

Understanding lead-time implications for financial performance: a qualitative study

SLTs'
implications
for ROI

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Abstract

Purpose – The purpose of the study is to describe the implications of strategic lead times (SLTs) for return on investment (ROI).

Design/methodology/approach – This study was part of an interactive research project and is based on the logic of theory application leading to theory building. It uses a multiple case study with five holistic single cases. Empirical data (ED) have mainly been collected from interviews and focus groups.

Findings – The length of and uncertainty in SLTs have implications for companies' financial performance. These implications vary in strength and can be either direct or indirect. These findings are incorporated into a framework on SLTs' implications for ROI.

Research limitations/implications – The presented array of SLTs' implications for ROI could be further investigated, focussing on their strength. Additionally, it would be interesting to substantiate the findings in the context of environmental and social sustainability (i.e. the triple bottom line).

Practical implications – The findings offer practitioners a rich description and understanding of SLTs' actual implications for financial performance in terms of ROI. This knowledge can support practitioners in analysing supply chain designs based on financial performance.

Originality/value – Using a combination of a relative financial performance measure (ROI) and a set of SLTs (systems perspective), this study focuses on SLTs' actual implications for ROI. The findings provide evidence that different sections of a supply chain can have different implications for revenue, cost and investment (i.e. the three absolute measures related to ROI).

Keywords Decoupling point, Lead-time analysis, Financial performance, Postponement, Mass customisation

Paper type Research paper

1. Introduction

Lead time is relatively simple to measure. But a standardised way of estimating the cost of reducing lead time is missing. – *Strategic purchaser, TurbineCo*

... it is challenging to clearly see the actual payoff from reducing lead times. This means that we [PumpCo], in some situations, do not prioritise short lead times in projects involving procurement. The focus is on traditional measurements. – *Inbound/outbound manager, PumpCo*

Lead time is an important aspect when it comes to competing for customer orders. It is, however, difficult to assess the value of lead time. In product costing, it is usually the cost of the product that is

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valuated, not the lead time itself. Also, the reasons for shortening lead times are often met with the argument, "This will increase the price of the product". So how to value shorter lead times? – *Logistics manager, LuminaireCo*

The preceding quotes describe some issues raised by manufacturing companies' representatives in a recent research project. As evident from these quotes, the goal of businesses is to generate money and earn profit (Goldratt and Cox, 2016; Leon, 2016). A key part in generating profit rests in the design and control of supply chain operations (Gligor, 2017; Wagner *et al.*, 2012). Hence, supply chain operations managers play a strategic role in contributing to business profitability. Historically, managers have intuitively understood this role and worked to reduce supply chain operations costs. Currently, supply chain operations managers have started to gain a more widespread understanding of this relation, realising that supply chains and shorter lead times can be used to compete and generate profit (Stank *et al.*, 2019). Nonetheless, most supply chain operations managers lack a detailed understanding of lead times' actual implications for financial performance (Stank *et al.*, 2019). Furthermore, performance measures are usually unable to reflect the relation between lead-time performance and financial performance (Godinho and Veloso, 2013), impeding the ability to make informed decisions on when lead-time changes are financially desirable (Gelsomino *et al.*, 2016; Godinho and Veloso, 2013; Ponte *et al.*, 2018).

Previous research has mostly studied lead-time implications for financial performance using a cost perspective, for instance, in terms of changes in direct materials and inventory costs from sourcing materials from low-cost countries (see, e.g. Blackburn, 2012; De Treville *et al.*, 2014; Whicker *et al.*, 2009). Cost is an important measure but still an absolute one, meaning that it does not consider whether a costlier solution may be more profitable if the potential increase in revenue exceeds the costs. Acknowledging this fact, some studies use relative financial performance measures, such as return on investment (ROI), including not only cost but also revenue and investment (see, e.g. Christensen *et al.*, 2007; Droge *et al.*, 2004; Gligor, 2017; Jayaram *et al.*, 1999; Vickery *et al.*, 1995; Wagner *et al.*, 2012). Using quantitative approaches, these studies demonstrate that lead times have implications for financial performance and that these implications can have different magnitudes. However, these studies bypass the question of how such implications manifest themselves in practice. Hence, supply chain operations managers know that lead times have implications for financial performance, but they lack a detailed understanding of the actual implications (Stank *et al.*, 2019).

Some important exceptions exist, in which the qualitative aspects of lead-time implications for financial performance have been addressed (see, e.g. Stalk and Hout, 1990; Towill, 1996; Wouters, 1991). These studies acknowledge that different types of lead times, such as delivery lead time, can have different implications for the three absolute measures that together form ROI: revenue, investment and cost. However, these studies and the current one differ in three ways. First, published studies address lead time from a general perspective, not basing it on a systems perspective, such as the strategic lead times (SLTs) used here. SLTs are important from either a demand or a supply perspective and are based on a system boundary (Wikner, 2014, 2018). Second, published studies focus on reducing and compressing lead times to increase profit. In contrast, the present study acknowledges that it might sometimes be more profitable to prolong lead times, such as when less costly materials can be sourced from low-cost countries (Blackburn, 2012). Third, analysing different sections of a supply system (i.e. a supply chain) separately is also possible using SLTs, in which each section can be prolonged, reduced or kept unchanged for increased profitability, for instance. In accordance with these three aspects and the managerial challenges, the purpose of the current study is to describe SLTs' implications for ROI, with the objective of operationalising these implications. The main research question (RQ) is therefore:

RQ. What are SLTs' implications for ROI?

The remainder of this paper is organised as follows. [Section 2](#) elaborates on ROI and its use in lead-time research. The section also presents the theory of decoupling thinking, including SLTs and their main implications for ROI, as summarised in a conceptual model (CM) (presented in [Wikner, 2015](#)) substantiated with the additional literature. [Section 3](#) describes the research design, including the procedures used in the case study design, data collection and analysis. [Section 4](#) summarises the findings from each case company, whereas [section 5](#) offers a cross-case analysis. [Section 6](#) discusses and interprets these findings vis-à-vis the extended CM (presented in [section 2](#)), answering the main RQ. In [section 7](#), SLTs' implications for ROI are operationalised in a framework. Lastly, [section 8](#) presents the study's conclusions, contributions, limitations and offers opportunities for further research.

2. Theoretical framework

This section starts by clarifying ROI and presenting a synthesis of the studies on the relation between lead time and ROI. Next, the theory of decoupling thinking is addressed, followed by a discussion on six of the SLTs within decoupling thinking and their implications for ROI from a conceptual perspective.

2.1 Return on investment, lead time and their relation

Financial performance measures should support managerial decisions ([Gelsomino et al., 2016](#)) and be easy to use ([Godinho and Veloso, 2013](#)). A useful model or equation for bridging the gap between operations and finance is the DuPont model. This model is based on the accounting measure of ROI, which measures profitability, is easy to use and is frequently applied ([Leon, 2016](#); [Weijiao et al., 2018](#)). ROI has also been used in previous studies on the relation between lead time and financial performance. Using for instance ROI, [Vickery et al. \(1995\)](#) studied the relation between time compressions and financial performance in the furniture industry. [Vickery et al. \(1995\)](#) found that business performance was strongly related to lead-time. Using a similar research design, [Jayaram et al. \(1999\)](#) studied the relation between lead time and overall financial performance (e.g., using ROI) in three car manufacturers in North America. The study provided empirical support for a positive relation between lead-time performance and financial performance.

ROI is thus considered suitable for studying SLTs' implications for financial performance. It is “a relative measure of financial performance that provides a means for comparing various investments by calculating the profits returned during a specific time period” ([APICS Dictionary, 2013](#), p. 151). It helps determine when a financial investment might generate the most profit ([Leon, 2016](#)) and provides a useful overall approximation of the success of a company's past investment policy ([Drury, 2000](#)). Briefly, ROI can be calculated as net income (revenue minus cost) divided by investment ([Leon, 2016](#)). ROI is therefore based on three absolute measures: *revenue*, *cost* and *investment*.

2.2 Decoupling thinking

The theory of decoupling thinking is defined as a *management philosophy based on a holistic and integrated approach to flow discontinuities, focussing on creating effective flows using SLTs to position strategic decoupling points* (adapted from [Wikner, 2018](#), p. 445). The positioning of strategic decoupling points has a direct relation to the length of the related SLTs and the manufacturing strategy used. For instance, one of the main strategic decoupling points is the customer order decoupling point (CODP; [Giesberts and van der Tang, 1992](#); [Wikner, 2018](#)), also known as the order penetration point ([Olhager, 2003](#); [Sharman, 1984](#)), which separates decisions about initiating flow based on speculation on future customer orders from the commitment to actual customer orders ([Hoekstra and Romme, 1992](#); [Wikner, 2018](#)). The CODP

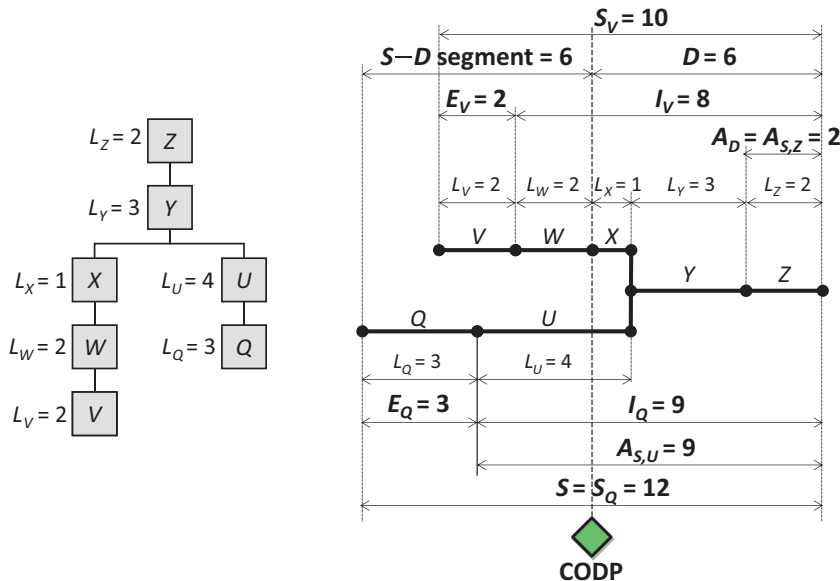
has been used in supply chain operations management studies to differentiate and study manufacturing strategies, such as engineer-to-order, make-to-order, assemble-to-order and make-to-stock (see e.g. Hedenstierna and Ng, 2011; Hoekstra and Romme, 1992; Olhager, 2003; Wikner, 2014). The positioning of the CODP is thus a strategic decision related to manufacturing companies' competitive priorities, such as delivery speed, flexibility and price (Olhager, 2003).

Because of the direct relation of decoupling thinking to competitive priorities and manufacturing strategies, it is expected to be a useful theory to study the relation between lead time and financial performance. Wouters (1991) used the CODP to study the economic consequences of lead-time reduction but addressed lead time rather generally, in line with the APICS Dictionary's (2013, p. 90) definition of lead time as the "span of time required to perform a process". However, in a supply chain operations management context, identifying the most significant lead times is important, as all available lead-time measures are too numerous. The present study uses a triadic perspective, in line with the study of Wikner (2018), in which the focal actor (i.e. the actor used as the basis for the analysis) is supplied by an upstream supplier actor, and in turn, supplies the downstream customer actor. SLTs reflect this triadic perspective, and because of their strategic emphasis, they can be expected to have significant implications for ROI.

2.3 Strategic lead times and their implications for return on investment

This study considers six types of SLTs, grouped into control-, risk- and variant-based SLTs (Wikner, 2018). From a systems perspective, these SLTs address three important flow aspects—whether the flow is controllable or uncontrollable by an actor, whether activities are conducted on speculation or commitment to customer orders and whether the offering is standardised or customised. As a time perspective is significant, a time-phased bill of materials (BOM) is a useful way to illustrate the implications of these SLTs. The traditional material-based BOM (on the left side of Figure 1) can be transformed into a time-phased BOM (on the right side of Figure 1), in which the horizontal distances between the two filled circles correspond to each item's lead time in the material-based BOM. In Figure 1, for instance, the *system lead time* (S) is the cumulative lead time of the complete product, that is, the supply system and equals 12 time units. The SLTs are further described and exemplified in Sections 2.3.1–2.3.3 when presenting their main implications for ROI and its three absolute measures according to a conceptual approach. The main implications are also summarised in the three columns labelled "CM" in Table 3. Note that contract and payment terms, among others, have not been elaborated on in this study.

2.3.1 Category 1: control-based SLTs. The controllable part of a system is related to the *internal lead time* (I), whereas the part outside the system's control is related to the *external lead time* (E). Wikner (2018, p. 444) further classified E into the external upstream lead time (E_{US} , pre – control) and the external downstream lead time (E_{DS} , post – control). However, this study only addresses E_{US} (hereafter simply referred to as E). Control is defined as the extent to which resources can be considered finite (Wikner, 2018). A controllable lead time denotes the use of resources at the system's discretion. Typically, lead times can gradually change from uncontrollable to controllable (Wikner, 2018), but in this study, they have been simplified as either/or. Because E is based on the lead time beyond the system's control, it is usually associated with purchased materials and hence direct material costs (Wikner, 2015). Conventional wisdom suggests that as the replenishment lead time (here corresponding to E) increases, so do inventory and safety stock (Blackburn, 2012; Er and MacCarthy, 2006). Furthermore, both the length of and uncertainty in E have implications for the investment in raw materials and inventory-carrying costs (Blackburn, 2012; Wikner, 2015).



Source(s): Adapted from Wikner, 2014, p. 187

Figure 1. Material-based and time-phased bills of materials

I is then related to the transformation of direct materials and thus to the capacity associated with direct labour costs. Additionally, I represents the time spent by an item in the system; a high I value could be an indication of the time slack embedded in the system per the 0.05–5% rule. According to this rule, most products receive value only 0.05–5% of the time when they are in the supply system (Stalk and Hout, 1990). This value-adding percentage can be increased by decreasing machine utilisation, resulting in reduced queues and waiting times. I can also be shortened by reducing batch sizes. This can result in an earlier detection of quality issues and a decrease in scrap and expenses for repairing defective products. Consequently, I is also linked to the amount of materials and items in the system, here referred to as work in process (WIP; Gregory and Rawling, 1997; Wouters, 1991).

In summary, I and E are important from both the cost and the investment perspectives. Note that each branch within the supply system has a separate tuple of E and I , as shown in Figure 1 (see $E_Q + I_Q$ and $E_V + I_V$), which are indicated by subscript k in Tables 2–4, representing a specific branch, that is, branch k .

2.3.2 Category 2: risk-based SLTs. Risk-based SLTs are related to demand-based risks and the extent of speculation required. The *delivery lead time* (D) can be one or more of the following: (D_1) what the company tells its customers, in which they have no involvement in the decision, (D_2) the requested lead time from the customer or (D_3) the lead time that would give the company a competitive edge in the marketplace (Mather, 1988). For this study, D corresponds to customers' requested lead time (i.e. $D = D_2$; hereafter simply referred to as D), whereas S is the cumulative lead time of the complete supply system. Note that S is based on $E_k + I_k$ (for each branch k). From an item perspective, each branch within the supply system has a separate S_k . From a complete supply system perspective (product perspective), as used here, the branch with the longest cumulative lead time reflects the cumulative lead time of the complete supply system (e.g. a supply chain), corresponding to S_Q in Figure 1. Therefore, the upstream end of S indicates the point at which a company should start taking a material-

based risk (Mather, 1988; Towill, 1996). Correspondingly, the upstream end of D indicates the positioning of the CODP (Hoekstra and Romme, 1992; Wikner, 2018). This means that if S is longer than D , the company should start taking a material-based risk-based on speculation (Hedenstierna and Ng, 2011; Hoekstra and Romme, 1992). The $S - D$ segment (i.e. the time span upstream of D but within S , equals 6 time units in Figure 1) is thus based on speculation; in such situations, WIP will most likely accumulate and have an impact on investments. Furthermore, if the $S - D$ segment can be reduced, the forecast window is also reduced. Consequently, the inventory-carrying cost may be lessened through improved accuracy and reduced safety stocks (Forza *et al.*, 2008; Gregory and Rawling, 1997; Mather, 1988). A higher demand uncertainty also relates to a higher S variance and then more investment in buffers throughout the system (Christensen *et al.*, 2007).

The activities during D (i.e. the flow downstream from the CODP to delivery) are based on commitment to customer orders, which decreases the supplier's risk (Mather, 1988; Wikner, 2015; Wouters, 1991). As mentioned, D determines the CODP's position and consequently, the main buffer point related to the CODP (Hedenstierna and Ng, 2011; Hoekstra and Romme, 1992). To reduce D , a company could decrease the load on its resources involved in D by increasing available capacity or decreasing capacity requirements, increase buffer levels and/or supply based on speculation. Hence, reducing or prolonging D affects the CODP's position and the amount of capital invested in the main buffer (Hoekstra and Romme, 1992; Wouters, 1991). D is also a key SLT for generating a competitive advantage and increasing revenue (Hedenstierna and Ng, 2011; Hoekstra and Romme, 1992; Vickery *et al.*, 1995). For example, if the company can gain a competitive edge in the marketplace and offer a superior service by reducing D , then this can also improve its sales volume and/or selling prices (Wouters, 1991), increasing its revenue. The revenue thus depends on the lead time facing the customer (i.e. D) and the company's capability to leverage D to provide a competitive offering (Wikner, 2015).

In summary, S and D are both important from an investment perspective, where D is also vital from a cost perspective and significant from a revenue perspective.

2.3.3 Category 3: variant-based SLTs. Variant-based SLTs pertain to certain points in the supply system when demand or supply provides a basis for variants (Wikner, 2015). As the *adapt lead time – supply based* (A_S) corresponds to all lead times downstream from where it is possible to create delivery-unique variants, there could be multiple $A_{S,i}$ within a supply system, as shown in Figure 1 (see $A_{S,U}$ and $A_{S,Z}$) and identified by subscript i in Tables 2–4.

When comparing $A_{S,i}$ with D , one can identify the subset that can be used for delivery-unique offerings. The A_S farthest upstream but still within D is called *adapt lead time – demand based* (A_D). In Figure 1, two $A_{S,i}$ are identified (i.e. $A_{S,U}$ and $A_{S,Z}$). However, only $A_{S,U}$ is possible for delivery-unique offerings, as it is within D ; hence, $A_{S,Z}$ is selected as A_D . Assuming that A_D is market oriented (i.e. customisations are based on customers' requirements), it shows an obvious potential for increasing revenue (Gregory and Rawling, 1997; Wikner, 2015). If this point of differentiation can be moved downstream, reducing A_D , then customers' input for product differentiation features is required at a later point, resulting in increased order flexibility (Er and MacCarthy, 2006; Forza *et al.*, 2008) and possibly higher revenue due to a possible D reduction and increase in market share.

However, A_S is related to supply and a product's untapped possibilities for customisation. Thus, the implications of A_S are not as obvious because the customisation has not yet been requested by the market. The potential cost implications are more prominent, as this would result in more item numbers (Wikner, 2015).

In summary, A_S and A_D are both important from a revenue perspective; A_S is also essential from a cost perspective.

3. Research design

This study uses theory application, along with an element of theory-building logic (see, e.g. Eisenhardt, 1989), to describe SLTs' implications for ROI. A CM (presented in Wikner, 2015) has been substantiated with relevant literature and is used as a basis to empirically investigate SLTs' implications for ROI. A multiple case study with five holistic single cases (i.e. five companies) is used (see Yin, 2009) to explore the linkages between SLTs and ROI. The design is based on the suggestions of Voss *et al.* (2002) for matching the research purpose with the methodology, as well as on Wacker's (1998) recommendations for refuting analytical conceptual work. The results of the analysis are summarised and combined with the CM, using logic reasoning (i.e. analytical conceptual research), resulting in a more elaborate framework.

3.1 Company and respondent selection

This study was part of an interactive research project on the structural analysis of flow in terms of lead time and the financial valuation of lead time. Based on the project's interactive approach, the research purpose was developed and finalised together with the participating companies, and thus, the companies were selected prior to the finalisation of the research project's design. Furthermore, the research project was a continuation of a former research project in which all the companies participated and where the question "What is the cost of lead time?" was raised. Thus, the company selection for both the larger project as well as the present study is based on a pragmatic grounds approach (Swanborn, 2010), where the companies were already part of the researcher's network and where the company representatives had professional interests in the research. Nevertheless, the five case companies were still considered suitable following the four inclusion criteria developed from the study's purpose and RQ. First, the companies are all for-profit manufacturing companies. Second, the companies have some form of customer-order-driven production (i.e. $D > 0$). Third, the companies produce customised products (i.e. $A_D > 0$). Fourth, the companies and their representatives have interest in and basic knowledge of SLTs, increasing the probability of relevant and fruitful discussions and access to high quality empirical data (ED).

The five manufacturing companies are all located in Sweden and fairly large, each with 200–3,000 employees. All their representatives were managers in supply chain operations, with substantial knowledge of their respective organisations' supply chain operations (see Table 1). For the purpose of confidentiality, the companies' products, in combination with "Co" (abbreviation of the company), are used as pseudonyms to identify the companies in this paper. These are PumpCo (hydraulic pumps and motors), TelecomCo (telecommunication equipment), LuminaireCo (luminaires), AircraftCo (aircraft systems) and TurbineCo (gas turbines). The companies differ in the types of products produced, product volume and variety, types of markets, supply chain complexity, number of suppliers and length of and uncertainty in SLTs. However, the companies all struggle with similar challenges in understanding how SLTs have implications for their firms' financial performance.

3.2 Data collection and analysis

As this study was carried out as part of a research project, numerous on-site tours of the manufacturing facilities, document studies, interviews and workshops were conducted. As such, prior to the study initiation, the researchers already had previous knowledge of the case companies' manufacturing facilities, their supply chain designs and contextual information regarding lengths of SLTs. The activities specifically pertaining to this study can be divided into three main parts. This is illustrated in Table 1, presenting a condensed version of the research protocol used in the study.

Part 1 was a workshop whose objective was to improve the company representatives' understanding of SLTs and their implications for ROI. A moderator presented the CM

Table 1.
Condensed research
protocol

Part	Research activity	Respondent – Position	Company	Interview/focus group (duration)
Part 1 – An introduction workshop	<p>(1) General introduction to the study, including its purpose, the research design and the data sought</p> <p>(2) Presentation on the SLTs and their implications for ROI to increase the respondents' understanding of SLTs and create a common understanding</p> <p>(3) Opportunity for the respondents to ask any initial questions</p> <p>(4) The workshop was audio recorded and the researchers listened to the entire audio file in order to identify any possible misunderstandings</p>	R1 – Inbound/outbound manager	PumpCo	Face-to-face focus group (80 min)
		R2 – Project administrator, pump and motor division	PumpCo	
		R3 – Senior supply developer	TelecomCo	
		R4 – Operational developer	TelecomCo	
		R5 – Logistics manager	LuminaireCo	
		R6 – Master planner and planning team leader	LuminaireCo	
		R7 – Team leader, operational purchaser	LuminaireCo	
		R8 – Senior logistics manager	AircraftCo	
		R9 – Demand planner, sales and operations planning	TurbineCo	
		R10 – Strategic logistics developer	TurbineCo	
		R11 – Strategic purchaser	TurbineCo	

(continued)

Part	Research activity	Respondent – Position	Company	Interview/focus group (duration)	
Part 2 – Combined individual and group interviews	<p>Research activity</p> <p>(1) Semi-structured interviews on each SLT's implications for the three absolute measures related to ROI</p> <p>(2) Used the interview protocol consisting of 36 questions per interview. The 36 questions were based on the same formulation, where only the SLT (<i>E</i>, <i>I</i>, <i>S</i>, <i>D</i>, <i>A_S</i>, <i>A_D</i>), absolute measure (revenue, cost and investment), and reduced or prolonged were changed until every possible combination was asked. The questions were "if <i>E</i>/<i>I</i>/<i>S</i>/<i>D</i>/<i>A_S</i>/<i>A_D</i> is prolonged/reduced, what are the implications for revenue/cost/investment?"</p> <p>(3) Probing questions to follow up on interesting leads</p> <p>(4) Audio recordings transcribed and notes taken during interviews were analysed (within-case) after each interview</p> <p>(5) Offered the respondents the opportunity for further comments and clarifications (data checking)</p> <p>(6) Cross-case analysis using the results of the within-case analysis</p>	R1 – Inbound/outbound manager	PumpCo	Face-to-face individual interview (85 min)	
		R3 – Senior supply developer	TelecomCo	Face-to-face group interview (98 min)	
		R4 – Operational developer	TelecomCo		
		R5 – Logistics manager	LuminaireCo	Face-to-face group interview (95 min)	
		R6 – Master planner and planning team leader	LuminaireCo		
		R7 – Team leader, operational purchaser	LuminaireCo		
		R8 – Senior logistics manager	AircraftCo	Face-to-face individual interview (92 min)	
		R9 – Demand planner, sales and operations planning	TurbineCo	Online group interview (79 min)	
		R12 – Manager, sales and operations planning	TurbineCo		

(continued)

Table 1.

Table 1.

Part	Research activity	Respondent – Position	Company	Interview/focus group (duration)
Part 3 – A workshop dedicated to discussing and further analysing and updating the results of the cross-case analysis	<p>(1) Presentation of the results of the cross-case analysis</p> <p>(2) Opportunity for the respondents to provide their feedback on the results and discuss them with one another and with the researchers</p> <p>(3) Probing questions to follow up on interesting leads</p> <p>(4) Audio recording transcribed and used to further analyse and update the cross-case analysis</p> <p>(5) Compared the results with the conceptual module (pattern matching)</p>	<p>R1 – Inbound/outbound manager</p> <p>R2 – Project administrator, pump and motor division</p> <p>R4 – Operational developer</p> <p>R13 – Global supply chain architect</p> <p>R5 – Logistics manager</p> <p>R7 – Team leader, operational purchaser</p> <p>R8 – Senior logistics manager</p> <p>R10 – Strategic logistics developer</p> <p>R12 – Manager, sales and operations planning</p>	<p>PumpCo</p> <p>PumpCo</p> <p>TelecomCo</p> <p>TelecomCo</p> <p>LuminaireCo</p> <p>LuminaireCo</p> <p>AircraftCo</p> <p>TurbineCo</p> <p>TurbineCo</p>	<p>Face-to-face focus group (148 min)</p>

(summarised in the “CM” columns in [Table 3](#)), which was followed by interactive discussions among the respondents, similar to a focus group (see [Saunders et al., 2012](#)). The workshop was audio recorded, and the researchers listened to the entire recording shortly after the workshop to identify any possible misunderstandings by the participants that needed to be followed up before or during Part 2 of the study.

Combined individual and group interviews were conducted in Part 2 of the study (see [Table 1](#)). In line with the procedures proposed by [Saunders et al. \(2012\)](#), an interview protocol was developed for these semi-structured interviews, and probing questions were asked to follow up on interesting leads. As presented in [section 1](#) and [section 2.3](#), lead-time implications for cost have mainly been studied by making changes to the length of lead times. Therefore, to aid the respondents in discussing the question of *What are SLTs' implications for ROI?* (the RQ) it was decided that the implications should be discussed in relation to changes in the SLTs (i.e. prolonged or reduced). Furthermore, to isolate each SLT's implications for ROI, the SLTs and the three absolute measures related to ROI (revenue, cost and investment) should be addressed individually. Thus, based on the RQ, the respondents were asked “*If E/I/S/D/A_S/A_D is prolonged/reduced, what are the implications for revenue/cost/investment?*” As such, almost the same question was asked 36 (6*3*2) times per interview, where only the SLT (6), absolute measure (3) and prolonged/reduced (2) were changed until every combination had been discussed. Shortly before the interviews, the interview protocol was sent to the respondents to prepare them for the interview, as recommended by [Voss et al. \(2002\)](#). The interview protocol was structured as a table (resembling [Table 2](#) in [section 4](#)), with the six SLTs presented in the rows and the three absolute measures related to ROI presented in the columns. Each SLT row was divided into two sub-rows, one called “prolong” and the other “reduce”. During the interview, the interviewer also took notes within the different columns of the table, ensuring that each of the 36 questions was discussed. The unit of analysis is each company's supply system (i.e. supply chain), which was discussed and illustrated using key products produced by the respective companies. Lasting around one to two hours each, all the interviews were conducted on-site and face to face, except for that with TurbineCo, which was conducted online via a communication tool (see [Table 1](#)). After each interview, the notes and audio recordings were imported to NVivo version 11 and grouped by case company before being transcribed, coded and grouped by construct category (i.e. the different SLTs and the three absolute measures). In accordance with the recommendation of [Voss et al. \(2002\)](#), the transcripts were done within 24 h to maximise recall and simplify any need to follow up on gaps in the data. The raw data were first analysed separately for each company and entered into separate condensed tables (i.e. data display). The tables were then sent to the corresponding respondents for feedback and data checking – a process that [Carlson \(2010\)](#) defines as member checking. [Section 4](#) presents a condensed summary of these data displays, where each SLT's implications for the three absolute measures related to ROI are provided for each case separately. These tables were then compared with the data from the other case companies to identify similarities and differences. [Section 5](#) offers a condensed summary of this case comparison. These steps can be considered to constitute within-case and cross-case analyses (see, e.g. [Eisenhardt, 1989](#); [Voss et al., 2002](#)).

In Part 3 of the study, the results of the cross-case analysis were discussed in a workshop. Lasting almost two and a half hours, the discussion resembled a focus group. As in Part 1, a moderator presented the empirical results for each SLT, which was followed by interactive discussions among the respondents. Just as in Part 2 of the study, the session was also audio recorded, transcribed and imported into NVivo. The results of the cross-case analysis were further analysed using the transcribed data from Part 3. These results (presented in [section 5](#)) were then compared with the CM using a pattern-matching logic, as described by [Yin \(2009\)](#). [Section 6](#) presents a condensed summary of this comparison. The comparison revealed that

the CM did not capture some key elements of the dynamics between SLTs and ROI that were perceived by the respondents. These findings were logically combined with the conceptual framework, using analytical conceptual reasoning (see Wacker, 1998), resulting in a more elaborate framework on SLTs' implications for ROI.

3.3 Reliability and validity

The drawbacks associated with a case study approach include misjudging of single events and exaggeration of available data. The use of multiple cases and cross-case comparison somewhat mitigated these issues and enhanced the external validity of this research (Eisenhardt, 1989; Merriam, 2009). The respondents' comments on the transcribed interview data and the case descriptions were sought to minimise researcher bias and misunderstandings.

One drawback of this study is its lack of triangulation and internal validity. However, most of the interviews were conducted in groups, and all the respondents from each company reviewed the data, so this limitation was somewhat mitigated.

Merriam (2009) argued that a qualitative study conducted twice would not produce the same results. Reliability should therefore not measure whether the study can be replicated by others but whether the results can be perceived as sensible by others, given the collected data (Merriam, 2009). To aid the reader in this assessment, and to some degree support a chain of evidence, the case study report (this article) presents the RQ, a condensed version of the research protocol (including a summary of the 36 interview questions), citations on specific data sources (including actual citations and summaries of data, in terms of the within-case analysis, the cross-case analysis and pattern matching).

4. Findings

Table 2 provides a summary of the findings for each case company, organised according to the SLTs described in the theoretical framework. A check mark (✓) indicates that the respondents from the different case companies consider an SLT to have implications for an absolute measure related to ROI.

5. Cross-case analysis

The presentation of the cross-case results is organised based on the SLT categories given in the theoretical framework.

5.1 Category 1: control-based SLTs

The respondents explained that *E* and *I* could be either prolonged or reduced by switching suppliers and the mode of transportation, by changing the time slack and the level of flexibility or by outsourcing activities. As presented in Table 2, all companies perceived that changes to *E* and *I*, in terms of both length and uncertainty, would have strong implications, not only for cost in terms of tied-up capital and capacity requirements but also for investment in these resources, for instance. However, the respondents did not consider *E* and *I* to have direct implications for revenue. This is probably best summarised by R4: "*I [i.e. R4] do not see how I or E can have a direct implication for revenue . . . indirectly you could always find one.*" Similarly, R7 and R12 said that if they could reduce costs by either prolonging or reducing *E* and *I* and if the cost reduction would be used to decrease the sales price, then it could have an indirect implication for revenue in terms of increased sales.

5.2 Category 2: risk-based SLTs

As seen in R8's statement in Table 2, *S* can be considered the critical path or the end-to-end lead time of the system. As such, *S* can be either prolonged or reduced in different ways, such as by switching to a global or a local supplier, changing the transportation mode to either a

Co	SLT	Data on each SLT's implications for the three absolute measures related to ROI	R	C	In
PumpCo	E_k	R1 explained that it would be more important that E be stable and predictable rather than short and unpredictable. A predictable E would result in less uncertainty and need for costly safety buffers. However, to increase the certainty in E , the supplier might need to keep a higher inventory or safety capacity on its end, thus increasing cost. R1 also said that increasing the certainty in E ($\sigma_E \rightarrow 0$) enabled them to better fulfil their internal production plans ($\sigma_I \rightarrow 0$) and thus increase the delivery certainty ($D_k \rightarrow 0$)	✓	✓	✓
	I_k	Reducing I would most likely result in less buffers and WIP but would increase the need for more flexibility and investments in capacity, in line with the classic trade-off between lead time and capacity. In contrast, increasing I by adding safety time would improve the possibility of levelling production	✓	✓	✓
	S	Reducing S might lead to increased uncertainty and disruptions, resulting in more replanning and expediting of orders. Either reducing or prolonging S also has implications for the amounts of materials and resources needed in the supply system to achieve and maintain the length of S	✓	✓	✓
	D	PumpCo focuses on low volume, delivery-unique products, with more demanding customers. Reducing D has allowed PumpCo to charge premium prices for its products. R1 explained, "We have been able to charge a premium price because our D is shorter than those of our competitors, and we have been more responsive in accommodating our customers' "demand". Skill, PumpCo has reached a point where any possibility to earn higher revenue through a reduced D is outweighed by the cost. More capacity and/or material stock should be acquired to reduce D . Additionally, if an activity performed during D could be minimised or eliminated, rather than reducing D , the saved time could be used as time slack to increase delivery certainty	✓	✓	✓
	A_{Sj}	An increase in potential delivery-unique variants might lead to an increase in not only market share but also in item numbers, product range, potential suppliers and time slack, as adding complexity typically adds queue time. This would heighten the need for more planning and control, as well as time slack or mixed flexibility in terms of resources	✓	✓	✓
	A_D	R1 stated that by offering some delivery-unique solutions, PumpCo had succeeded in winning over customers from competitors, as well as being able to charge premium prices. However, PumpCo previously had issues with A_{Sj} being longer than D , where customer orders were lost. Moreover, when falling behind on delivery-unique orders, PumpCo responded by prioritising them. This created disturbances and queue time in production and entailed time and money in terms of planning and control. According to R2, PumpCo has now stopped prioritising orders: "We said to ourselves that we shall not go in and prioritise anything, it should be solved by itself. Suddenly, everything flowed, and we managed to reduce queue time." To maintain A_{Dj} , PumpCo also invested time and money in designing more stable and flexible processes for activities carried out during A_{Dj}	✓	✓	✓

(continued)

Table 2. A condensed summary of the data displays from the interviews in Part 2 of the study

Table 2.

Co	SLT	Data on each SLT's implications for the three absolute measures related to ROI	R	C	In
TelecomCo	E_k	According to R3, a predictable E results in less uncertainty and need for costly safety buffers. Moreover, if one knows the length of E and it is always the same (stable), then they do not need to use a safety buffer at all; they will always get the material at the time they planned for its arrival	✓	✓	✓
	I_k	I can be prolonged through increased safety lead time, resulting in not only greater flexibility but also more materials accumulating. In contrast, increasing capacity makes it possible to reduce I and the amount of materials accumulating	✓	✓	✓
	S	Prolonging S results in a system that is less responsive to changes in products or technology, where more materials and investment accumulate in the system. Prolonging S , where D is unchanged, also results in a longer $S - D$ segment and more uncertainty where more activities must be conducted on speculation	✓	✓	✓
	D	If an activity performed during D could be minimised or eliminated, then rather than reducing D , the saved time could be used as time slack to increase delivery certainty. Still, R3 and R4 recognised key motives for reducing D and potentially increasing the market share. However, they did not see the possibility of increasing the selling price due to their highly competitive market	✓	✓	✓
	A_{Sj}	Only the A_{Sj} that are at or downstream of the upstream end of D can be used for delivery-unique offerings and possibly increase the market share. However, creating these variants will result in more item numbers and possibly increase both the volume and the mix of items in stock	✓	✓	✓
	A_D	A_D has obvious potential for enhancing a company's ability to generate revenue. However, the complexity of planning and controlling these orders increases with more delivery-unique offerings	✓	✓	✓

(continued)

Co	SLT	Data on each SLT's implications for the three absolute measures related to ROI	R	C	In
LuminaireCo	E_k	Prolonging E would result in an increase in raw material inventory. In contrast, in reducing E , LuminaireCo might have to use faster and more expensive transportation modes and/or increase the cost of direct materials by purchasing more from local suppliers. Even so, R6 believed that an increased certainty in E "could result in additional sales because we [LuminaireCo] are able to keep what we have promised [promised due date]". R5 said that increasing the certainty in E ($\sigma_E \rightarrow 0$) enabled them to better fulfil their internal production plans ($\sigma_T \rightarrow 0$) and thus increase the delivery certainty ($D_e \rightarrow 0$). Moreover, if E could be reduced so that it would fall within D , then less materials would need to be purchased on speculation, reducing the risk of being out of stock, as well as buying wrong items in terms of the demand.	✓	✓	✓
	I_k	Reducing I would most likely result in less buffers and WIP but would increase the need for more flexibility and investments in capacity, in line with the classic trade-off between lead time and capacity.	✓	✓	✓
	S	Prolonging S results in a system that is less responsive to changes in products or technology and where more materials and investment accumulate in the system. For instance, LuminaireCo is undergoing a technology transition; traditional light sources are being replaced with light-emitting diode technology. According to R5, they "have over 80 generational changes this year", and these changes have resulted in reengineering products, sourcing new items and phasing out outdated ones. R6 provided an example: "We are acquiring things [components] now in February, and it is not until August/September that the change will take place according to plan. But in case this does not go down as planned, we might have to postpone the change until October/November [...] We also retrofit the demand by using campaigns, when we are too late with the generational change and need to get rid of components and products. Not having enough of the right materials in stock may also result in loss of sales, where customers are unwilling to wait for the products to be produced. Still, this is an indirect implication, where D could not be fulfilled".	✓	✓	✓
	D	Reducing D has obvious and strong implications for a company's ability to generate more customer orders, especially if D is an order winner. R5 even said, "We get more customers because we have short lead times [D], or we can reduce our D even more, which our competitors can't". In contrast, not fulfilling D would most likely result in loss of sales. Moreover, R6 argued that an increased delivery certainty could result in additional sales because it would improve the company's credibility. However, to fulfil a shorter D , more materials and capacity have to be stored at the main buffer point related to the CODP. If this point is moved downstream, the materials stored here have also undergone more value-adding activities, increasing the value of the stock.	✓	✓	✓
	$A_{S,i}$	According to R5, offering some delivery-unique solutions may increase revenue through increased demands and/or the ability to charge premium prices. An increase in potential customisations may nonetheless lead to an increase in item numbers, product range, potential suppliers and time slack, as adding complexity typically adds queue time. This will heighten the need for more planning and control, as well as time slack or mixed flexibility in terms of resources. LuminaireCo responded to this by prioritising delivery-unique orders when it was falling behind. This created disturbances and queue time in production and entailed time and money in terms of planning and control.	✓	✓	✓
	A_D	D determines whether A_S has the possibility of being considered A_D . R5 explained, "We are not the cheapest on the market, but we can deliver what the customer wants and within the time they want it". R7 supported this by claiming their ability to offer delivery-unique products as a vital revenue source. The length of A_D determines when customisation can be performed, which should be as late as possible. If customisation occurs later (i.e. further downstream), then the materials and activities specific to such customisation can be respectively acquired and performed later, perhaps based on a particular customer order.	✓	✓	✓

(continued)

Table 2.

Table 2.

Co	SLT	Data on each SLT's implications for the three absolute measures related to ROI	R	C	In
AircraftCo	E_k	If it is assumed that the risk of acquiring materials on speculation decreases closer to D , then if a supplier is replaced by one that can offer a reduced E so that it falls downstream of the CODP (i.e. within D), "then, in a way, the whole risk [of purchasing on speculation] will disappear since we [AircraftCo] can buy on customer order" (R8). However, the material cost (i.e. direct material cost) will likely increase	✓	✓	✓
	I_k	Extending I , adding time slack to the system can improve machine usage by levelling production. R8 explained, "If we have 10 days to produce something, then we can choose to, for instance, merge some production orders. We can somehow work with sequences in order to increase resource utilisation. But if we only have five days to produce the same things, then this window of opportunity closes [...] how we plan the orders, in which sequence. And that should have negative cost implications; cost should go up." Thus, a longer I would decrease set-up costs but result in longer lot sizes, greater WIP and higher inventory-carrying costs. Under the assumption that quality would remain unchanged or improve, R8 explained that I could also be reduced by outsourcing some part of the production. Although this would result in a higher direct material cost, it would reduce the cost of direct labour and the investments in resources for these value-adding activities. This could be an option if "the supplier has other customers, increasing the efficiency of what they [the suppliers] do, thus gaining economies of scale" (R8)	✓	✓	✓
	S	R8 stated, "In some way, S symbolises the critical path, which gives you your planning horizon. The longer this is, the more uncertain it is; the demand over there [in the upstream end of S] [...] for a forecast manager, the critical path, is very important, so how far into the future am I [the forecast manager] acting?"	✓	✓	✓
	D	There is a higher risk of carrying out activities upstream of D , as these are performed based on speculation. This is especially true for companies producing different products and variants. With changes in the mix and volume, the company may produce or buy materials it does not need or even create shortages in the materials it needs. This issue is addressed in the following statement by R8: "If E [upstream of D] can be reduced so much that it comes inside of D [downstream of D], then, in a way, the whole risk will disappear since we [companies] can buy on customer order [commitment] [...]. If we reduce D] so much that a planning point is moved upstream [of], then it ends up in uncertainty. Then, cost and investment go up". In many ways, D is an order winner and has significant implications for revenue. Even as an order qualifier, D has potential implications for revenue, such as when D is too long and results in order losses. This point is illustrated in R8's statement: "If D were to be prolonged, you would most definitely lose business". A longer D may also indicate that a company needs to compensate customers by offering products at discounted prices. R8 also said, "The forecast becomes more and more reliable [certain] the closer to the CODP you come. If that is the case, then you would profit from a reduced [S - D segment] [...]. Suppose that there are high-volume products where you can work with forecasts based on [demand] history, then the probability of the forecast being better closer to CODP is higher". If D were prolonged, resulting in a reduced S - D segment, then fewer activities would have to be undertaken based on speculation, leading to reduced risks and decreased buffers (both cycle stocks and safety stocks), which would further reduce the costs of and investments in the buffers	✓	✓	✓
	A_{Sj}	By offering some delivery-unique solutions, revenue may increase through increased demands and/or the ability to charge premium prices. In fact, according to R8, if customers are made aware of the potential delivery-unique solution, they may even be willing to accept a longer D to obtain the product they want. "Even though the lead time [D] is extended, the revenue might increase because the demand somehow increases because the customers see something they did not know existed" (R8)	✓	✓	✓
	A_D	R8 did not perceive a correlation between the length of A_D and a potential increase in revenue, arguing that a customer is typically not interested in the actual length of A_D as long as it is within D . The planning and control related to the delivery-unique offerings will increase cost and investment	✓	✓	✓

(continued)

Co	SLT	Data on each SLT's implications for the three absolute measures related to ROI	R	C	In
TurbineCo	E_k	More materials accumulate in the system under the same flow rate because of the longer E and/or the uncertainty in E , increasing the inventory-carrying cost and investments in them. R12 said that increasing the certainty in E ($\sigma_E \rightarrow 0$) enabled them to better fulfil their internal production plans ($\sigma_I \rightarrow 0$) and thus increase the delivery certainty ($D_e \rightarrow 0$)	✓	✓	✓
	I_k	In reducing I enough for the upstream end to be moved downstream of the CODP (i.e. within D), activities can be aligned to committed customer orders. Less value-added activities will thus be performed on the materials or components stored in the main buffer point located at the CODP. In turn, this will reduce the value and cost of capital at that buffer point. I can be reduced by adding more resources and materials, increasing the production flexibility so that the $S-D$ segment is also reduced, then less activities must be conducted on speculation, also reducing the related risk and cost	✓	✓	✓
	S	Prolonging S results in a less responsive system, where more materials accumulate throughout the system. In relation to D , if S instead can be reduced R12 argued that an increased delivery certainty could result in additional sales because it would improve the company's credibility. In fact, if an activity performed during D could be minimised or eliminated, rather than reducing D , the saved time could be used as time slack to increase delivery certainty. To reduce D , the company may need to increase its flexibility and consequently increase its capacity costs and, in some cases, investments. If the process is less stable, the company may incur higher costs in terms of planning and control, as well as of express transport, to ensure high delivery certainty. In the long run, a higher demand because of a reduced or more reliable (certain) D will require greater capacity, such as machines and employees, resulting in increased costs and investments	✓	✓	✓
	$A_{S,i}$	Shorter $A_{S,i}$ enable more delivery-unique offerings to be achieved within D . Offering these new customisations can increase the market share. If the materials can be purchased on speculation, then shortening $A_{S,i}$ can result in more items in stock	✓	✓	✓
	A_D	R12 explained that if customisation would occur later (i.e. further downstream), then this might give customers less time to change their minds, reducing the complexity of episodes where customers would make changes to open orders. If A_D is shorter than D , then a customer can place an order before deciding on the final customisation. This increased flexibility could be perceived as a service, possibly leading to increased customer satisfaction and more orders	✓	✓	✓

Note(s): C = cost, Co. = company, In. = investment, R = revenue

Table 2.

slower, more sustainable alternative or to a faster one, or adding or reducing the time slack (e.g. safety time) in the system. Similarly, D can be either prolonged or reduced by using a slower or a faster transportation mode, increasing or reducing the time slack in the system and/or insourcing or outsourcing activities, respectively. Making changes to S and D will thus have implications for the supply chain design and the level of flexibility, for instance. As such, the respondents considered both S and D to have strong implications for cost and investment in terms of capacity needs and material accumulation in the system (see Table 2). Furthermore, all the respondents indicated that D is a key lead time. This can also be observed in Table 2 when comparing the comments on the other SLTs and the relative number of comments related to D . According to the respondents, reducing D has obvious and strong implications for a company's ability to generate more customer orders and thus more revenue, especially if D is an order winner. Companies can also be motivated to reduce the length of or uncertainty in D as a result of changes to any of the other five SLTs. For instance, if S can be reduced, decreasing costs and investments, a company may sacrifice these savings for a reduced or more reliable (certain) D and a potential revenue increase. According to the respondents (except R3 and R4 from TelecomCo), this increase in revenue can even be twofold, that is, increasing both the market share and the ability to charge a premium price. However, R3 and R4 did not see the possibility of increasing the selling price due to their highly competitive market. Moreover, an attempt at reducing D will most likely imply increased costs, unless the product's architecture is significantly changed to allow late software configurations, for example.

5.3 Category 3: variant-based SLTs

The respondents explained that A_S and A_D could be either prolonged or reduced by making changes to the product's architecture or by redesigning the process for producing the product. Another way of offering A_S as A_D is through a prolonged D . Based on the definition, the respondents also considered the two variant-based SLTs to have an obvious relation to D . Specifically, if A_S for one or more branches of the supply system can be reduced such that it becomes shorter than D (i.e. downstream of the CODP) or through a prolonged D so that D becomes longer than an A_S , it could potentially increase revenue by resulting in a new alternative for delivery-unique offerings (i.e. becoming a potential A_D). However, this likelihood is based on the assumptions that the potential customisation is or will be desired by the market, and it will not excessively cannibalise other products offered by the same company. The increase in potential customisations may nonetheless lead to an increase in item numbers, product range, potential suppliers and time slack, as adding complexity typically adds queue time. All representatives of the case companies (except R8 from AircraftCo) thus stated that either prolonging or reducing A_S and A_D could have strong implications for all three absolute measures. However (as seen in Table 2), AircraftCo (R8) did not see a correlation between the length of A_D and a potential increase in revenue since customers are typically not interested in where the customisation is achieved (the upstream end of A_D), as long as it is within D . Nonetheless, any uncertainty in A_D could have implications for the uncertainty in D and thus indirect implications for revenue.

The subsequent discussion about the length of A_S and A_D can be summed up by the following statement by R8: "About A_S , it seems that there are only three cases. Either A_S is equal to zero [there is no delivery-unique offering], or A_S is somewhere in between zero and D [downstream of CODP] [...]. But if A_S would be to the left of D , in other words, longer than D , on the wrong side of the CODP, then this will have rather severe implications" Therefore, the length of A_S in relation to D determines the implications for all three contingent absolute measures related to ROI.

6. Comparing the empirical data with the conceptual model

The findings presented in sections 4 and 5 provide a comprehensive overview of how SLTs have implications for ROI. The case companies differ in terms of product type, volume and variety, type of market, supply chain complexity, number of suppliers and length of and uncertainty in SLTs. Even so and in line with the arguments by Stank *et al.* (2019), the case companies all face the same challenge of understanding how SLTs have implications for their financial performance. This study suggests that SLTs are central to customer–order–driven manufacturing companies and that the findings are general for SLTs.

In this section, the empirical findings are compared with the CM described in the theoretical framework (section 2). In several aspects, the findings validate the CM, but the data provide additional insights that allow extending the CM. The comparison is presented in Table 3, where a check mark (✓) indicates that the CM or the ED considers an SLT to have implications for an absolute measure related to ROI. The comparison thereby answers the RQ: *What are SLTs' implications for ROI?*

Both the respondents and the CM suggest that . . .

- (1) the length of and uncertainty in E and I have implications for cost and investment but no direct implications for revenue,
- (2) S has implications for investment but no significant direct implications for revenue,
- (3) D has strong implications for all three absolute measures,
- (4) A_S has implications for revenue and cost and
- (5) A_D has implications for revenue (except for R8 from AircraftCo, who does not see a relation between the length of A_D and revenue, as long as A_D is within D . Rather, the delivery-unique offering has implications for revenue).

The differences are that only the respondents consider . . .

- (1) S to have implications for cost,
- (2) A_S to have implications for investment and
- (3) A_D to have implications for cost and investment.

The core theme derived from the original CM is that the actual *length* of SLTs is fundamental, as confirmed by the respondents. This conclusion is not ground-breaking, since the notion that a *shorter* lead time can be a source of competitive advantage has been well established in the literature (see, e.g. Christensen *et al.*, 2007; De Treville *et al.*, 2014; Gregory and Rawling, 1997; Towill, 1996). However, as indicated by the respondents and Blackburn (2012), *prolonging* lead times rather than reducing them might sometimes be more financially beneficial, for example, when E , and thereby S , are prolonged so that less costly materials can be sourced from low-cost countries, or when I is prolonged to achieve production levelling by using buffers to isolate variations.

Apart from the length of each SLT, the respondents considered the risks related to the *uncertainty* associated with SLTs. The uncertainty concerns not only SLTs related to supply but also those related to customer requirements. In a customer-order-driven context, D is uncertain *per se*, but the customers may also change their requirements during D . The uncertainty in the forecast may also affect the upstream parts of supply. In total, all parts of the supply system (i.e. all SLTs) may be affected by uncertainty. Length and uncertainty in SLTs are thus two fundamental properties of a time-based entity. However, this study also presents the properties of the actual implication itself. As observed by the respondents, the implication may have different *strengths* or may even be non-existent. Finally, in several

Table 3.
Comparing the
conceptual model with
the empirical data

SLT	R		C		In		Description of the comparison between the conceptual model (CM) and the empirical data (ED)
	CM	ED	CM	ED	CM	ED	
E_k	✓	✓	✓	✓	✓	✓	The ED support Wikner's (2015, 2018) work, suggesting that the length of E has implications for a company's investments and inventory-carrying costs of raw materials, for instance. However, the ED stress the importance of considering not only the length but also uncertainties in E , as these have significant implications for investment and cost related to safety buffers, in line with the findings of Blackburn (2012) and Er and MacCarthy (2006)
I_k	✓	✓	✓	✓	✓	✓	In terms of I , the findings suggest that the length of and uncertainty in I will have implications for cost and investment in terms of capacity. For instance, the respondents argued that in many cases, a longer I was a result of larger lot sizes in order to decrease set-up costs and use capacity more efficiently, in which more materials (ie. WIP) accumulated within the system, increasing both the inventory-carrying costs and the investments made in WIP. This is related to Stalk and Hout's (1990) 0.05–5% rule, also supporting Wouters' (1991) results
S	✓	✓	✓	✓	✓	✓	The upstream end of S indicates the point in the flow at which the company must start taking a material-based risk. S , especially the $S - D$ segment, is therefore related to the amount of investment in the materials within the system (Christensen et al., 2007; Wikner, 2015). This is supported by the empirical findings, in which the respondents argued that a longer S would usually result in more materials accumulating in the system. However, they also recognised the cost of investing in these materials. They added that a consequence of a longer S would be a system that would be less responsive to product and technology changes, exacerbating costs further, especially for companies with shorter product life cycles. The empirical findings thus suggest that S has strong implications for both cost and investment, rather than just investment, as discussed by Wikner (2015)
D	✓	✓	✓	✓	✓	✓	For its part, D determines the position of the CODP and of the related inventory point and consequently, the capital tied up in the materials (Hedenstierna and Ng, 2011; Hoekstra and Komme, 1992). Furthermore, an improved accuracy in D (improved certainty in lead time, not volume) would reduce the needed safety buffer at the CODP, consequently reducing the inventory-carrying cost (Forza et al., 2008; Gregory and Rawling, 1997; Mather, 1988; Wouters, 1991). This is supported by the respondents, who recognised both the investment and the cost in the CODP buffer and/or the capacity dimensioning downstream of the CODP. Moreover, the CM states that D represents a key lead time for creating a competitive advantage (Hedenstierna and Ng, 2011; Hoekstra and Komme, 1992; Vickery et al., 1995), which is an opportunity for boosting revenue by increasing the sales volume and/or the selling prices (Wouters, 1991). The respondents agreed, adding that this implication might be stronger if D was an order winner in terms of length or certainty, for example. All respondents discussed D in relation to the other SLTs and called for reducing these SLTs and the decision points downstream of D (downstream of the CODP) because of the costs associated with the risk of performing activities on speculation. Thus, in a sense, they emphasised the importance of D as an SLT

(continued)

SLT	R		C		In		Description of the comparison between the conceptual model (CM) and the empirical data (ED)
	CM	ED	CM	ED	CM	ED	
$A_{S,i}$	✓	✓	✓	✓	✓	✓	Agreeing with the CM (Gregory and Rawling, 1997; Wikner, 2015), the respondents said that reducing an A_S such that it would be pushed downstream of the CODP, becoming an A_D candidate, could potentially increase revenue. R1 explained that a revenue increase could stem from a higher demand and the ability to charge a premium price. However, the implications of A_S for revenue could be regarded as indirect because once an A_S becomes an A_D , it is A_D that has implications for revenue. However, the respondents also indicated that this untapped possibility for increasing revenue might not be realised easily if the customisations had not been requested by the market. In such a case, the potential cost implications would probably be more significant, as these would result in more item numbers, for instance. The respondents also mentioned that costs could increase, owing to the expenses incurred in setting up and maintaining new items. However, deviating from Wikner (2015), the respondents also argued that higher investments would be needed to stock up on the additional items
A_D	✓	✓	✓	✓	✓	✓	One of the main differences between the CM and the empirical findings is related to A_D . Gregory and Rawling (1997) and Wikner (2015) argued that A_D had an obvious potential to generate more revenue, a view shared by the respondents. However, R8 from AircraftCo did not perceive a relation between the length of A_D and a company's revenue-generating capability. R8 believed that offering customisation within the requested D would have implications for revenue, but the length of A_D <i>per se</i> would have none. Nonetheless, Er and MacCarthy (2006), Forza <i>et al.</i> (2008) and Wikner (2015) suggested that if the point of differentiation could be moved downstream (i.e. if A_D was reduced), then the customer's input for product differentiation would become necessary at a later point. Thus, the customer can place an order at an earlier point but decide on the customisation specifics later, increasing the order flexibility and the possible revenue. However, the respondents presented an aspect not covered in the CM. Specifically, if a reduced A_D could be obtained through postponement (see, e.g. Forza <i>et al.</i> , 2008), for example, then this could result in reduced investments and inventory-carrying costs, in which materials and components could be acquired and/or produced on commitment to customer orders instead of being maintained in the inventory

Note(s): C = cost, In. = investment, R = revenue

Table 3.

cases, the respondents struggled with the cause–effect relation between SLTs and ROI. The implication was perceived as simple and direct in some cases, but in others, it was formulated as more indirect; for example, an increased certainty in E has indirect revenue implications when it results in an increased certainty in D . It is thus important to consider if an implication is *direct* or *indirect*.

7. A framework on SLTs’ implications for ROI

As indicated in the preceding section, the CM does not capture some key elements of the dynamics between SLTs and ROI, as perceived by the respondents. These empirical aspects have been summarised as supplementary properties, that is, the *length* of and *uncertainty* in the SLTs and the *strength* and *indirect/direct* nature of their implications. Here, these four areas are combined with the CM, resulting in a more elaborate framework. This framework provides a more detailed picture of the relation between the independent and the dependent variables and supports the operationalisation of SLTs’ implications for ROI. The framework is illustrated in Table 4, where the rows correspond to the independent variables (SLTs), and the columns correspond to the dependent variables (the three absolute measures related to ROI). Each cell represents the causation between the independent and the dependent variables. A range of causation functions is defined to operationalise the relations. The functions are based on the set *Chains*, which is assumed to represent all significant causations, direct and indirect, between the independent variables (x) and the dependent variables (y). The causation can range from weak to strong, and the causation with the most significant implication is of main interest. The “max” function is used to identify the causations with the most significant implication, that is, the maximum strength. Furthermore, the extension of the SLTs captures the uncertainty in terms of stochastic properties, represented by the expected value and the SD. For example, if x is the independent variable and y is the dependent variable, the strongest causation would be represented by

$$y = \max_{\text{Ch} \in \text{Chains}} \{y_{\text{Ch}}(\tilde{x})\}; \text{Chains} = \{\text{Significant causations for } x \text{ on } y\}.$$

This function represents the causation between the independent and the dependent variables. It is quite detailed, and the point of departure is the set of Chains, which includes all the significant cause–effect relations of x on y , directly or indirectly. For each element (Ch) in the set, the implication for y is evaluated by considering x , where a tilde (\sim) indicates the stochastic properties of the independent variable; correspondingly, the dependent variable could be stochastic although this is not assumed here. All causations are evaluated, and the most straightforward approach is to select the chain with the maximum implication as the dominant causation, even though other chains could also be significant. In the framework, this is abbreviated to $y = f_{x,y}(\tilde{x})$, a condensed representation in which the subscript x, y indicates that

		Absolute measures related to ROI		
		Revenue (R)	Cost (C)	Investment (I)
SLTs	E_k	$R = f_{E_k,R}(\tilde{E}_k)$	$C = f_{E_k,C}(\tilde{E}_k)$	$I = f_{E_k,I}(\tilde{E}_k)$
	I_k	$R = f_{I_k,R}(\tilde{I}_k)$	$C = f_{I_k,C}(\tilde{I}_k)$	$I = f_{I_k,I}(\tilde{I}_k)$
	S	$R = f_{S,R}(\tilde{S})$	$C = f_{S,C}(\tilde{S})$	$I = f_{S,I}(\tilde{S})$
	D	$R = f_{D,R}(\tilde{D})$	$C = f_{D,C}(\tilde{D})$	$I = f_{D,I}(\tilde{D})$
	$A_{S,i}$	$R = f_{A_{S,i},R}(\tilde{A}_{S,i})$	$C = f_{A_{S,i},C}(\tilde{A}_{S,i})$	$I = f_{A_{S,i},I}(\tilde{A}_{S,i})$
	A_D	$R = f_{A_D,R}(\tilde{A}_D)$	$C = f_{A_D,C}(\tilde{A}_D)$	$I = f_{A_D,I}(\tilde{A}_D)$

Table 4.
Framework on SLTs’
implications for ROI

the function is unique to that particular combination of independent and dependent variables. Note that in Table 3, for E_k , I_k and S, the causation details in relation to revenue are empty. However, this is not the case in Tables 4; Table 3 only covers direct causations, whereas Table 4 also includes indirect causations. The intersections in the framework represent potential combinations to be investigated, totalling 18 unique intersections.

8. Conclusions and further research

The study makes several noteworthy theoretical contributions. It builds on and goes beyond the notion that lead times *have* implications for financial performance (see, e.g. Blackburn, 2012; De Treville *et al.*, 2014; Jayaram *et al.*, 1999; Vickery *et al.*, 1995; Whicker *et al.*, 2009), also identifying how these implications manifest themselves in reality.

The study's main theoretical contribution is that not only do the expected *length* of and *uncertainty* in SLTs have implications for companies' financial performance, but these implications can also *differ in strength* and have a *direct* or an *indirect* nature. As such, the study supports the findings of Stalk and Hout (1990), Towill (1996) and Wouters (1991), as well as adds a more nuanced understanding. This increases the possibility of questioning the idea that lead times should always be reduced, such as time compression and time-based management (Stalk and Hout, 1990; Towill, 1996). In line with Blackburn's (2012) conclusion, the study demonstrates that increasing lead times can be more profitable in reducing cost or providing customised offerings, for instance.

Finally, using the theory of decoupling thinking, the study contributes to further developing the theory by establishing the relations between decoupling thinking and financial performance. The use of decoupling thinking and SLTs also increases the possibility of examining different parts of a supply chain, such as the $S - D$ or the E , and the findings provide evidence that different sections of a supply chain can have different implications for revenue, cost and investment.

The study also contributes to practice by illustrating that how the supply chain is designed and operated has implications for the company's bottom line and shows the intricate and complex relation between SLTs and financial performance. These findings are incorporated into a framework, offering a structured tool for analysing different supply chain design options. The framework, in combination with the empirical examples and the time-phased BOM (see Figure 1 for an example), may aid practitioners in analysing and designing supply chains for profitability. This is supported by the respondents, who all agreed that this way of presenting SLTs and ROI helped them understand the strategic importance of lead time and its implications for their companies' financial performance. R12 said, "*The relation between "cost for lead time" and "change in lead time" has been highlighted and exemplified for some of our products, which has led to a correction of the strategic focus where we, in a better way, have managed to justify where we are going and why.*"

The study is nevertheless subject to limitations and provides opportunities for further research. The presented array of SLTs' implications for ROI is not exclusive, and the authors welcome further studies where the strength of the implications could be further investigated. During the second focus group, the SLTs' implications for non-financial performance measures, such as environmental sustainability, were briefly discussed. It would be interesting to investigate whether the findings could be substantiated in the context of environmental and social sustainability (i.e. the triple bottom line). Payment terms could also be studied in line with the supply chain financing literature (see, e.g. Gelsomino *et al.*, 2016).

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