Order-to-delivery process performance in delivery scheduling environments

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Abstract

Purpose – The purpose of this paper is to generate a performance model for an order-to-delivery (OTD) process in delivery scheduling environments. It aims to do this with a triadic approach, encompassing a customer, a supplier and a logistics service provider.

Design/methodology/approach – The paper takes the form of a conceptual analysis and a triadic case study on performance measurement requirements in an OTD process characterized by delivery scheduling, and generating performance models.

Findings – Two OTD process performance models, one for the supplier's delivery sub-process and one for the customer's delivery scheduling, the logistics service provider's transportation and the customer's good receipt sub-process, in delivery scheduling environments are generated.

Research limitations/implications – A single case study limits the levels of external validity and reliability to analytical generalization.

Practical implications – The generated performance models include definitions of four sub-processes and outline ten performance dimensions that should be of relevance for several companies to apply.

Originality/value – This is the first approach that generates performance models for a triadic OTD process for use in delivery scheduling environments.

Keywords Order processing, Delivery lead time, Performance management, Supply chain management

Paper type Research paper

Introduction

The importance of supply chain performance is emphasized by several scholars (e.g. Beamon, 1999; Lee, 2000; Brewer and Speh, 2000). Only a few studies (e.g. Lohman *et al.*, 2004) have, however, analyzed the management of supply chain performance in any depth. From a logistics perspective, the order-to-delivery (OTD) process is one of the most important processes to manage. It can be defined as consisting of four sub-processes; customer's ordering, supplier's delivery, logistics service provider's (LSP's) transportation, and customer's goods receipt sub-process (Mattsson, 2004). We

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have some knowledge about performance management of the respective sub-process. But focusing on the individual sub-process is not enough, if striving towards supply chain performance. The knowledge about performance management of the entire OTD process is more limited and needs to be further developed. This research need for more holistic measurement of supply chain performance, avoiding local sub-optimization, was pointed out by, for example, Shepherd and Günter (2006).

The OTD process involves at least three actors: a customer, a supplier and a LSP, which together can be called a triad (Larson and Gammelgaard, 2001). The performance of the OTD process is affected by all three actors and performance management of this process should consequently be conducted with a triadic approach. Very few references have empirically studied triads, involving how LSPs contribute to supply chain performance, according to, e.g. Bask (2001). Only few references have studied performance management in dyads, i.e. involving customers and suppliers (e.g. Forslund and Jonsson, 2007). Phillips *et al.* (1998) advocated a management expansion from dyads to triads and then to supply chains, but this study did not focus on performance management.

Lead time-related performance is central in a general OTD process. An extensive amount of research has concerned lead time reduction, e.g. related to the business process reengineering or lean and agility literature (e. g. Melan, 1993; Mason-Jones *et al.*, 2000). However, lead time length is normally not considered the most important OTD process performance dimension; other dimensions such as on-time delivery are often ranked as being more important (Keebler *et al.*, 1999; Forslund and Jonsson, 2007). Lead time performance concerns, except lead time length and on-time delivery, also other dimensions such as lead time adaptability and lead time flexibility (Mattsson, 2004; Supply-chain Council, 2005; Zhang *et al.*, 2005). Previous studies (e g Mattsson, 2004; Forslund and Jonsson, 2007) show that even though customers require high on-time delivery and flexibility, the perceived performance is on average low.

The different performance dimensions are related to the respective OTD sub-processes, and the performance of one sub-process are dependent on the performance of the other sub-processes. For high performance in the overall OTD process, the performance should be managed from the overall OTD process perspective. There is, consequently, a need to explore what performance dimensions are important to measure and manage in the overall OTD process. A performance model with metrics for the overall OTD process would be valuable to generate.

The specific type of OTD process configuration affects the design and use of performance management. Most existing performance dimensions, such as on-time delivery (e.g. Forslund and Jonsson, 2007) and delivery flexibility (e.g. Supply-chain Council, 2005), are developed for OTD processes in order-by-order environments, where orders appear in a non-cyclic mode. An environment characterized of using long-term delivery schedules combined with call-offs is, however, becoming more common. No identified study addressed performance management and no established performance model in such environments have been identified. Therefore, this study focuses on a configuration where the customer has a make-to-delivery schedule type of OTD process. The supplier's delivery sub-process is triggered by delivery schedules rather than individual orders; a configuration commonly applied in, e.g. the automotive and white goods industries. The approached knowledge gap is the lack of performance models for OTD processes in delivery scheduling environments.

Thus, the purpose of this article is to generate a performance model for an OTD process in delivery scheduling environments. The article is organised as follows; first, a conceptual review of performance dimensions and metrics for an OTD process in order-by-order environments is conducted. After the methodology, a triadic case study of an OTD process in a delivery scheduling environment is presented. The analysis identifies OTD process performance dimensions and generates models for OTD process performance in delivery scheduling environments.

An OTD process performance framework

This section contains the three sub-sections: the OTD process, OTD process performance dimensions and OTD process performance metrics. Here, focus is on the OTD process performances in order-by-order environments. The presented order-by-order performance framework is used as input to the case analysis and the generation of a performance model for delivery scheduling environments.

The OTD process

From a supply chain perspective the OTD process can be considered as a cross-company business process involving a supplier, a LSP and a customer. Order fulfillment processes and procurement processes that are considered as company individual processes are then together with transportation processes rather sub-processes within such integrated cross-company processes (Mattsson, 2000). An OTD process in order-by-order environments starts with the recognition of a need to order and ends when the delivery of goods is made available for use; accordingly it starts and ends at the customer. The major sub-processes involved are:

- the ordering sub-process at the customer, starting with the recognition of a need to order and ending when the purchase order reaches the supplier;
- the delivery sub-process at the supplier, starting with the receipt of the order and ending when the goods is available to ship;
- the transportation sub-process, starting when the ordered goods is available to pick up and ending when unloaded at the goods receiving at the customer; and
- the goods receipt sub-process, starting when the ordered goods is received and ending when it is made available for use.

The OTD process and its four sub-processes are illustrated in Figure 1. The letters A, B and C indicate the sub-process interfaces.

OTD process performance dimensions

The performance of an OTD process concerns traditionally lead time and on-time delivery. In a logistics context, lead time is typically defined as the elapsed time between recognition of the need to order and the receipt of goods (Blackstone and Cox, 2005). On-time delivery is the extent to which the lead time, and as a consequence the delivery date, and the delivered quantity corresponds to what has been confirmed (e.g. Forslund and Jonsson, 2007; Kallio *et al.*, 2000). There are, however, other performance dimensions that in order-by-order environments also may be important: lead time variability, lead time adaptability and lead time flexibility. To simplify, these dimensions are only related to the delivery and transportation sub-processes in the

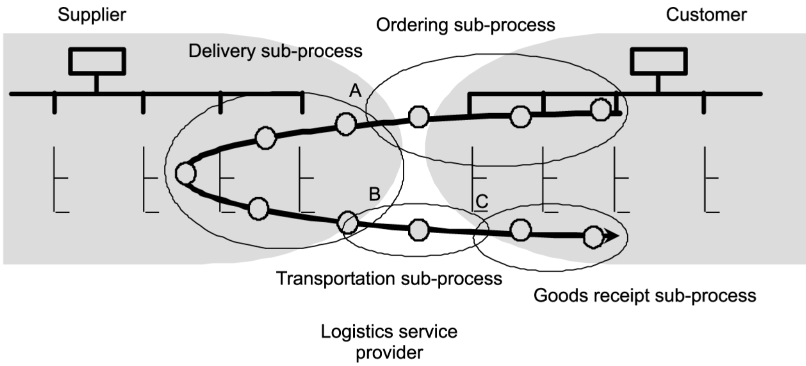

Figure 1.
The order-to-delivery process with its sub-processes

discussion below, but they are also applicable for the ordering and goods receipt sub-processes.

A way to characterize these dimensions is to relate them to the different phases in the OTD process. LaLonde and Zinszer (1976) identified three phases: pre-transaction, transaction and post-transaction. To be able to appropriately characterize various OTD process performance dimensions, the model was extended by Mattsson (2004) to five phases "before order", "at order", "from order to delivery", "at delivery" and "after delivery". The "after delivery" phase is not relevant in an OTD context and is accordingly omitted here.

Lead time "before order" refers to an estimated but not committed lead time typically maintained in the ERP system. Lead time "at order" is the lead time that is valid at the date of the order and that is confirmed by the supplier and the LSP. To distinguish the two types of lead time the first one is called anticipated lead time and the second confirmed lead time. Knowing the lead time "before order" is, however, of minor importance if it does not correspond reasonably well to the lead time "at order". The difference between the two lead times from order to order, when repeatedly issuing orders for the same item, can be labeled lead time variability. Bowersox and Closs (1996) define lead time variability as a firm's ability to perform at the expected delivery time over a large number of performance cycles.

The offered lead time from the supplier or LSP might be a problem for the customer. Due to whatever reason he/she possibly needs a delivery within a shorter time frame. The ability of the supplier and the LSP to adapt the currently applied lead time to a lead time requested by the customer is called lead time adaptability.

Lead time flexibility also relates to the length of the lead time. Various types of flexibility have been defined in the literature. One of the most referenced is Slack (1988) who identifies four types: product flexibility, mix flexibility, volume flexibility and delivery flexibility. Delivery flexibility could be seen as another word for lead time flexibility. It is defined as the extent to which delivery dates can be brought forward, which means that his definition only covers the ability to deliver earlier than confirmed or anticipated. The critical performance related to lead time flexibility is the ability to adapt the lead time to the customers needs during the phase "from order to delivery".

The relationship between lead time, lead time adaptability, lead time variability and lead time flexibility can be characterized as follows. Lead time adaptability concerns the difference between the lead time originally offered by the supplier or LSP "at order" and the confirmed lead time. Lead time variability concerns the difference between the anticipated lead time “before order” and the confirmed lead time “at order”. Finally, lead time flexibility concerns the difference between the confirmed lead time “at order” and the lead time adapted by the supplier or LSP on the customer’s request. Beyond these relationships there is also a relationship between confirmed lead time and actual lead time “at delivery”. This performance dimension is lead time accuracy or on-time delivery (e.g. Forslund and Jonsson, 2007). The relationships are illustrated in Figure 2.

OTD process performance metrics

To assess the performance related to the performance dimensions discussed above, different performance metrics have to be applied. Such metrics may be implemented on each sub-process and/or on the OTD process as a whole. Lead time length performance can be measured both as an absolute and a relative value. Measuring lead time length performance in absolute terms can be based on the definition that lead time is the elapsed time between recognition of the need to order and the receipt of goods (Blackstone and Cox, 2005). It could be measured more or less automatically in the ERP system or be estimated based on experience. To make it useful for assessment purposes it has to be compared through benchmarking or by having access to some kind of best practice figures.

Lead time length performance measurement in relative terms can be carried out in two respects, as cycle time efficiency and as lead time efficiency. The cycle time efficiency refers to the extent to which the cycle time for the process concerns time for value-adding activities. It can be expressed as the relationship in percent between time for value-adding activities and the total cycle time for the whole process. Similarly lead time efficiency refers to the extent to which the lead time for the process concerns time for value-adding activities and expressed as the relationship in percent between time for value-adding activities and the lead time for the whole process. Accordingly lead time efficiency reflects both the cycle time inefficiencies and inefficiencies due to inflated lead time caused by delays in the interfaces between sub-processes and by management time addition. Similar definitions of cycle time efficiency and lead time efficiency have been provided by Hopp and Spearman (2001).

Lead time adaptability refers to the extent to which the supplier/LSP can reduce the originally offered lead time to the current needs of the customer “before order” (e.g. Supply-chain Council, 2005). It can be expressed as how many percent the offered lead time can be reduced on request of the customer and be measured as the originally offered lead time minus confirmed lead time in percent of the originally offered lead time.

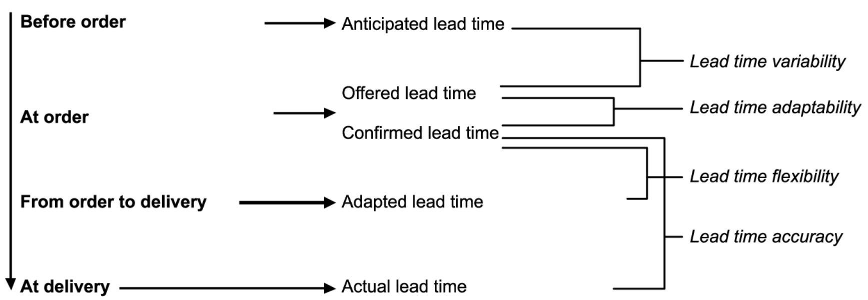

Figure 2.
An OTD process performance model for order-by-order environments

Quite a few different lead time variability metrics exist in the literature (e.g. Hopp and Spearman, 2001). Considering that different items can have very different lead times, a relative metric should be most appropriate. An example of such a metric is the range between the largest and smallest difference between anticipated lead time "before order" and confirmed lead time "at order" divided by the average anticipated lead time and expressed in percent.

Lead time flexibility can be expressed as how many percent the confirmed lead time can be reduced during the phase "from order to delivery" on request by the customer and measured as the "at order" confirmed lead time minus the actual lead time in percent of the originally confirmed lead time. Alternative metrics are the SCOR's adaptability and flexibility metrics (Supply-chain Council, 2005).

Lead time accuracy, or on-time delivery, is the extent to which the lead time, and as a consequence the delivery date, and the delivered quantity "at delivery" corresponds to what has been confirmed (e.g. Forslund and Jonsson, 2007; Kallio *et al.*, 2000). It is often measured as the percentage of confirmed order lines delivered on time.

Methodology

A single case study was conducted in order to explore the performance measurement requirements and needs in a delivery scheduling environment. Such an approach is considered appropriate in early stages of emerging topics. In order to handle qualitative research in a structured way, the steps in the case study was conducted following the principles of Yin (2003). The triad was selected by convenience sampling (Bass, 1990). The studied customer is an OEM in the automotive industry, the supplier is a component manufacturer and their LSP completes the triad. The case should, thus, be very relevant for analysis of a delivery scheduling environment. A case study protocol was developed based on the purpose and the theory review. Data were collected from multiple sources, which are shown in Table I. Personal and telephone interviews using the case study protocol were conducted. Quantitative performance data from December 2007 to March 2008 were taken from the customer company's ERP system. Case descriptions were validated by the respondents. The quality and the limitations of the study are further discussed in the final section.

The triadic case study

The case study is presented by sub-process. Each section is introduced with brief company and sub-process characteristics. As the empirical study is conducted in a delivery scheduling environment, the first sub-process is called delivery scheduling sub-process rather than ordering sub-process.

Company	Respondents	Data collection
Customer: OEM manufacturer	Manager materials control Manager inbound logistics Material planner Head process management development	Personal interviews February Telephone interviews March
Supplier: component manufacturer	Account manager Material planner	Personal interviews March
Logistics service provider	Account manager	Personal interview March

Table I.
Studied companies and applied data collection

The performance of the customer's delivery scheduling sub-process

The customer company manufactures vehicles, which are to a large extent customer-specific and are sold through dealers all over the world. Normally, the manufacturer has ten days frozen time period towards their dealers.

At start of the delivery scheduling sub-process, the planned lead time for the activities, recognition of the need to order, checking of delivery schedule and sending the delivery schedule to the supplier is 2.6 days. The lead time varies; the minimum lead time is one day and the maximum lead time is four days. This is estimated by experience and is not measured and followed up with any measurement system. Variation is mainly related to the time addition of weekends, which can be well predicted. Lead time flexibility can be achieved when needed by manual work. For this sub-process, no measurements are perceived to be necessary.

The performance of the supplier's delivery sub-process

The component supplier delivers a number of options articles that may be built into the vehicles. Its products are complex hydraulic cylinders. From the customer's perspective, the anticipated lead time, or the frozen time for this sub-process, is 20 days.

Before the frozen time period, the supplier does not act on the delivery schedule, as it enters their ERP system automatically. They are however aware of that they have access to demand information which could be used for long-term planning. Scheduled quantities for a given week can vary from −86 percent to +600 percent between the delivery schedules. At freezing of the delivery schedule, changes in delivery quantities are seldom made. The activities are an internal order acknowledgement that generates a production order and triggers the ordering of the main components for the hydraulic cylinders. This acknowledgement is not sent to the customer company, because the related EDI function is not yet up running. The basis for a measurement system of changes at freezing hence exists in the ERP system.

During the frozen period, the lead time for the purchased material takes place. The last days before delivery, the production process occurs. It consists of metal processing, welding, assembly, quality check and painting, with a planned lead time of five days. Changes here occur approximately once a month and concern demand for shorter lead time. A manual contact is taken and an adapted delivery date is negotiated. Even if the customer accepts this new delivery date, it does not change in the delivery plan, which gives the supplier lower delivery date accuracy than it deserves. The production lead time of the supplier can be compressed to two to three days in cases of emergency. A new transport must also be booked. The day before delivery, dispatch information must be booked in the LSP's booking system. As the customer stands for the transportation, delivery date accuracy or sending date accuracy is measured and is on average 95 percent. After delivery, a notification of delivery must be sent to the customer. The supplier does not know how the customer uses this information.

The performance of the LSP's transportation sub-process

The LSP handles inbound and outbound transports for the customer. Transports are organized with fixed days for pick-up and delivery via an own terminal. It is possible to order an extra transport if necessary to speed up this sub-process. Lead time accuracy is measured by the customer on vehicle level. This cannot be related to each supplier's performance on article level. The LSP measures the goods on weight and volume and does not provide the customer with any measurement data.

The start of the transportation sub-process is when the goods are available to be picked up. The time from start to finish of the transportation sub-process consists of loading, transportation to terminal, unloading and reloading at the terminal, transportation to and unloading at the customer site. The time for finishing the transportation sub-process is mostly related to which of the scheduled trucks from the LSP's terminal that has capacity to load the goods. The anticipated lead time is three days, varying from two to five days. The LSP is only communicating exception messages and does not offer track and trace services and proof of collection messages.

The performance of the customer's goods receipt sub-process

The anticipated lead time for this sub-process in the customer's ERP system is on average four days, two days which are referred to as transportation waiting time and two days' safety time; this time is supposed to cover the activities internal movements, quality check, registration and putting into buffer stock, plus being a time buffer. This time is estimated by the material planner's experience with the supplier and the sub-process. It is possible to rush an order through this sub-process manually in six hours. No measurements exist.

Generating an OTD process performance model

The analysis contains two phases. The first compares the measured performance dimensions of the case with the reviewed literature. The second generates two performance models for OTD processes in delivery scheduling environments, i.e. it presents performance models argued to fulfill the measurement needs of situations similar to that in the case study.

Measured OTD performance dimensions

The OTD lead time length is calculated and used as an anticipated lead time by the customer. It is the sum of the length in the four sub-processes. From the customer's perspective, the total lead time for this supplier is approximately 28 days. Lead time can be compressed to seven days, which corresponds to the maximum lead time flexibility that can be provided in the OTD process.

Several mismatches between what is considered important to measure and what is actually measured are observed, but also between what is "easy" to measure, i.e. where available data exist, and what is actually measured. Before the frozen time period and at freezing time point, lead time and quantity information is available in the ERP systems but are not used. Quantity variability and adaptability are therefore not measured, contradicting the suggestions of Mattsson (2004). During the frozen time period, lead time and quantity information is not available in the ERP systems. Therefore, the related quantity and delivery date flexibility performance is not either measured. The above performance dimensions were though considered important to measure in the case study, especially the quantity and delivery date flexibility. At delivery, quantity and lead time information is available in the ERP systems, and the related quantity and delivery date accuracy are measured. They are the only measured performance dimensions in the studied OTD process; this accords to the findings of Forslund and Jonsson (2007). Both customer and supplier carry out measurement, which also accords with Forslund and Jonsson (2007). The measurement point is at the end of the supplier's delivery sub-process (the letter B in Figure 1), and consequently not in the end of the entire OTD process. Overall OTD quantity and delivery date accuracy is hence not measured.

For the delivery scheduling and goods receipt sub-processes, lead time flexibility is considered more important than lead time accuracy. The possibilities for flexibility are known, as the customer has the estimated min, max and average lead times for these sub-processes in its ERP system. But no measurement systems are applied currently to measure lead time flexibility. Not either is lead time accuracy measured in these processes. For the transportation sub-process the lead time length is on average one day but can be longer. Also in this sub-process, the lead time flexibility is considered more important than lead time accuracy.

OTD process performance models in delivery scheduling environments

Several gaps were identified between the performance measurement needs, measured performance dimensions in the studied case and the presented order-by-order performance model. As compared to an OTD process in order-by-order environments, it is consequently necessary to extend the performance model for delivery scheduling environments to cover delivery performance in a broader sense, by not just including various dimensions of lead time but also some quantity dimensions. Doing so means considering anticipated quantities, frozen quantities, confirmed quantities, adapted quantities and delivered quantities parallel to the corresponding lead time dimensions.

To fit the delivery scheduling environment, two different performance models are developed, firstly for the supplier's delivery sub-process and secondly for the other three sub-processes. The lead time for the supplier's delivery sub-process refers in this case to the length of the frozen period in the delivery schedule. The length of the frozen period is accordingly a performance dimension representing the supplier's capability to provide short delivery lead times. Being a part of a mutual agreement, the lead time is then fixed and given before order. Anticipated lead times and lead time variability have consequently no meaning. Instead it is reasonable to talk about anticipated quantities understood as the quantities just "before the frozen period" that the supplier anticipate to have to deliver when he/she next gets a new delivery schedule and these quantities lie within the frozen period. If there are restrictions concerning how much these quantities just "before the frozen period" are allowed to be changed by the customer from one delivery schedule to the next, these restrictions represent the extent to which the supplier can cope with these kinds of changes. The restrictions imposed on the customer then constitute a quantity variability performance dimension for the supplier.

"At freezing of a delivery schedule", the customer may face problems with the restrictions stated in the mutual agreement on how much he is allowed to change the scheduled quantities entering the frozen zone. He has however always an opportunity to overrule the terms in the agreement by asking the supplier to accept changes larger than stated. The supplier's ability and willingness to accept such changes represents a quantity adaptability performance dimension for the supplier. The quantities and delivery dates "during the frozen period" represent confirmed orders. The supplier's ability and willingness to change these quantities and dates if requested by the customer during the period from receiving the delivery schedule to delivery, represents then a quantity and delivery date flexibility performance dimension for the supplier.

"At delivery" the customer gets the actual delivery date and actual delivered quantity. The difference between the quantity delivered and the quantity stated in the delivery schedule represents a quantity accuracy performance dimension for the supplier. In the same way the difference between this delivery date and the date stated in the delivery schedule then represents a delivery date accuracy or on-time delivery performance dimension. The performance model for the supplier is illustrated in Figure 3.

The performance dimensions for the other three sub-processes are closer to the order-by-order model but even in this case anticipated lead time, offered lead time, lead time variability and lead time adaptability have no meaning due to the cyclic pattern in environments where ordering takes place through delivery schedules. "At start of the sub-processes", its more reasonable to talk about a planned lead time, and in the case of the transportation sub-process a confirmed lead time through an agreement with the LSP. To the extent this lead time can be modified "from start to finish" of the process on request of the customer, the difference between the planned lead time and the modified lead time can be considered as a lead time flexibility performance dimension. The difference between actual lead time and confirmed lead time "at finishing the sub-process" represents the performance dimension lead time accuracy. Quantity has no significance as a performance metric for these three sub-processes. The performance model for the delivery scheduling sub-processes, the transportation sub-process and the goods receipt sub-process in delivery scheduling environments will therefore be as illustrated in Figure 4.

Conclusions, limitations and suggestions for further research

The purpose of this article was to generate a performance model for an OTD process in delivery scheduling environments. Two performance models for OTD process performance in delivery scheduling environments were developed, which are theoretical contributions of this study. The OTD process performance models in delivery scheduling environments contain four sub-processes and ten performance dimensions. As delivery scheduling environments focus more on delivery quantities

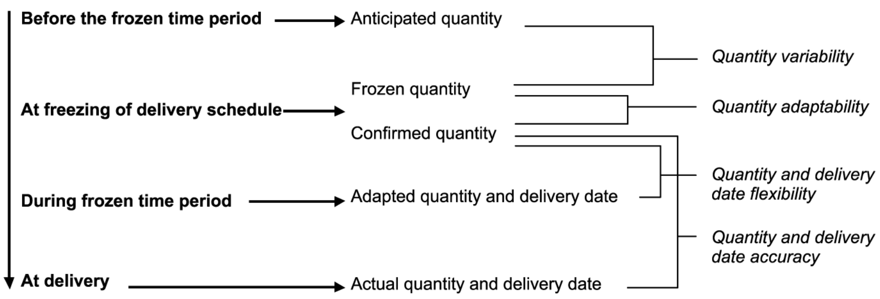

Figure 3.
The performance model for the supplier's delivery sub-process

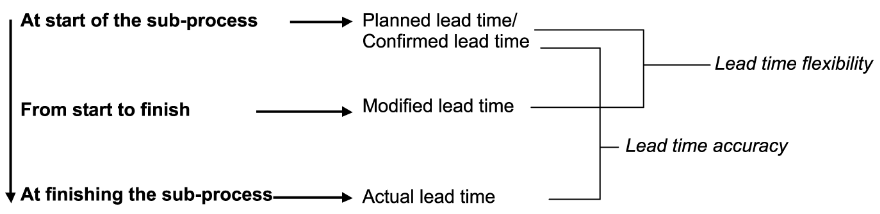

Figure 4.
The performance model for the delivery scheduling, transportation and goods receipt sub-processes

than delivery times, the models are also more oriented towards quantity than time performance metrics. Delivery accuracy, or on-time delivery, is the most common OTD performance dimension in practice. Additional performance dimensions were defined in the conceptual analysis and identified as important in the empirical study, and were hence included in the performance model. It was also identified that flexibility is often more important than accuracy. The applied triadic approach enabled a more holistic supply chain performance study, as called for by, for example, Shepherd and Günter (2006).

Some limitations to the results have to be commented. Construct validity (Yin, 2003) was increased by the use of a case study protocol and by collecting data from multiple sources. The case descriptions were validated by the respondents. External validity (Yin, 2003) is, due to the explorative character of the study and the single case approach, limited to analytical generalization. We, however, believe that the case is typical for a delivery scheduling environment. The study was conducted in a Swedish setting, which might, although we cannot argue otherwise, limit the possibilities to generalize the findings. The use of a case study protocol also increases reliability (Yin, 2003). Reliability was further increased by the fact that all interviews were conducted by two, and the same, authors.

The findings and some observations during the study lead to several tracks for further research. The operative metrics for the ten performance dimensions are not defined in the way they were in order-by-order environments. This is important to do in order to further develop and validate the presented models.

Several obstacles to the low level of OTD process performance management were observed, related to poor sub-process interaction. The customer impacts the supplier's performance by the high quantity variability in the delivery schedule, which puts high lead time flexibility requirements on the supplier. The fact that the LSP only measures goods weight and volume and not article numbers is a problem for customers and suppliers. The LSP's transport precision, defined as the proportion of trucks on time, is consequently of low value. It is not possible for the LSP to provide customers with order acknowledgements and track and trace information which could decrease the quantity and delivery date flexibility needs of the customer. The LSP's booking system is considered difficult to manage which affects the accuracy of transport booking and further increases the lead time flexibility requirements. The customer is responsible for the transportation and therefore all communication in the triad is dyadic; between LSP-customer and between supplier-customer. The supplier impacts the customer's and LSP's performance by the long lead time, which has negative impact on almost all other performance dimensions. The supplier has started to build up a finished goods inventory in order to increase delivery flexibility and perform higher delivery accuracy. This results in higher costs and more tied-up capital at the supplier. Another example of a problem in the ERP systems in the triad is that the supplier makes a delivery notification in the ERP system which just is used for internal purposes and never reaches the customer. Consequently, the following are some empirically identified obstacles for high OTD process performance:

- The LSP's measurement is not compatible with the measurement of the suppliers and customers.
- Improper ERP/administrative systems or improper use of these systems are obstacles for high OTD process performance.
- Dyadic communication is an obstacle for high OTD process performance.

Several mismatches between what is considered important to measure and what is actually measured were also observed, but also between what is easy to measure, i.e. where available data exist, and what is actually measured. These observations and their effects should be studied further, in for example broader survey studies, in order to test the possibilities to generalize and develop the OTD process performance model.

Long lead time is a major cause to low OTD process performance. It would be relevant to conduct a deeper study on lead time length performance. Studying lead time efficiency could reveal patterns related to cycle time inefficiencies, delays in sub-process interfaces and also in time additions made by management. Knowing more about lead time length behavior could positively impact the other performance dimensions.

References

Bask, A.H. (2001), "Relationships among TPL providers and members of supply chains – a strategic perspective", *Journal of Business & Industrial Marketing*, Vol. 10 No. 1, pp. 59-68.

Bass, B.M. (1990), *Bass & Stogdill's Handbook of Leadership: Theory, Research and Managerial Applications*, The Free Press, New York, NY.

Beamon, B. (1999), "Measuring supply chain performance", *International Journal of Operations & Production Management*, Vol. 19 No. 3, pp. 275-92.

Blackstone, J. and Cox, J. (Eds) (2005), *APICS Dictionary*, 11th ed., APICS – The Association for Operations Management, Alexandra, VA.

Bowersox, D. and Closs, D. (1996), *Logistical Management*, McGraw-Hill, New York, NY.

Brewer, P.W. and Speh, T.W. (2000), "Using balanced scorecard to measure supply chain performance", *Journal of Business Logistics*, Vol. 21 No. 1, pp. 75-93.

Forslund, H. and Jonsson, P. (2007), "Dyadic integration of the performance management process: a delivery service case study", *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No. 7, pp. 546-67.

Hopp, W. and Spearman, M. (2001), *Factory Physics – Foundations for Manufacturing Management*, Irwin-McGraw-Hill, New York, NY.

Kallio, J., Saarinen, T., Tinnilä, M. and Vepsäläinen, A. (2000), "Measuring delivery process performance", *The International Journal of Logistics Management*, Vol. 11 No. 1, pp. 75-87.

Keebler, J.S., Manrodt, K.B., Durtsche, D.A. and Ledyard, D.M. (1999), *Keeping Score – Measuring the Business Value of Logistics in the Supply Chain*, prepared for CLM, CLM, Oakbrook, IL.

LaLonde, B. and Zinszer, P. (1976), *Customer Service: Meaning and Measurement*, National Council of Physical Distribution Management, Chicago, IL.

Larson, P.D. and Gammelgaard, B. (2001), "The logistics triad: survey and case study results", *Transportation Journal*, Vol. 41 Nos 2-3, pp. 71-83.

Lee, H. (2000), "Creating value through supply chain integration", *Supply Chain Management Review*, No. 5, pp. 30-6.

Lohman, C., Fortuin, L. and Wouters, M. (2004), "Designing a performance measurement system: a case study", *European Journal of Operational Research*, Vol. 156 No. 2, pp. 267-86.

Mason-Jones, R., Naylor, B. and Towill, D. (2000), "Engineering the leagile supply chain", *International Journal of Agile Management Systems*, Vol. 2 No. 1, pp. 54-61.

Mattsson, S.-A. (2000), *Embracing Change – Management Strategies in the E-economy Era*, Intentia International, Stockholm.

Mattsson, S.-A. (2004), "Logistical implications of delivery lead time variability and flexibility", *Proceedings of the NOFOMA Conference in Linköping*, Linköping University, Linköping.

Melan, E. (1993), *Process Management: Methods for Improving Products and Services*, McGraw-Hill, New York, NY.

Phillips, J.M., Liu, B.S. and Costello, T.G. (1998), "A balance theory perspective of triadic supply chain relationships", *Journal of Marketing Theory & Practice*, Vol. 6 No. 4, pp. 78-92.

Shepherd, C. and Günter, H. (2006), "Measuring supply chain performance: current research and future directions", *International Journal of Productivity & Performance Management*, Vol. 55 Nos 3/4, pp. 242-58.

Slack, N. (1988), "Manufacturing systems flexibility", *Journal of Computer Integrated Manufacturing Systems*, Vol. 1 No. 1, pp. 25-31.

Supply-chain Council (2005), *Supply-chain Operations Reference Model: SCOR Version 7.0 Overview*, Supply-chain Council, Brussels.

Yin, R. (2003), *Case Study Research: Design and Methods*, Sage Publishing, Thousand Oaks, CA.

Zhang, Q., Vonderembse, M. and Lim, J-S. (2005), "Logistics flexibility and its impact on customer satisfaction", *International Journal of Logistics Management*, Vol. 16 No. 1, pp. 71-95.

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