Visualising suppliers' constraints to the buying company makes it possible to generate more feasible plans and have specific supplier-focused activities, e.g. a supplier capacity-planning meeting, or stakeholder involvement, e.g. a procurement manager in the S&OP team and/or supplier representation in S&OP meetings, implemented in the process. Jonsson *et al.* (2021) also emphasise the need to adopt an extended eco-system perspective on S&OP in dynamic environments. Even though these internal and external co-management adaptations are mentioned in the S&OP literature, no realized effect of any adaptation has been reported or empirically assessed (Kristensen and Jonsson, 2018; Kreuter *et al.*, 2021). Procurement integration is often mentioned on the highest S&OP maturity levels, which are reported to seldom be reached in practice (Danese *et al.*, 2018).

There are at least three areas of the literature on procurement and S&OP to which this study relates. The first is the literature focusing on S&OP as a process. This literature was historically dominated by grey literature but now contains a fair mix of grey and academic journal publications (see Kristensen and Jonsson, 2018; Kreuter *et al.*, 2022). A result of the relatively large body of grey literature on the topic and the focus on S&OP as a business process has been that practically rooted problems and relevance-driven research have, to a large extent, guided the academic research. This literature can roughly be related to contextualisation and contingent process design (Kristensen and Jonsson, 2018), the coordination and integration of the process (Tuomikangas and Kaipia, 2014; Noroozi and Wikner, 2017), and value and performance outcomes (Thomé *et al.*, 2012b; Danese *et al.*, 2018). This literature is, to a large extent phenomenon-driven and, generally, weaker in terms of the theoretical foundation and framing of S&OP (Kreuter *et al.*, 2022). This study provides an explicit procurement focus on S&OP and contributes to the S&OP literature with empirically assessing the outcome of procurement focused demand and supply balancing through S&OP. As such it builds on the existing S&OP literature and contributes to it by empirically testing the effect of procurement integration. With the information processing theory perspective it also contributes to the theorizing of S&OP.

The literature on demand and supply integration and supply chain integration constitutes a second area of literature. This relatively small body of literature focuses on the coordination of supply- and demand-focused activities within and across an organisation's functional units (Esper *et al.*, 2010; Stank *et al.*, 2012) but without a specific focus on mechanisms or processes (e.g. S&OP) contributing to make this integration happen. This literature adopts a marketing/customer perspective on managing and synchronising supply and demand for an organisation. The literature on the intra- and inter-organisational integration in supply chains, building on or relating to, for example, Frohlich and Westbrook (2001) and Flynn *et al.* (2010) and extending into supply chain visibility (e.g. Santharm and Ramanathan, 2022), is much wider and larger. This literature indirectly relates to demand and supply integration and S&OP by proposing performance effects of demand and supply integration.

The third area of the literature to which this study relates is the procurement-focused literature on demand and supply integration. This is a less established and focused research field as compared to the first two areas, but there is different procurement research focusing on widening the perspective and role of procurement into a supply-chain-integrated and strategic component. This includes organizing the internal and external co-management of procurement (Kaipia *et al.*, 2006; Foerstl *et al.*, 2013; Wagner and Eggert, 2016), information sharing and digitalisation (Lorentz *et al.*, 2021; Seyedghorban *et al.*, 2020) and the impact of supply chain contingencies, e.g. dynamics, on procurement (Silva and Ruel, 2022), for example. Our study contributes to these two last areas of literature with an understanding of how S&OP can be a mechanism for co-management of procurement, and for procurement to contribute to demand and supply integration.

Consequently, this study relates to all three areas of the literature but especially to the S&OP process literature by adopting an explicit procurement and information processing theory perspective on the S&OP process and performance, as well as to the procurement-focused literature on demand and supply integration by operationalizing and empirically testing the effect of procurement-specific buffering and bridging strategies on supply and demand integration performance levels. This study also relates to the resilience literature by analysing responses to imbalance situations from the procurement perspective.

Model development

S&OP from the information processing theory perspective

The tasks related to S&OP typically suffer from significant uncertainty because it can be said that the inputs, processes and outputs of such a work system lack predictability (Griffin *et al.*, 2007). Indeed, customer demand is typically irregular, production lead times and yields may vary, and suppliers' operations and deliveries may deviate from expectations in an unpredictable operating environment. S&OP may therefore be framed as an information processing theory (IPT) problem (Galbraith, 1974; Tushman and Nadler, 1978) because "... the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance" (Galbraith, 1974). Usefully, IPT suggests that organisational effectiveness may be achieved by accomplishing a fit between the needs or requirements for information processing and the capacity for information processing in organisations. This places an emphasis on the drivers of the information processing need (uncertainty and its causes), as well as the mechanisms through which the capacity for information processing comes about (Tushman and Nadler, 1978), or more accurately, the fit between need and capacity can be managed.

Regarding the underlying dimensions and causes of uncertainty, the literature, affiliated with IPT suggests the following. The seminal work of Duncan (1972) distinguishes between complexity and dynamism, and these prominent high-level contingency factors may plague the *internal* task execution or the *external* task environment. In the supply chain context, complexity-driven uncertainty may arise due to the nature of a task (scale, variety, novelty and product characteristics), supply source (location, length of relationship and process characteristics) and supply chain (horizontal, vertical and spatial complexity; Bode and Wagner, 2015; Busse *et al.*, 2017). In addition to this kind of *detail complexity*, both downstream and upstream dynamism, or *dynamic complexity* (e.g. stochastic demand levels and supplier lead times), have been shown to have a negative effect on manufacturing performance, suggesting uncertainty and a need for information processing (Bozarth *et al.*, 2009). Essentially, these contingency factors (internal/external complexity and internal/external dynamism) serve as a means of characterising the *contexts* in which procurement seeks to contribute to S&OP from the point of view of information processing.

In terms of managing the fit between information-processing needs and capacity, the literature suggests two principal methods. First, the need may be reduced by managing the environment, creating slack resources and creating self-contained tasks through isolation (Galbraith, 1974). In the supply chain disruption-management context, Bode *et al.* (2011, p. 836; see also Meznar and Nigh, 1995) suggest *buffering* as a general means of reducing information-processing needs in, for example, supplier relationships because a "firm can build up slack resources to act as 'shock absorbers', such as larger inventories, flexible production processes, redundant suppliers, and product designs that are not dependent on a specific supplier". Drawing on Galbraith (1974), the buffering construct is further elaborated here and it is suggested that, in the procurement context, the reduction of information-processing needs related to the S&OP task may be achieved through *redundancy* (akin to creation of slack resources) and *demand change* (akin to managing the environment). Procurement may achieve buffering by redundancy via, for example, securing flexibility for a production capacity increase in the supply base (establishing second sources or maintaining options for extra capacity) and maintaining safety stocks internally or at suppliers (cf. Azadegan *et al.*, 2021). In addition to figuratively throwing money at the problem, procurement may seek to implement fundamental changes in demand or address the root causes for the need to process information. This may be achieved by reducing dependence on the supplied item (e.g. reduced demand), changing item specifications in order to allow sourcing from more favourable (predictable) markets (design-for-sourcing; Schuh *et al.*, 2009) and levelling manufacturing requirements collaboratively with production and sales (Olhager *et al.*, 2001).

Second, the fit between information-processing needs and capacity may be managed by increasing capacity (Galbraith, 1974; Daft and Lengel, 1986). For example, in the inter-organisational-relationship context, the multiplicity of information channels, the frequency of information exchange, joint action and commitment, as well as information system linkages may increase such capacity (Bensaou and Venkatraman, 1995). In a supply chain disruption management context, Bode *et al.* (2011, p. 836; see also Meznar and Nigh, 1995) suggest *bridging* to be "associated with investments in collaborative structures or initiatives such as joint risk management systems, or with scanning approaches such as monitoring or intensifying information exchanges". In this vein the current paper suggests that, in the procurement context, an increase in information-processing capacity related to the S&OP task may be achieved by bridging the gap between the buyer and the supplier by the means of collaboration and monitoring. In more detail, procurement may engage in *collaboration* with suppliers in terms of capacity management, production and delivery scheduling, risk management and information sharing (Kaipia *et al.*, 2017; Cao and Zhang, 2011) in a two-way bilateral fashion. In contrast, procurement may also seek to reduce uncertainty by increasing the capacity to *monitor* suppliers' delivery performance, production scheduling and capacity utilisation in a more unilateral manner (Maestrini *et al.*, 2018), for example, using information systems means in the S&OP (Schlegel *et al.*, 2021). Essentially, the above discussed mechanisms for managing the need-capacity fit help characterise the *methods* with which procurement seeks to contribute to S&OP imbalance resolution from the point of view of information processing.

Hypotheses

The previous section framed S&OP from the IPT perspective and identified several relevant constructs for our research. First, it is suggested that the IPT constructs of buffering (via redundancy and demand change) and bridging (via collaboration and monitoring) serve as the independent constructs enabling procurement to contribute to favourable S&OP outcomes. Second, it is suggested that these outcomes, as the dependent constructs, may be defined in a dichotomous fashion as related to either cost or delivery performance (Srinivasan and Swink, 2018). In more detail, the nature of procurement's contribution is the ability to resolve demand–supply imbalances, when they occur, *efficiently*, meaning without cost escalation, or *effectively*, meaning without disruptions in deliveries. For example, if, in the S&OP process, demand is forecasted to increase to an unexpected level, procurement is called to establish balance by perhaps confirming additional supplier capacity for the plan, optimally doing so without budget overruns or jeopardizing the delivery and production plans. Third, all of the above actions take place in various procurement contexts, such as were defined above as the contingency factors. Additionally, it is useful to consider the co-management of S&OP as procurement contexts (Wagner and Eggert, 2016). In the following, a set of hypotheses is developed reflecting this general set up.

Procurement may increase its ability to resolve demand–supply imbalances by engaging in *buffering by demand change*. By fundamentally changing the nature of demand, procurement addresses the root causes of the occurring imbalances by reducing demand for the supplied item, reducing demand volatility (Olhager *et al.*, 2001) and seeking to support design-for-sourcing (Schuh *et al.*, 2009). Essentially, buffering by demand change thus enables the minimisation of demand–supply imbalances, both in terms of frequency and degree and, furthermore, allows procurement to operate with a greater degree of freedom and relational power in supply markets. For example, the changed design and specification of the requirement may allow the buying of standardized, instead of supplier proprietary components, with low switching costs and several alternative suppliers in the market (Cox, 2015). Buffering by demand change therefore implies the resolution of demand–supply imbalances cost-efficiently due to occurrence minimisation and an increase in relational power of the buyer, as well as fewer delivery delays or disruptions due to occurrence minimisation and a greater degree of item interchangeability and flexibility. The following hypotheses are stated:

H1a. Buffering by demand change has a *positive* relationship with (i) cost-efficiency and (ii) delivery performance in demand–supply imbalance resolution.

However, the beneficial effect of buffering by demand change may vary depending on the context. Sourcing managers often face internal complexity within their area of responsibility, such as a commodity group or purchasing category, involving multiple items, perhaps even in the hundreds. The category management task may therefore be characterised as complex (detail) due to the number of decision-making factors (Duncan, 1972), the number of stock-keeping units that must be managed (Bozarth *et al.*, 2009) and the number of subtasks not easily factored into independent parts. The resulting information diversity and cognitive load (Campbell, 1988) implies reduced efficiency and effectiveness in imbalance resolution, and therefore, efforts toward demand change, involving for example standardisation and reduction of items, may be expected to have particularly beneficial effects in such complex contexts. Furthermore, the dynamic variation of demand serves as a source of significant dynamic complexity, causing stock-outs, obsolescence, the bullwhip effect (Bozarth *et al.*, 2009; Lee *et al.*, 1997) and general uncertainty. By standardising and simplifying categories, as well as by levelling dynamic customer demands or production volumes, uncertainty and information processing need is reduced with buffering by demand change, and the imbalances may be resolved more efficiently and effectively. The following hypotheses are posited:

H1b. The positive relationship between buffering by demand change and *cost-efficiency* in demand–supply imbalance resolution will be *greater* in contexts characterised by (i) category complexity and (ii) demand dynamism.

H1c. The positive relationship between buffering by demand change and *delivery performance* in demand–supply imbalance resolution will be *greater* in contexts characterised by (i) category complexity and (ii) demand dynamism.

Procurement may increase its ability to resolve demand–supply imbalances by engaging in *buffering by redundancy*. By securing flexibility in the supply base with second sources and options for extra production capacity at suppliers or by maintaining higher safety stocks internally or at suppliers (cf. Azadegan *et al.*, 2021), procurement may essentially insulate against uncertainty and reduce the information-processing need for S&OP and the successful realisation of the plan. While both the use of backup suppliers and flexibility through options are potent buffering practices, it has been shown in a simulation study that the use of second sources may be a preferable practice in comparison to capacity flexibility in terms of both cost reduction and service level improvement (Kamalahmadi *et al.*, 2022). However, the net effect of buffering for demand–supply imbalance resolution by the means of redundancy may also be paradoxical, or have the opposite of the intended beneficial effects, because the fragmentation of spending across multiple suppliers implies the foregoing of volume discounts (due to smaller volumes allocated for each supplier), and also as it may involve a heavy reliance on and investment in safety stocks. While safety stocks may allow for the resolution of demand–supply imbalances without disruptions and delays in deliveries (Chung *et al.*, 2018), the cost of buffering with inventory may be significant (Fredriksson and Jonsson, 2009; Raman and Kim, 2002). The following hypotheses are stated:

H2a. Buffering by redundancy has a *negative* relationship with (i) cost-efficiency and a *positive* relationship with (ii) delivery performance in demand–supply imbalance resolution.

Context may play a significant role in terms of how these generally hypothesised associations play out. Internal category complexity, i.e. the management of large numbers of stock-keeping units, may amplify the negative relationship with a cost-efficient resolution of imbalances because product variety is bound to increase the overall inventory for market mediation (Randall and Ulrich, 2001). Essentially, non-standardised categories with many SKU variants imply higher safety stocks and therefore aggravate the cost implications of resolution through redundancy. However, a mature S&OP process in which procurement is internally integrated and co-managed (Wagner and Eggert, 2016) enables the proactive planning of resources and better inventory management, and therefore, such an environment may alleviate the negative relationship with the cost-efficient resolution of imbalances (Bower, 2006) because less inventory is needed with better resource utilisation. Regarding the ability to resolve imbalances without disruptions or delays in deliveries, buffering by redundancy may be a particularly potent remedy in unpredictable contexts, such as those characterised by dynamic variation in demand and also of supply (Bozarth *et al.*, 2009, p. 81). By isolating procurement from dynamic complexity on both the demand and supply sides by the means of inventory buffers, uncertainty and information-processing needs may be reduced, and delivery performance may be effectively secured. The following hypotheses are posited:

H2b. The negative relationship between buffering by redundancy and *cost-efficiency* in demand–supply imbalance resolution will be *greater* in a context characterised by (i) category complexity and *lower* in a context characterized by (ii) the internal co-management of procurement in S&OP.

H2c. The positive relationship between buffering by redundancy and *delivery performance* in demand–supply imbalance resolution will be *greater* in contexts characterised by (i) demand dynamism and (ii) supply dynamism.

Next, it is examined how procurement may resolve demand–supply imbalances by means of *bridging by collaboration*. The evidence suggests that buyer–supplier collaboration plays a significant role in the buyer's efforts to draw on the supplier's flexibility and responsiveness capabilities, as well as achieving responsiveness in its own operations (Squire *et al.*, 2009). Warning capability with collaborative information sharing across the dyad may reduce the effects of supply disruptions (Craighead *et al.*, 2007), both in terms of service level and cost because, with early warning, the length of business interruption can be minimised (Norrman and Wieland, 2020). Indeed, the essential mechanism at play draws on the bilateral nature of the collaborative relationship, involving for example direct contact, use of boundary spanning integrators (e.g. on-site supplier development engineers; Hartley and Choi, 1996) and group meetings with several functions participating across the buyer–supplier interface (Cooper *et al.*, 1997). With broader bandwidth (Aral and Van Alstyne, 2011), such information processing mechanisms facilitate "information richness" for clarification of issues and learning in a timely manner (Daft and Lengel, 1986, p. 560), for example about changes and threats regarding supplier's capability to supply and trends and opportunities regarding demand. Fundamentally, bridging by collaboration allows the minimisation of the imbalances, both in terms of degree and frequency, enabling service levels, and furthermore, supports the crucial initiation of early and proactive measures for imbalance resolution, including, for example, the cost-efficient and early reservation of suppliers' production capacity (late-reservation more costly) or the use of normal transport modes instead of faster and more expensive modes for rush orders. The following hypotheses are posited:

> *H3a.* Bridging by collaboration has a *positive* relationship with (i) cost-efficiency and (ii) delivery performance in demand–supply imbalance resolution.

Considering the contexts of these associations, the following may be noted. Collaboration, in terms of information sharing in a two-way manner, is likely to allow procurement to better handle variability and unpredictable patterns in both demand and supply, as well as the consequent bullwhip and ripple effects (Lee *et al.*, 1997; Dolgui and Ivanov, 2021). More specific evidence suggests that there are broad beneficial effects on the part of involving suppliers in even the higher levels of decision-making and planning, particularly in contexts with high demand uncertainty (Ambulkar *et al.*, 2023). Indeed, suppliers benefit from customer forecasts and planned order information distinctly when demand is non-stationary (Jonsson and Mattsson, 2013). Regarding the supply side, Wong *et al.* (2011) show that supplier integration under uncertainty is associated with higher delivery performance; however, this association is absent for production cost. Nevertheless, the cost-efficient resolution of demand–supply imbalances, especially in uncertain conditions, may be expected to be more likely in the presence of collaboration due to early warning and response (Craighead *et al.*, 2007). Furthermore, mature S&OP processes with advanced elements for external information sharing and co-management engage the supplier in collaborative planning, facilitate the supplier's access to forecast or point-of-sale data and, thus, endow it with an improved ability to respond to customer requests (Kaipia *et al.*, 2017; Wagner and Eggert, 2016). Furthermore, the external co-management of S&OP provides an information-processing infrastructure for leveraging knowledge gained from external sources (Schoenherr and Swink, 2012). The achieved supplier responsiveness and the customer infrastructure for leveraging knowledge support the cost-efficient (with fewer rush orders and earlier capacity reservation) and timely (with early warnings) resolution of demand–supply imbalances on the customer side. The following propositions are stated:

> *H3b.* The positive association between bridging by collaboration and *cost-efficiency* in demand–supply imbalance resolution will be *greater* in contexts characterised by (i) demand dynamism, (ii) supply dynamism and (iii) the external co-management of procurement in S&OP.

> *H3c.* The positive association between bridging by collaboration and *delivery performance* in demand–supply imbalance resolution will be *greater* in contexts characterised by (i) demand dynamism, (ii) supply dynamism and (iii) the external co-management of procurement in S&OP.

Finally, procurement resolving demand–supply imbalances by the means of *bridging by monitoring* is considered. The literature on the topic suggests inconclusive results regarding the benefits of supplier monitoring. On one hand, it has been suggested that supplier monitoring positively affects the suppliers' operational performance (Maestrini *et al.*, 2018; cf. also Croom *et al.*, 2018), while on the other hand, there are indications that monitoring practices have little effect on the performance of the supplier (Akamp and Müller, 2013; Cousins *et al.*, 2008) or of the buying organisation, particularly in a context of an arms–length relationship, i.e. when the other side of the coin, collaboration, is missing (e.g. Ittner *et al.*, 1999). In this vein, Joshi (2009, p. 145) reveals the nuances involved in monitoring and controlling suppliers: the buyer's attention should be focused "on the supplier's underlying capabilities rather than solely on the tangible and concrete activities and outcomes". Joshi also acknowledges that these "underlying capabilities are difficult to access and may be even more difficult to discern" without integration and socializing (cf. Akamp and Müller, 2013; Cousins *et al.*, 2008). In conclusion, it may be postulated that as the effects of supplier monitoring may be limited (Shafiq *et al.*, 2022), buying firms should emphasise collaborative assessment over potentially ineffective hands-off monitoring to ensure the full transparency of supplier operations in order to assess the supplier's true capabilities and foster continuous improvement.

When one transitions from the normal steady-state conditions to our research context, i.e. whether procurement is better able to efficiently and effectively resolve unexpected demand–supply imbalances (with time constraints) when relying heavily on bridging by monitoring, it is possible to hypothesise even for a paradoxical outcome. In contrast to collaboration strategy in supplier relationships, in which there are opportunities for capability control (Joshi, 2009) and equivocality reduction through rich information (Daft and Lengel, 1986), allowing an early understanding of potential supply capability issues, the monitoring strategy in supplier relationships may have to rely mostly on more superficial control measures, as well as "explicit questions" with limited potential for deep insights and the early detection of supply issues (Daft and Lengel, 1986). In essence, it may not be simply possible to fully bridge the asymmetric information between the buyer and the supplier with monitoring (Boström, 2015). Therefore, the resolution of demand–supply imbalances, when they occur, is likely to be more reactive in nature, with fewer options on the table for cost-efficient outcomes. This is because with time-constrained reactive rush orders, transportation modes may need to be switched to faster and more expensive alternatives and capacity reserved in short notice and therefore at higher rates, suggesting inefficiency of imbalance resolution in terms of cost. In contrast, the monitoring strategy may be beneficial in terms of effectively safeguarding deliveries due to the slight edge in warning capability (Craighead *et al.*, 2007). The on-time delivery of supplies may be secured even on short notice, but at high cost.

It is perhaps easy to accept that supplier monitoring has its limits, or indeed, diminishing returns (Shafiq *et al.*, 2022) also in the time-constrained imbalance resolution context. However, instead of assuming that more intensive monitoring contributes at least somehow to cost efficiency, there may also be grounds for hypothesizing a paradoxical association, i.e. the more one emphasizes the monitoring strategy, the lower the cost efficiency of imbalance resolution. This hypothesis may be based on two logics. First, "looking harder" may not resolve the problem of asymmetric information (Boström, 2015): there are simply limits to what you can learn by examining supplier KPIs, and thus one may not be able to expand the narrow time window in which resolution must be achieved, and so there are only few available and costly options. Earlier warning and mitigation cannot be achieved and therefore the preferred long lead time resolution options, such as proactive supplier capacity risk mitigation and onboarding a new supplier, are off the table. Second, similarly to redundancy with safety stocks, high levels of monitoring "are likely to yield exponentially higher costs to the buying firm" (Shafiq *et al.*, 2022, p. 690), as this implies for example ever higher levels of inspection and auditing activity, investment into data sharing systems and portals, and indeed diseconomies of scale, due to intensive monitoring related non-value-added work (Liu *et al.*, 2009). In summary, while the cost of monitoring increases, the already limited time window for response does not expand for less costly resolution options, suggesting a negative association of monitoring with cost-efficiency of imbalance resolution. We propose that this short-term and reactive nature of bridging by monitoring has an important positive effect on the *delivery performance* in the demand–supply imbalance resolution, but that it does not have a positive effect on *cost-efficiency*. Monitoring directly increases the short-term operational costs and will most likely indirectly lead to reducing some long-term demand–supply imbalance-related costs. It is, however, hard to estimate this potential long-term cost effect. Therefore, we suggest a negative association of monitoring with cost-efficiency of imbalance resolution.

The following hypotheses are posited:

H4a. Bridging by monitoring has a *negative* relationship with (i) cost-efficiency and a *positive* relationship with (ii) delivery performance in demand–supply imbalance resolution.

Again, context matters and may indeed affect the hypothesised relationships. When supply dynamism, in the form of, for example, unreliable lead times (Bozarth *et al.*, 2009), is high, monitoring may offer beneficial effects through timelier reactions and thus alleviate the problem in terms of delivery performance. In contrast, such a dynamic context is likely to further aggravate the inadequacy of monitoring for cost-efficient resolutions because larger and more frequent imbalances imply higher costs, given an increased number of reactive and late efforts for capacity reservation, for example. Furthermore, supply base complexity within a synergistic procurement category may imply the existence of several suppliers per item, suggesting diversification as a risk management strategy (Chod *et al.*, 2019) and method of securing deliveries. However, paradoxically, it has been shown that increases in horizontal complexity, with the addition of second sources, have the most significant negative effect on the frequency of supply disruptions because, with more suppliers, it is more likely that something will go wrong; the population is difficult to monitor and map beyond the first tier (Bode and Wagner, 2015). Increased and better resourced monitoring efforts may therefore work particularly well in such contexts and increase the prospects for demand–supply balance resolution in terms of maintaining delivery performance. In this vein, the maturity of S&OP in terms of the external co-management of procurement (Wagner and Eggert, 2016), focused on market information provisioning is likely to have similar effects (cf. Wagner *et al.*, 2014) due to its synergy with monitoring. The following hypotheses are proposed:

H4b. The positive association between bridging by monitoring and *delivery performance* in demand–supply imbalance resolution will be *higher* in contexts characterised by (i) supply dynamism, (ii) supply base complexity and (iii) the external co-management of procurement in S&OP.

H4c. The negative association between bridging by monitoring and *cost-efficiency* in demand–supply imbalance resolution will be *higher* in contexts characterised by supply dynamism.

The above development of hypotheses has identified a group of contextual variables which may, for example, amplify or reduce the relationships between bridging and/or buffering and demand–supply imbalance resolution. However, these contextual variables and their direct relationships with cost-efficient and disruption-free demand–supply imbalance resolution are interesting in their own right. For the sake of technically testing these direct relationships, a set of hypotheses are stated that fundamentally draw on the above discussion of the contexts involved. In a nutshell, complexity and dynamism, both internally and externally, make it difficult to resolve imbalances, whereas the maturity of S&OP in terms of both the internal and external co-management of procurement (Wagner and Eggert, 2016) supports such efforts. A notable exception to this pattern is the redundancy-inducing effect of supply base complexity, which supports the disruption-free resolution of imbalances. The following hypotheses are posited:

H5a. (i) Category complexity, (ii) supply base complexity, (iii) demand dynamism and (iv) supply dynamism have *negative* relationships with *cost-efficiency* in demand–supply imbalance resolution, whereas (vi) the internal co-management of procurement in S&OP and (vii) the external co-management of procurement in S&OP have *positive* relationships with *cost-efficiency* in demand–supply imbalance resolution.

H5b. (i) Category complexity, (ii) demand dynamism and (iii) supply dynamism have a *negative* relationship with *delivery performance* in demand–supply imbalance resolution, whereas (v) supply base complexity, (vi) the internal co-management of procurement in S&OP and (vii) the external co-management of procurement in S&OP have *positive* relationships with *delivery performance* in demand–supply imbalance resolution.

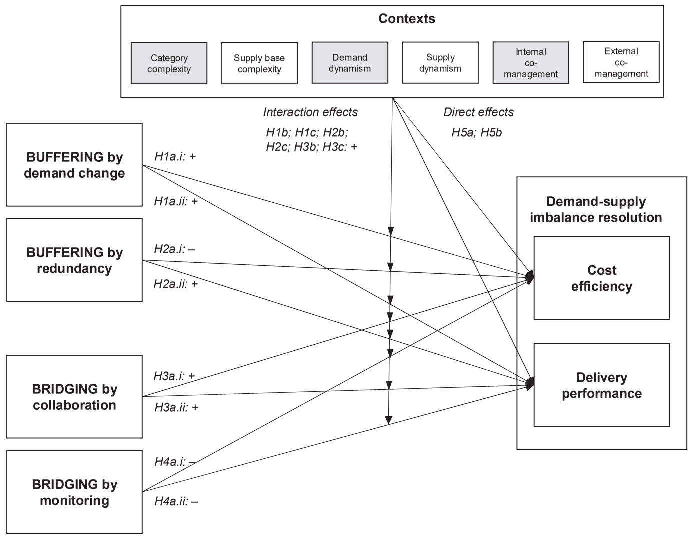
Panel A of Figure 1 provides an overview of the research model, and Panel B summarizes the detailed research hypotheses.

Methods

Measurement

The measurement items for buffering and bridging are based on the work of Bode *et al.* (2011), who identified buffering and bridging as alternative coping strategies for supply chain disruptions. Originally representing generic responses to supply chain disruptions, buffering and bridging were adapted to the procurement context. Viewed within the IPT, buffering reduces information-processing needs by establishing safeguards against risk and uncertainty in the environment (Bode *et al.*, 2011; Manhart *et al.*, 2020). *Buffering by demand change* (BufDC) attempts to address the root cause of supply-demand imbalances by managing the environment, while *buffering by redundancy* (BufR) aims at reducing exposure to imbalances through the creation of slack resources. Bridging strategies, in turn, attempt to create linkages with the environment through boundary-spanning activities to increase information-processing capacity (Bode *et al.*, 2011; Manhart *et al.*, 2020). *Bridging by collaboration* (BridgC) increases the information-processing capacity between the buyer and the supplier by means of collaboration, and bridging by monitoring (BridgM) aims to achieve the same via supplier monitoring.

The outcome side follows Srinivasan and Swink (2018), who examined the relationship between visibility and operational performance improvement. Following their operationalisation reflecting cost and delivery performance, the ability to resolve demand–supply imbalances from the procurement perspective was divided into two constructs: *cost efficiency* (Cost) and *delivery performance* (Delivery) in demand–supply imbalance resolution. Furthermore, the researchers used a group of contextual variables, which may amplify or reduce the relationships bridging and/or buffering and demand–supply imbalance resolution. Three single items were used: *category complexity* (CC) was measured as the approximate number of active parts (Bozarth *et al.*, 2009), *demand dynamism* (DD) as the stability of manufacturing plans (Bozarth *et al.*, 2009) and *supply base complexity* (SBC) as the approximate number of first-tier suppliers (Bode and Wagner, 2015). Single-item measures are acceptable if the object of the construct is "concrete singular" and the attribute of the construct is concrete and easily and uniformly imagined (Bergqvist and Rossiter, 2007,



Independent variables: Direct effects (in bold) & Interaction effects of context variables	Dependent variables: Cost efficiency	Dependent variables: Delivery performance
BUFFERING by demand change	***H1a.i:* +** Category complexity (*H1b.i*): + Demand dynamism (*H1b.ii*): +	***H1a.ii:* +** Category complexity (*H1c.i*): + Demand dynamism (*H1c.ii*): +
BUFFERING by redundancy	***H2a.i:* –** Category complexity (*H2b.i*): + Internal co–management of procurement in S&OP (*H2b.ii*): –	***H2a.ii:* +** Demand dynamism (*H2c.i*): + Supply dynamism (*H2c.ii*): +
BRIDGING by collaboration	***H3a.i:* +** Demand dynamism (*H3b.i*): + Supply dynamism (*H3b.ii*): + External co-management of procurement in S&OP (*H3b.iii*): +	***H3a.ii:* +** Demand dynamism (*H3b.i*): + Supply dynamism (*H3b.ii*): + External co–management of procurement in S&OP (*H3b.iii*): +
BRIDGING by monitoring	***H4a.i:* –** Supply dynamism (*H4c*): +	***H4a.ii:* +** Supply dynamism (*H4b.i*): + Supply base complexity (*H4b.ii*): + External co–management of procurement in S&OP (*H4b.iii*): +

Source(s): Authors' work

Figure 1.
Research hypotheses

p. 176). In this study, single items are deemed unambiguous and concrete. For *supply dynamism* (SD), the respondents were asked to indicate whether the delivery performance of their suppliers varied a great deal and whether supplier lead times were too long (Bozarth *et al.*, 2009). Procurement's involvement in S&OP was measured using two constructs inspired by the co-management concept of Wagner and Eggert (2016) and S&OP frameworks (Grimson and Pyke, 2007; Thomé *et al.*, 2012a; Tuomikangas and Kaipia, 2014; Wagner *et al.*, 2014; Noroozi and Wikner, 2017). The first (with four items) is called *internal co-management of procurement in S&OP* (Int-CoMgmt). It adopts an internal co-management perspective on procurement and measures the maturity of the fundamental characteristics and design parameters of S&OP. The second (with two items) is called *external co-management of procurement in S&OP* (Ext-CoMgmt). It adopts an external co-management perspective and measures the extent of supply market information in the S&OP.

The operationalisation of all constructs is shown in column A of the Appendix. Means and standard deviations for each item in the sample are shown in columns B and C. All constructs had the areas of supply management responsibility (categories of items) as the unit of analysis. Apart from some of the above-described single items, the measures used a seven-point Likert scale ranging from (1) completely disagree to (7) completely agree. Turnover was also included as a four-category control variable: (1) 0–2 million, (2) 2.1–10 million, (3) 10.1–50 million and (4) over 50 million EUR. Furthermore, the industry sectors were divided into three broader categories: the process industry; the assembly industry and trading, services and other. To control for potential differences between industry sectors, the two first categories were used as dummy variables in the regression analysis.

Data collection

To promote content validity, the survey instrument was first tested with three industry experts, each with more than 10 years of experience in procurement. Paying particular attention to the newly developed measurement scales, the industry experts were asked to critically review each construct and item, and they were also able to suggest additional or redundant items. As a result, improvements were made to the questionnaire concerning wording, clarity and practical relevance.

Data were collected in Finland and Sweden. Finland and Sweden are both Nordic countries with high levels of political stability, competitiveness, education and technology. Moreover, supplier–customer relationships are similar, for example, in terms of collaboration (Lindblom *et al.*, 2009). The business culture and business structure in both countries are very similar, and the business environments are well developed and stable. Results may thus be cautiously generalisable across other developed economies and contexts. In Finland, the online questionnaire was launched in June 2021 and in Sweden in November 2021. In Finland, the invitations to participate were sent to (1) experienced procurement professionals in the authors' professional networks ($N = 72$, response rate 76.4%), (2) a sample of procurement personnel with contact details (email addresses) on a platform of a commercial provider of company contact details ($N = 104$, response rate 13.5%) and (3) as part of a newsletter for the procurement forum of LOGY (Finnish Association of Purchasing and Logistics). In Sweden, the invitation was sent to (1) experienced procurement professionals in the authors' professional networks ($N = 44$, response rate 56.8%), (2) a sample of PLAN (a Swedish logistics association) members with a position in purchasing or supply chain management ($N = 235$, response rate 14.9%) and (3) as a part of a newsletter for Silf (Swedish Association of Purchasing and Logistics). The respondents could choose whether they wished to receive a report and an invitation to a webinar in which the results would be discussed. The majority of respondents provided their contact information. Given that the quality of the report and webinar depend on the input of the respondents, it can be assumed that the respondents took the questionnaire seriously. The duration required to fill in the questionnaire was also recorded. No abnormally short response times were detected, with the median duration being 11 min.

The use of single respondents was justified because the unit of analysis was each respondent's area of supply management responsibility, such as the category of spend (Krause *et al.*, 2018). There informants were procurement professionals who are knowledgeable about their own micro-level procurement practices and their ability to resolve demand–supply imbalances from the procurement perspective (Montabon *et al.*, 2018). The present research question focused on the respondents' own domain of management in one functional area of a firm, and monadic constructs were employed. Furthermore, the relationship between the respondents' skills and expertise and the research constructs were aligned and relevant. Thus, the single-source research design is less likely to suffer from respondent bias; in other words, the respondents are expected to occupy a role that makes them knowledgeable about the issues that are investigated (Flynn *et al.*, 2018).

After removing incomplete responses, the final number of responses was 150. The sample covered a variety of industries, with the majority representing manufacturing (Table 1). Respondents show sufficiently high levels of procurement experience. *A priori* and *post-hoc* power analyses were performed using the G*Power software (Faul *et al.*, 2009). With the *a priori* test with a medium effect size $f^2 = 0.15$, $\alpha = 0.05$ and power = 0.80 (Cohen, 1988), the minimum sample size required for testing the full model was 45. In the post-hoc test, the power obtained for our sample size of 150 was 0.999, indicating that the sample size is sufficient.

To reduce the likelihood of consistency motive bias, the independent and dependent constructs were separated and placed in different phases of the survey. To avoid social desirability bias, the respondents were assured of their confidentiality and anonymity and could either complete the survey anonymously or reveal their email address to receive an

Table 1. Respondent profiles ($N = 150$)

Turnover		*Industry*	
0–2 million EUR	2	*Industry category: Process industry*	
2.1–10 million EUR	10	Food, Beverages and Tobacco	11
10.1–50 million EUR	30	Paper	4
Over 50 million EUR	108	Chemicals and Petrochemicals	6
		Pharmaceuticals	8
Country		Rubber and Plastic	2
Finland	100	Non-metallic mineral products	3
Sweden	46	Basic metals	16
Other	4	*Industry category: Assembly industry*	
		Textiles and Apparel	1
Respondent's position		Electronics	27
Top management	10	Machinery and Equipment	40
Head of function	43	Transport equipment	7
Manager	45	Furniture and Other manufacturing	10
Specialist	41	*Industry category: Trading, services and other*	
Assistant	4	Repair and installation	1
N/A	7	Construction	2
		Wholesale	2
Professional experience in procurement (years)		Retail	3
Mean	12.61 [0; 31]	Services	2
Work experience at the current employer (years)		Other	5
Mean	8.75 [1; 33]		

Source(s): Authors' work

invitation to a practitioner webinar in which the results were discussed. The comparison of early and late respondents across theoretical constructs and demographic variables with an independent-samples *t*-test (Armstrong and Overton, 1977) showed no significant differences (*p*-values between 0.167 and 0.837), indicating that a significant nonresponse bias did not influence the results (Anderson and Gerbing, 1988).

Common method variance

Collecting data on dependent and independent variables via a single respondent may raise concerns regarding common method variance (CMV). As a procedural remedy, independent and dependent variables were places in different sections of the questionnaire (Podsakoff *et al.*, 2003). Years of professional experience was used as a theoretically unrelated marker variable to test for CMV. A modified Lindell–Whitney test was performed in which the mean correlation between the marker variable and other variables (0.058) was used to adjust the correlation coefficients and their significance (Lindell and Whitney, 2001). The modified approach was chosen so as to reduce the risk that the smallest possible correlation had occurred by chance. All significant coefficients remained significant after the adjustment, which suggests that CMV is not likely to substantially reduce the validity of the results (Table 2).

It is also reasonable to assume that different capabilities in terms of demand–supply imbalance resolution may affect information-processing needs and capacity. To test the extent to which the results could be affected by reverse causality, it was tested whether cost efficiency and delivery performance affect buffering by demand change, buffering by redundancy, bridging by collaboration or bridging by monitoring. The results suggest a lack of significant associations for other variables apart from the relationship between delivery performance and buffering by redundancy. To further assess the potential endogeneity of the exogenous variables in the research model, a Durbin–Wu–Hausman test (Lu *et al.*, 2018) with the work experience of the respondent as an instrumental variable was performed. The parameter estimates for the residuals were not significant, which supports the assumption of exogeneity. Thus, although reverse causality cannot be fully excluded, it does not seem to drive the results. Finally, Little's MCAR test was conducted. Based on the results, the missing values in the data can be assumed to be missing completely at random (χ^2 = 346.495 df = 325, p = 0.095).

Results

Measurement model

Confirmatory factor analysis (CFA) was performed to test the psychometric properties of the multi-item scales of buffering by demand change (bufDC), buffering by redundancy (bufR), bridging by collaboration (bridgC), bridging by monitoring (bridgM), cost performance (Cost), delivery performance and the external (Ext-CoMgmt) and internal (Int-CoMgmt) co-management of procurement in S&OP. The results (Table 3) suggest that the measurement model fits the data adequately (X^2/df = 1.543, CFI = 0.911, IFI = 0.948, TLI = 0.906, RMSEA = 0.061, p-value = 0.050). All items loaded on their respective constructs. The standardised factor loadings were significant and ranged from 0.653 to 0.927, mostly exceeding the recommended threshold of 0.7 (Hair *et al.*, 2010). Three items were slightly below this value and thus retained. All the constructs demonstrated acceptable reliability, consistency and convergent validity (average variance extracted, AVE >0.50; alpha >0.70, composite reliability >0.70) (Fornell and Larcker, 1981; Garver and Mentzer, 1999).

Two tests were performed to evaluate discriminant validity. Firstly, the square root of AVE was compared with measurement error-adjusted inter-construct correlations between

Table 2.
Zero-order correlations and adjusted correlations of the major research variables

	BufDC	BufR	BridgC	BridgM	Cost	Delivery	Ext-CoMgmt	Int-CoMgmt	Marker variable
BufDC	1	0.467**	0.357**	0.259**	−0.032	0.150*	0.214*	0.202*	−0.006
BufR	0.499**	1	0.478**	0.279**	−0.116	0.126	0.326**	0.175*	−0.008
BridgC	0.395**	0.509**	1	0.549**	0.196*	0.153*	0.527**	0.273**	−0.012
BridgM	0.303**	0.322**	0.576**	1	−0.233	0.101	0.359**	0.186*	0.068
Cost	0.028	−0.051	0.244**	−0.161	1	0.589**	−0.051	0.192*	−0.032
Delivery	0.200*	0.178	0.203	0.154	0.614**	1	0.136	0.063	0.084
Ext-CoMgmt	0.261**	0.366**	0.555**	0.397**	0.010	0.187*	1	0.330**	0.091
Int-CoMgmt	0.249**	0.224*	0.316**	0.234*	0.240*	0.119	0.370**	1	−0.104
Marker variable	0.053	−0.019	0.047	0.118	0.028	0.138	0.145	−0.039	1

Note(s): Zero-order correlations are below the diagonal; adjusted correlations are above the diagonal
*$p < 0.05$; **$p < 0.01$
Source(s): Authors' work

Latent variables	VIF	Unstandardised factor loading	Completely standardised factor loading	*t*-value
Buffering by demand change (α = 0.770, CR = 0.825, AVE = 0.542)				
BUFF_DC1	1.706	1.000	0.684	–[a]
BUFF_DC2	2.283	1.172	0.764	5.747
BUFF_DC3	2.549	1.332	0.792	5.808
BUFF_DC4	2.000	1.062	0.698	4.818
Buffering by redundancy (α = 0.705, CR = 0.772, AVE = 0.531)				
BUFF_R1	2.167	1.000	0.779	–[a]
BUFF_R2	2.231	1.082	0.709	4.576
BUFF_R4	2.221	1.054	0.695	5.253
Bridging by collaboration (α = 0.864, CR = 880, AVE = 0.648)				
BRIDG_C1	4.851	1.000	0.877	–[a]
BRIDG_C2	3.997	0.975	0.848	11.547
BRIDG_C3	3.255	1.001	0.718	8.893
BRIDG_C4	3.136	1.027	0.767	9.825
Bridging by monitoring (α = 0.776, CR = 0.833, AVE = 0.629)				
BRIDG_M2	2.633	1.000	0.880	–[a]
BRIDG_M3	3.655	0.960	0.828	8.964
BRIDG_M4	1.823	0.0.862	0.653	5.454
Cost efficiency (α = 0.758, CR = 0.812, AVE = 0.592)				
COST1	2.235	1.000	0.809	–[a]
COST2	2.023	0.961	0.796	6.843
COST3	1.928	0.825	0.698	5.954
Delivery performance (α = 0.846, CR = 0.875, AVE = 0.636)				
DELIVERY1	2.659	1.000	0.746	–[a]
DELIVERY2	3.398	1.177	0.821	7.135
DELIVERY3	3.587	1.124	0.845	7.274
DELIVERY4	3.350	1.088	0.774	6.838
External co-management of procurement in S&OP (α = 0.907, CR = 0.906, AVE = 0.825)				
MATU1	5.142	1.000	0.927	–[a]
MATU2	4.167	0.946	0.893	10.693
Internal co-management of procurement in S&OP (α = 0.814, CR = 0.835, AVE = 0.559)				
MATU3	2.792	1.000	0.720	–[a]
MATU4	2.943	1.389	0.730	5.858
MATU5	2.902	1.673	0.806	6.219
MATU6	2.581	1.567	0.731	5.856

Note(s): χ^{2}/df = 1.543, CFI = 0.911, IFI = 0.948, TLI = 0.906, RMSEA = 0.061; *p*-value = 0.050; a = fixed for scaling
Source(s): Authors' work

Table 3. Results of the confirmatory factor analysis

each construct (Voorhees *et al.*, 2016). The square root of AVE (displayed on the diagonal of Table 4) was greater than the zero-order correlations with other constructs (lower part of Table 4), thereby implying discriminant validity (Fornell and Larcker, 1981).

The heterotrait-monotrait (HTMT) test has been represented as a superior method for assessing discriminant validity as compared to the traditional constrained Phi approach (Henseler *et al.*, 2015). Recently, Roemer *et al.* (2021) introduced the HTMT2 as an improved version of the HTMT. The HTMT2 test ratios are presented above the diagonal in Table 4. All of them are below 0.85 (Henseler *et al.*, 2015), which provides evidence of discriminant validity.

Table 4.
Discriminant validity test with the Fornell–Larcker criterion (below diagonal) and HTMT2 ratios (above diagonal)

	BufDC	BufR	BridgC	BridgM	Cost	Delivery	Ext-CoMgmt	Int-CoMgmt
BufDC	*0.736*	0.744	0.496	0.368	0.166	0.290	0.301	0.378
BufR	0.607**	*0.729*	0.740	0.474	0.165	0.373	0.534	0.531
BridgC	0.498**	0.641**	*0.805*	0.698	0.103	0.172	0.644	0.438
BridgM	0.355**	0.377**	0.633**	*0.793*	0.089	0.090	0.502	0.436
Cost	0.164	−0.141	0.128	−0.128	*0.769*	0.711	0.488	0.240
Delivery	0.280**	0.290**	0.198**	0.101	0.719**	*0.797*	0.222	0.181
Ext-CoMgmt	0.354**	0.500**	0.629**	0.450**	0.138	0.209**	*0.908*	0.510
Int-CoMgmt	0.429**	0.512**	0.413**	0.356**	0.254**	0.145**	0.471**	*0.748*

Note(s): ** $p < 0.01$, the square root of AVE appears on the diagonal in italic
Inter-construct correlations are below the diagonal, HTMT2 ratios are above the diagonal
Source(s): Authors' work

To ensure measurement equivalence across data collected from Finland and Sweden, three steps outlined by Wiengarten and Pagell (2012) were used: calibration, translation and metric equivalence. The measurement units were on a seven-point Likert scale, which does not require calibration across countries. Their associated explanations, ranging from completely disagree to completely agree, are universally understood. For translation equivalence, the questionnaire was simultaneously developed in Finnish and English. Versions were compared and refined when this was deemed necessary.

One-way ANOVA was performed on key constructs to test for potential differences between Finland and Sweden. There were no statistically significant results ($p < 0.01$) for other variables, except for delivery performance, which had a statistically lower mean value in the Swedish sample. To assess metric equivalence, Cronbach's alpha values were calculated separately for each construct in the Finnish and Swedish sample. Consistent scoring across countries was supported because the variance of the alpha values was below the threshold of 0.10 (Wiengarten and Pagell, 2012).

Hypothesis tests

Table 5 shows the results of the hierarchical regression models. The assumptions of the regression analysis were first tested. The absolute values for univariate skewness and kurtosis were below the recommended thresholds of 2 and 7, respectively (Curran *et al.*, 1996). The linearity and equality of variances were supported by plotting standardised residuals against the standardised predicted values (Hair *et al.*, 2010). To avoid multicollinearity, variables were mean-centred before being entered into the regression model. Variance inflation factors (VIFs) (Table 4) are below the commonly accepted threshold of 5, apart from item MATU1. The Breusch–Pagan test detected the existence of heteroscedasticity, and therefore, robust error terms were used.

There are eight models: cost-efficiency is the dependent variable in Models 1–4, and delivery performance is the dependent variable in Models 586. In Models 1 and 4, the control variable of turnover and two industry dummies (process industry and assembly industry) were entered. In Models 2 and 5, the independent variables of BufDC, BufR, BridgC and BridgM were added. In Models 3 and 7, the context constructs of Ext-CoMgmt, Int-CoMgmt, SD, DD, CC and SBC were entered as independent variables. Models 4 and 8 add the interactions between BufDC, BufR, BridgC and BridgM, as well as context variables.

	Cost				Delivery			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Turnover	0.272	0.320	0.289	0.332	0.243	0.330	0.186	0.138
Process industry	−0.091	−0.071	−0.149	−0.174	−0.056	−0.131	−0.142	−0.150
Assembly industry	−0.542	−0.246	−0.209	−0.282	−0.433	−0.077	−0.310	−0.103
Buffering by demand change (BufDC)		0.158	0.111	0.156		0.209	0.219**	0.562**
Buffering by redundancy (BufR)		−0.139**	−0.112	−0.382**		0.226	0.230**	0.284**
Bridging by collaboration (BridgC)		0.312**	0.323**	0.346**		0.271	0.213**	0.185*
Bridging by monitoring (BridgM)		−0.311**	−0.405***	−0.379**		0.154	0.198*	0.169
Internal co-management (Int-CoMgmt)			0.166*	0.152			0.111	0.032
External co-management (Ext-CoMgmt)			0.018	0.038			0.175*	0.222**
Supply dynamism (SD)			−0.193**	−0.216**			−0.286**	−0.308***
Demand dynamism (DD)			−0.431***	−0.294*			−0.326**	−0.314**
Category complexity (CC)			−0.156	0.050			−0.162	−0.221**
Supply base complexity (SBC)			0.162	0.021			0.175*	0.211**
BufDC × DD				0.113				0.217**
BufDC × CC				0.220**				0.112
BufR × CC				−0.465***				
BufR × Int-CoMgmt				0.046				
BufR × SD								0.122
BufR × DD								0.077
BridgC × SD				0.038				0.015
BridgC × DD				0.063				0.085
BridgC × Ext-CoMgmt				0.172*				0.177**
BridgM × SD				0.012				0.116
BridgM × DD				−0.084				0.034
BridgM × SBC				0.091				0.119
BridgM × Ext-CoMgmt				0.021				0.055
Adj. R-square	0.012	0.081	0.214	0.317	0.032	0.101	0.296	0.456
F-change	1.335	1.616	3.822***	1.482	0.886	3.332**	4.525***	1.676*

Note(s): $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$
Source(s): Authors' work

Table 5.
Regression models for hypothesis testing

The results for cost-efficiency show that BridgC has a significant positive association ($p < 0.05$) and BridgM has a significant negative association ($p < 0.05$) with cost-efficiency (*M2–M4*), supporting H3a.i and H4a.i. BufR has a hypothesised (H2a.i) negative relationship with cost-efficiency in Model 2, but it disappears when context variables are added. Int-CoMgmt is also positively related to cost performance ($p < 0.10$) (H5a.vi). Regarding the other context variables, SD (H5a.iv) and DD (H5a.iii) are negatively related to cost (*M3–M4*). Adding the interaction terms in Model 4 did not significantly add to the variance explained in cost-efficiency, rejecting H1b, H2b and H3b. Interaction effects in Model 4 may indicate associations between BufDC and/or BufR and cost-efficiency in contexts characterized by category complexity (H1c.i and H2b.i), but these findings must be confirmed in a future study.

Concerning delivery performance, Models 7 and 8 show that BufDC has a significant positive relationship with delivery performance ($p < 0.05$) (H1a.ii). Models 7 and 8 also imply that there is a positive relationship between BufR and delivery performance ($p < 0.05$) (H2a.ii). Interestingly, Ext-CoMgmt shows a positive relationship in this regard (*M7* and *M8*) (H5b.vii). Furthermore, SD ($p < 0.01$) (H5b.iii), DD ($p < 0.05$) (H5b.ii) and CC ($p < 0.05$) (H5b.i) are negatively related to delivery performance, while SBC (H5b.v) is positively related to delivery performance. BufDC works particularly well when aiming to resolve demand–supply imbalances without delivery disruptions in contexts characterised by DD, supporting H1c.i. BridgC improves delivery performance, combined with external co-management (H3c.ii). However, the *F*-change is significant at $p < 0.10$, so the interaction effects should be interpreted with some caution and confirmed in a future study.

Main findings

First, an interesting pattern in terms of the associations between the key strategies or coping mechanisms and the outcome constructs was observed. *Buffering* in general is found to be associated with delivery performance, or the ability to resolve imbalances effectively without disruptions, but not with cost-efficient resolution. Both the demand change and redundancy varieties of buffering have a beneficial impact, although the former seems to have a stronger effect. It is proposed that, because buffering by demand change addresses the root causes of imbalances by seeking to, for example, reduce dependence on the supplied item or change specifications for allowing sourcing from more favourable markets, the implications of this particular mechanism are more profound and lasting in nature. Thus, the findings emphasise the importance of such concepts as design-for-sourcing (Schuh *et al.*, 2009) and cross-functional collaboration (Olhager *et al.*, 2001), which essentially require managers' time, often seemingly even a scarcer resource in procurement than the money thrown at increasing inventory levels for the sake of redundancy. In the long term, organisations are likely to be better off after addressing the root causes of imbalances.

In contrast, *bridging*, in general, is found to be associated with cost performance, or the cost-efficient resolution of imbalances, but not with delivery performance; however, the observations point out an interesting paradox in terms of producing effects opposite to those generally expected. Whereas the collaboration type of bridging offers clear benefits in terms of a cost-efficient resolution, the less resource-intensive alternative of monitoring seems to actually make things worse. Essentially, the findings are proposed to suggest that, in contrast to the more proactive collaboration, in which there is visibility into suppliers' operations and deeper and more nuanced understanding of its capabilities, monitoring relies on more superficial observations for addressing information asymmetry, becomes exponentially more expensive as intensity increases, and only offers opportunities for reactive resolution in narrow time-windows. The urgency and a lack of available alternatives, on short notice, often leave only relatively more expensive options on the table for managers. Early detection and mitigation through collaboration (cf. Craighead *et al.*, 2007) and the consequent securing of a variety of options early on, leaves room for procurement to manoeuvre cost-efficiently in imbalance situations.

Overall, it may be concluded that procurement must be co-managed (Wagner and Eggert, 2016) or integrated both internally (for demand change) and externally (for collaboration) in order to efficiently and effectively resolve demand–supply imbalances (Stank *et al.*, 2012) and not resort only to the independent and arms–length mechanisms of redundancy and monitoring in a knee-jerk manner, despite their appeal from the resource and time-usage perspectives. Essentially, the mechanisms for a more integrated approach support the realisation of an "extended scope" of the S&OP process, which has been suggested to be important for S&OP (Noroozi and Wikner, 2017; Roscoe *et al.*, 2020) and particularly suitable "in exceptional situations, such as peaking demand or capturing supply opportunities" (Jonsson *et al.*, 2021, p. 558).

Second, the results suggest patterns in terms of the context in which demand–supply imbalances must be resolved. It was hypothesised that the maturity of a firm's S&OP process may serve as an enabler of imbalance resolution because it involves procurement in the planning process and provides a framework for co-management and acting strategically. Here, the internal co-management of procurement for S&OP in particular, in the form of the alignment and comparison of procurement plans with transparency and metrics, seems to provide a fertile context for cost-efficient resolution. Indeed, such maturity on the part of the integration of procurement into S&OP may be associated with proactive involvement and thus enable the timely and strategic handling of imbalances. This is often conducive to being able to manoeuvre early on for the cost-efficient alternatives. In terms of delivery performance, the results suggest that the external co-management of procurement for S&OP provides similarly favourable conditions because the identification of supplier and supply market constraints and opportunities may be addressed to secure disruption-free deliveries and the execution of the plan. This pattern explicates the ways in which procurement may be co-managed or integrated into S&OP and points out the nuances of the outcomes in terms of demand–supply imbalance resolution: internal co-management contributes to a cost-efficient resolution, whereas external co-management secures delivery performance.

In contrast to the favourable conditions provided by S&OP maturity, our results suggest a detrimental role on the part of dynamism (both on the supply and demand sides) in achieving both the cost-efficient and disruption-free resolution of demand–supply imbalances. Dynamic complexity seems to trump detail complexity, as seems to have been the case since the classic work of Duncan (1972), as well as the more recent research of Bozarth *et al.* (2009) on the effects of detail and dynamic complexity in supply chains. Procurement seems to be relatively more able to resolve imbalances and contribute to S&OP in contexts plagued by multiplicity in terms of components and suppliers in comparison to environments afflicted by variation and volatility in demand and supply. Perhaps, procurement organisations have become adept at managing and mitigating the attentional burden due to complexity with, for example, intermediate coordinating units in the network (Zhou and Wan, 2017) or information systems with decision-support components (Lorentz *et al.*, 2021), whereas unpredictability remains a more pressing challenge from the demand–supply resolution point of view.

Third, the observations regarding the contexts in which the direct associations between the key strategies or coping mechanisms (bridging and buffering) with the outcome constructs are particularly useful or detrimental, i.e. interaction effects are discussed. The most potent strategy for tackling particularly problematic contexts appears to be buffering by demand change, with its focus on addressing root causes in a cross-functional manner. In the context of category complexity, buffering by demand change may result in the standardisation of items and the simplification of categories, and thus, it reduces information-processing needs and supports the cost-efficient resolution of demand–supply imbalances. More managerial attention per item and less frequent imbalance events support achieving successful outcomes. Similarly, buffering by demand change enhances the ability to resolve imbalances without disruptions to deliveries, with particular effectiveness in contexts where demand is volatile. Procurement's ability to, for example, level production requirements by means of cross-functional engagement is therefore shown to be effective in dynamic environments.

Furthermore, the previously discussed beneficial effect of buffering by redundancy is here challenged because the interaction effects suggest another paradox. While redundancy is associated with the improved resolution of imbalances without delivery disruptions, in contexts where category complexity is high, the resulting item variety implies a higher cost of resolution due to, for example, higher inventory levels (Randall and Ulrich, 2001). Having too many SKU variants makes resolution through stock investment prohibitive.

In terms of bridging, the interaction effects reveal an interesting observation. Bridging by monitoring, presented in our research as a paradoxical strategy with a negative relationship with the cost-efficient resolution of imbalances, appears to have a positive relationship with delivery performance, as hypothesized, but only in contexts where supply base complexity is high or there are likely to be second sources and redundancy to safeguard delivery. In such conditions, bridging by monitoring is perhaps what one might call "a good enough strategy" because redundancy in the form of back-up suppliers essentially compensates for the built-in deficiencies of monitoring and its capacity for the merely reactionary resolution of imbalances.

Conclusions

Theoretical contributions

This research drew on information processing theory (Galbraith, 1974; Tushman and Nadler, 1978) for the highly relevant concepts of buffering and bridging in order to capture the key strategy alternatives available for procurement to cope with the information-processing needs inherent in the task of demand–supply imbalance resolution (cf. Bode *et al.*, 2011; Schlegel *et al.*, 2021). Furthermore, information processing theory allowed us to identify and link several contextual factors with these coping mechanisms so as to characterise the task environment of procurement both internally and externally. This general set-up led us to put forth several literature-based hypotheses, the testing of which has brought clarity to the picture thus far provided by the somewhat fragmented literature regarding how procurement can engage with and enable demand–supply balancing in the S&OP process (e.g. Roscoe *et al.*, 2020; Jonsson *et al.*, 2021). Within the contextual perspective of the second research question, this research also contributes to the contingency perspective on the S&OP process research (Kristensen and Jonsson, 2018), with indications of when and how procurement's involvement in S&OP generates favourable outcomes. The operationalisation of the internal and external co-management of procurement into S&OP constructs and the subsequent empirical testing show how S&OP can be a mechanism for procurement management. This provides operational details for the procurement-focused literature on demand and supply integration (Wagner and Eggert, 2016).

It is worth re-emphasising the significance of the findings that suggest the need for integration both internally (for demand change) and externally (for collaboration) in order to effectively and efficiently resolve demand–supply imbalances, respectively. With the evidence regarding the superiority of collaborative demand change over more independent redundancy measures in terms of enabling effective responses and securing the delivery of key inputs, additional perspectives are brought to the literature on the benefits of the cross-functional integration of procurement (Foerstl *et al.*, 2013). Mitigating the root cause with joint efforts is more effective than attempting to isolate oneself from dynamism of supply. The evidence regarding the primacy of hands-on supplier collaboration over relatively more hands-off monitoring further clarifies the contexts in which collaborative or even deep supplier relationships (Kim and Choi, 2015) may be the relational strategy of choice (Terpend and Krause, 2015), that is, when resolving input shortages cost-efficiently is of primary importance. Because the literature suggests that supplier collaborations can draw on complex social interactions and a long history (cf. Foerstl *et al.*, 2010), such potentially valuable and unique resources may help manufacturing firms create sustained competitive advantages in the key domain of matching demand with supply. The big picture therefore suggests that the more demanding mechanisms bring in relatively higher benefits.

Considering our findings from the resilience perspective, the extant literature on resilience response describes, for example, COVID-19-related responses to supply chain disruptions (van Hoek, 2020) and strategies of food processing SMEs in coping with the COVID-19 crisis, emphasising the time and cost of reactions (Ali *et al.*, 2021). Lapide (2022) suggests the importance of a quick response with S&OP, and Dube *et al.* (2022) identify responses by public organisations in terms of ventilator procurement during COVID-19. While some generalisable propositions have been put forth regarding, for example, the association between collaboration among supply chain partners and shorter response times (Hohenstein *et al.*, 2015), our research provides more comprehensive insights into response as an outcome because it places the efficiency and effectiveness of imbalance resolution in the role of dependent constructs. This somewhat rare research design emphasises that the efficiency and effectiveness of a response are fundamentally different from more general outcomes, such as, for example, the cost or delivery performance of a firm or a procurement function. Thus, as the findings suggest, for example, that supplier monitoring paradoxically makes a purchasing manager worse off in the heat of an immediate imbalance response because it is more likely to result in reactive and expensive measures constrained by a limited number of alternatives in a short timeframe, whereas in a normal situation and in the long term, monitoring may well allow for the timely management of supplier delivery and cost (Maestrini *et al.*, 2018). With the above-described results, an important contribution to the broader supply chain resilience literature on response can be made, in addition to the procurement and S&OP literatures.

Managerial implications

The results of this study highlight the importance of procurement in the S&OP process, as well as calling for several tactical measures that can be taken to resolve and reduce the effects of supply and demand imbalances. However, the way in which procurement participates in and provides input for the S&OP process is typically not as advanced as the methods for modelling and analysing in-house production capabilities. One way of developing a better understanding of the risk of shortages in the supply network would be to add another pre-meeting to the supply side of the S&OP process. The objective of this meeting would be to take the unconstrained demand plan and load it into a supplier network model in which each supplier is represented according to contracted capacity or communicated and confirmed capacity. Such a novel approach would indicate the quantified load on the supplier network, with the resulting “heatmap” showing which suppliers are overloaded, by how much they are overloaded and when this occurs. The “when” must be outside the shortest reaction lead-time to enable proposing actions that will reduce the risk of a future imbalance, and therefore, the planning horizon and time fence may have to be increased. Focusing on this process of facilitating procurement’s ability to resolve imbalances can help implement the various tactical actions that this paper has highlighted, such as more proactive collaboration to support timely decision-making, even with relatively powerful suppliers.

As the importance of supply availability has increased, the focus of S&OP has, in many cases, changed from the unconstrained demand forecast to a constraining supply forecast. Supply forecasting may thus become as important as demand forecasting in more companies’

S&OP processes than this is true of today. As concluded in the study, both the internal and external co-management of procurement are keys to resolving imbalances because they are conducive to a better awareness of the challenges involved.

Limitations and future research

Our study adopts a cross-sectional research design with data collected from Finland and Sweden, which may limit the generalisability of the findings to other geographical contexts. While the focus of this research was not on demand–supply imbalances caused by disruptions due to COVID-19, the data were collected while the pandemic was still ongoing, which may have affected how the respondents perceived they had been able to resolve imbalance situations. Future research may also control for the size of imbalance situations and potential differences in demand patterns.

In terms of further research, a more detailed investigation of the best practices in reducing information-processing needs (buffering) and increasing information-processing capacity (bridging) is suggested, as well as how to better integrate procurement and supply base information into the S&OP process. This, for example, includes exploring the specific mechanisms and outcomes of buffering by demand change, the proactive interventions and cost implications of bridging by monitoring and the role of S&OP as a process for enhanced procurement co-management, especially in dynamic environments. The proposed procurement-specific S&OP interventions in the managerial implications section should be further developed, explored and assessed in future research. This includes the design and outcome of a supply pre-meeting and extending the supplier capacity visibility from a first tier to a multi-tier focus.

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Appendix

A		B Mean	C SD
Independent variables			
Buffering by demand change (Drawing on Bode *et al.*, 2011)			
Please assess how much you have used the following practices in your area of procurement responsibility (e.g. a spend category or an item) during the past year:			
BUFF_DC1	Make us less dependent of the purchased items (e.g. by the means of product redesign or part variant reduction)	3.494	1.494
BUFF_DC2	Make us less dependent of the current supplier(s) (e.g. by the means of re-specification, i.e. from custom to standard)	3.458	1.340
BUFF_DC3	Influence specifications for allowing sourcing from more favourable supply markets (e.g. design-for-sourcing)	3.683	1.471
BUFF_DC4	Collaborate with other functions for stabilizing manufacturing requirements/demand (production smoothing)	4.302	1.498
Buffering by redundancy (Drawing on Bode *et al.*, 2011)			
BUFF_R1	Secure reserve production capacity among the existing suppliers	4.423	1.324
BUFF_R2	Search/maintenance of additional production capacity in the supply market for the purchased item (e.g. by developing a second source)	4.440	1.464
BUFF_R3	Increase/maintain our own safety stock in order to safeguard against uncertainty regarding supplier production capacities	5.025	1.260
BUFF_R4	Require suppliers to hold extra stock in order to safeguard against uncertainty regarding supplier production capacities	4.327	1.402
Bridging by collaboration (Drawing on Bode *et al.*, 2011)			
BRIDG_C1	Establish a closer relationship with the suppliers in order to collaborate in production capacity management	4.974	1.182
BRIDG_C2	Cooperate more intensively with the suppliers in terms of their production and delivery scheduling	5.034	1.193
BRIDG_C3	Engage in risk management activities with the suppliers in order to secure production capacity	4.313	1.453
BRIDG_C4	Improve information exchange with the suppliers regarding production capacity management	4.547	1.390
Bridging by monitoring (Drawing on Bode *et al.*, 2011)			
BRIDG_M1	Tightening the control mechanisms on the suppliers	4.359	1.014
BRIDG_M2	Monitoring of suppliers' production capacity utilisation	3.568	1.475
BRIDG_M3	Monitoring of suppliers' production scheduling	3.448	1.505
BRIDG_M4	Monitoring of suppliers' delivery performance	5.000	1.172
Demand dynamism (Bozarth *et al.*, 2009)			
DDYNA	Manufacturing plans are stable in our firm. (reversed)	4.404	1.767
Supply dynamism (Bozarth *et al.*, 2009)			
SDYNA1	The delivery performance of our suppliers varies a lot (e.g. capacity, quality, time)	5.176	1.670
SDYNA2	Our supplier lead times are too long considering our customer delivery times	5.150	1.497
Low buyer power			
BP1	It is easy for us to change our current supplier to an alternative one. (reversed)	2.616	1.479

(*continued*)

Table A1. Measurement items

A		B Mean	C SD
BP2	Our suppliers typically heavily depend on us for sales revenue. (reversed)	3.452	1.394
Category complexity (Bozarth *et al.*, 2009)			
CC	Number of active items in my area of responsibility (approximately) (logarithm)	7108.145	21013.114
Supply base complexity (Bode and Wagner, 2015)			
SBC	Number of first tier suppliers in my area of responsibility (approximately) (logarithm)	331.393	1176.484
External co-management of procurement in S&OP (*Inspired by* Wagner and Eggert (2016), Grimson and Pyke (2007), Thomé *et al.* (2012a,b), Tuomikangas and Kaipia (2014), Wagner *et al.* (2014), Noroozi and Wikner (2017))			
We have an established and recurring (e.g. monthly) process with a timeframe of 3–18 months out where we . . .			
MATU1	. . . identify future possible supplier constrains and supply market opportunities	4.687	1.616
MATU2	. . . assess future supplier constrains and opportunities and decide on the appropriate procurement decisions	4.774	1.593
Internal co-management of procurement in S&OP (Inspired by Wagner and Eggert (2016), Grimson and Pyke (2007), Thomé *et al.* (2012a,b), Tuomikangas and Kaipia (2014), Wagner *et al.* (2014), Noroozi and Wikner (2017))			
We have an established and recurring (e.g. monthly) process with a timeframe of 3–18 months out where we . . .			
MATU3	. . . align the procurement plans with the production and demand plans and make adjustments when deviation	5.360	1.399
MATU4	. . . compare monetarised procurement plans to the business plan, and make adjustments when deviation	4.130	1.660
MATU5	. . . have full transparency of data and assumptions between the procurement function and other functions (operations, marketing/ sales, R&D)	3.917	1.806
MATU6	. . . use metrics in the procurement function that are defined to measure integrated supply chain performance	3.794	1.872
Turnover	(1) 0–2 million EUR, (2) 2.1–10 million EUR, (3) 10.1–50 million EUR, and (4) over 50 million EUR	3.630	–
Dependent variables			
Cost efficiency in demand–supply imbalance resolution (Drawing on Srinivasan and Swink, 2018)			
Please assess the way you can resolve demand–supply imbalances from the PROCUREMENT PERSPECTIVE (e.g. potential supply shortage due to sudden increase in demand)			
COST1	We have been able to resolve demand–supply imbalances WITHOUT CHANGES IN SUPPLIER'S PRODUCTION COSTS	4.181	1.586
COST2	We have been able to resolve demand–supply imbalances WITHOUT CHANGES IN TRANSPORTATION COSTS	3.705	1.711
COST3	We have been able to resolve demand–supply imbalances WITHOUT CHANGES IN WAREHOUSING COSTS	3.357	1.670
Delivery performance in demand–supply imbalance resolution (Drawing on Srinivasan and Swink, 2018)			
DELIVERY1	We have been able to resolve demand–supply imbalances QUICKLY	4.867	1.411
DELIVERY2	We have been able to resolve demand–supply imbalances WITHOUT INBOUND SUPPLY DISRUPTIONS	3.637	1.752
DELIVERY3	We have been able to resolve demand–supply imbalances ON-TIME	4.203	1.637
DELIVERY4	We have been able to resolve demand–supply imbalances WITHOUT DISRUPTIONS IN CUSTOMER DELIVERIES	4.469	1.752

Table A1.

Source(s): Authors' work