DELIVERY RELIABILITY IN OUTBOUND VEHICLE DISTRIBUTION – A FACTOR OF SUCCESSFULL AUTOMOTIVE SUPPLY CHAIN

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Abstract

Finished vehicle logistics is a complex activity focusing on outbound delivery accuracy and quality in the automotive supply chain (outbound vehicle distribution). Once the vehicle has been produced, it is transported from production plant to the dealership via outbound logistics. The most important criteria that reflect performance of successful automotive outbound supply chain are among other: on-time pickup, delivery reliability, lead time, dwell time and damage-free delivery (damage level). Therefore, the objective of this paper is to analyse delivery reliability as crucial factor of successful vehicle logistic provided by logistic service providers (3PL, 4PL or LLP). They play an important role in rising of efficiency in a complex automotive supply chain as outsourcing partners of original equipment manufacturers (OEM's) and evaluate their performance using Key Performance Indicators (KPIs) from which is the most important; on-time delivery (OTD) as indicator of delivery reliability. Premium segment of the automotive industry is creating optimised supply chain that realize short delivery times and high delivery reliability in order to maximize customer satisfaction. In formulating and analysing the research problem, the authors explore performance using Key Performance Indicators (KPIs). The findings indicate that continuously measurement of on-time delivery can improve overall automotive supply chain and fulfilment of customer requirements.

Key words: finished vehicle logistics, delivery reliability, outbound distribution, On-time delivery, key performance indicator (KPI)

1. INTRODUCTION

Outbound vehicle distribution is of crucial importance for an efficient automobile supply chain and impacts on customer satisfaction. There are many criteria that reflect a performance of successful automotive supply chain and most important are among other: on-time pickup, delivery reliability, lead time, dwell time and damage-free delivery (damage level).

Delivery reliability is one of the main determinants in automotive logistics that means ability to deliver logistics service when promised. Therefore is essential component of this research.

The aim of this paper is to analyse the delivery reliability as crucial factor of successful vehicle logistic provided by logistic service providers (3PL, 4PL or LLP) which play important role as outsourcing partners of original equipment manufacturers (OEM's).

In analysing and formulating the research problem, the authors used different combinations of scientific methods such as: the classification and comparative method, the method of deduction and induction, the method of description and the method of analysis and synthesis.

The paper is organised in five chapters. After *Introduction*, the second chapter titled *The main characteristics of automobile supply chain (outbound vehicle distribution)* introduces the main characteristics of complex supply chain in channel of finished vehicle logistic that includes also intermediaries and third-party service providers. *Key performance indicators (KPI's) – tools for improving and optimising outbound supply chain performance* focuses on main KPI's in a post-ante context in order to evaluate the past performance of a logistic service providers. Forth chapter is focused on *delivery reliability* and definition of delivery window as a framework for managing delivery performance. In *Conclusion*, the synthesis and explanation of the results of this research are given based on the collected information and data.

2. THE MAIN CHARACTERISTICS OF AUTOMOTIVE SUPPLY CHAIN (OUTBOUND VEHICLE DISTRIBUTION)

The Council of supply chain management professionals defines supply chain management (SCM) as encompassing, the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers (CSCMP, 2013, p.1). They define outbound logistics as processes related to the movement and storage of products from the end of the production line to the end user.

Outbound vehicle distribution are vehicle logistics services provided after they have left the production plants to go to dealers or importers. The vehicle distribution network of an automotive company consists of all activities required to deliver finished vehicles from the assembly plants to the dealers (Eskigun et al., 2005, p. 182).

The automotive industry is the world's largest single manufacturing activity. It uses 15 percent of the world's steel, 40 percent of the world's rubber and 25 percent of the world's glass. It also uses 40 percent of the world's annual oil output. Vehicle distribution or outbound logistics is the process of transporting vehicles from the assembly plant to the dealership or final customer with large fleets. The outbound distribution logistics is always done via train, truck and ship (Suthikarnnarunai, 2008, p. 1-3).

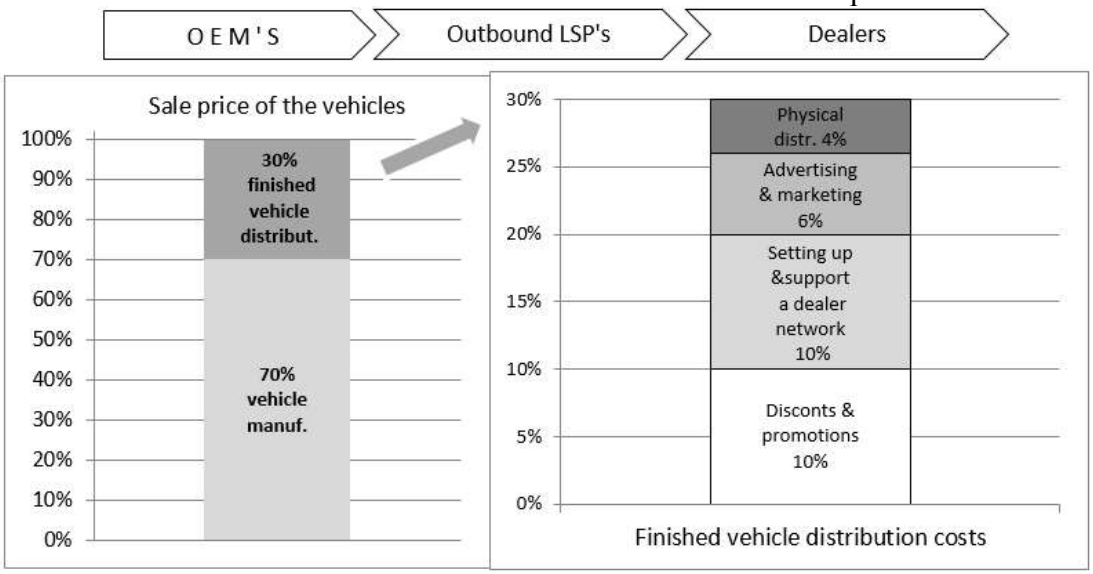
The researches on outbound logistics related activities include transportation mode selection and customer satisfaction through lead-time reduction (Eskigunet et al. 2005, Miranda & Garrido 2004, Chopra 2003), optimum location of distribution centres (Wasner & Zapfel 2004, Nozick 2001, Melkote & Daskin 2000), shipment consolidation (Tyan et al. 2003, Cetinkaya & Bookbinder, 2003). Therefore, most of the existing literature focuses on the vertical collaboration in outbound logistics systems. According to Bowersox et al. (2003, p. 18), the essence of horizontal collaboration is to jointly develop strategic plan and synchronize operations to achieve economies of scale, reduce or eliminate duplication and redundant operations.

Each automotive OEM operates its own outbound logistics network. The outbound logistics operations form the last step of the three main processes: order receiving from the dealers, manufacturing vehicles at the plants, and transporting finished vehicles to the dealers (Nazmul, 2012, p. 25).

Outbound vehicle distribution from the OEM vehicle assembly plant to dealer has influence on effectiveness of the overall supply chain by representing the lead time to customer which is interested when vehicle will be delivered. „Proportioning between manufacturing lead-time and distribution lead-time means little; customers only want to know when the merchandise will arrive." (Miemczyk & Holweg, 2004, p.5).

The review of the literature showed also that physical distribution of finished vehicles typically accounts for 4% of the sale price of the vehicle (figure 1.) and total finished vehicle distribution cost accounts for 30% of the sale price of the vehicle.

Figure 1. Finished vehicle distribution: breakdown of the sale price of a vehicle and the finished vehicle distribution costs into its main components



Source: European Car-Transport Group of Interest (ECG), 2010, p.51

Therefore, for all automakers, selection of an logistics service providers (LSP's) plays important role and have very high significance in terms of making the outbound supply chain as cost-efficient as possible. They are logistics intermediaries who on behalf of the automotive OEM's arrange logistics services. The outbound logistics

process flow begins with release of finished vehicle from the assembly plant and ends with the arrival of the vehicle to the dealer. Of course, some of the vehicles are delivered directly (eg. by truck), and other after arrival by vessel or rail to mixing centres or HUB's, where are consolidated from different plants. The aim of using such intermediaries/LSP's is to facilitate the logistics operations related to the deliveries of the vehicles.

Key skills of outbound logistics service providers in the automotive value chain are:

a) Ability to reduce lead time
b) Cost reductions
c) Effective management of volatile OEM's forecasts
d) Productivity and quality
e) Damage control
f) Ability to respect dealership requirements.

According to Pavlić Skender, Host and Nuhanović (2016, p. 22) „An intermediary is a person or a company that acts as a mediator between different parties with the goal of achieving a certain business deal. Most commonly, intermediaries specialize in one specific field among the various logistics function". In outbound vehicle supply chain are mostly involved three different types of intermediary; third-party logistics (3PL), fourth-party logistics (4PL) and so called lead logistics providers (LLP's). The following table shows the main characteristics and comparison of all types of mentioned providers.

Table 1. Comparison for different logistic service providers (LSP's)

Item/description	3PL	4PL	LLP
Scope of services	Logistics managed model incl. transportation, inventory management and freight forwarding	Full SC services including 3PL basic functions, Infor. Techn. services, and Business Process Manag..	Full SC services incl. Resource management, Information Central System, and Logistics synchronization.
Characteristics of services	Logistics specialty services focus on transportation and warehousing operation	SC alliance leading, single point-of-contact integrated service	Managing internal and external logistics to synchronize material flow
Facilities & warehouses	Possession of facilities and warehouses	Outsourcing	Outsourcing
Fleet	Possession of fleet	Outsourcing	Outsourcing
Information technology service	Not applicable	Develop and provide IT services	Develop and provide IT

Source: Huang et al., 2010, p. 168

Third-Party Logistics Providers (3PL) are organisations which provide multiple logistics services for use by customers. According to the Terms and Glossary of Supply Chain Management (2013) third-party logistics provider is a firm which provides multiple logistics services for use by customers. Preferably, these services are integrated, or "bundled" together by the provider. These firms facilitate the movement of parts and materials from suppliers to manufacturers, and finished products from manufacturers to distributors and retailers. Among the services which they provide are transportation, warehousing, cross-docking, inventory management, packaging, and freight forwarding.

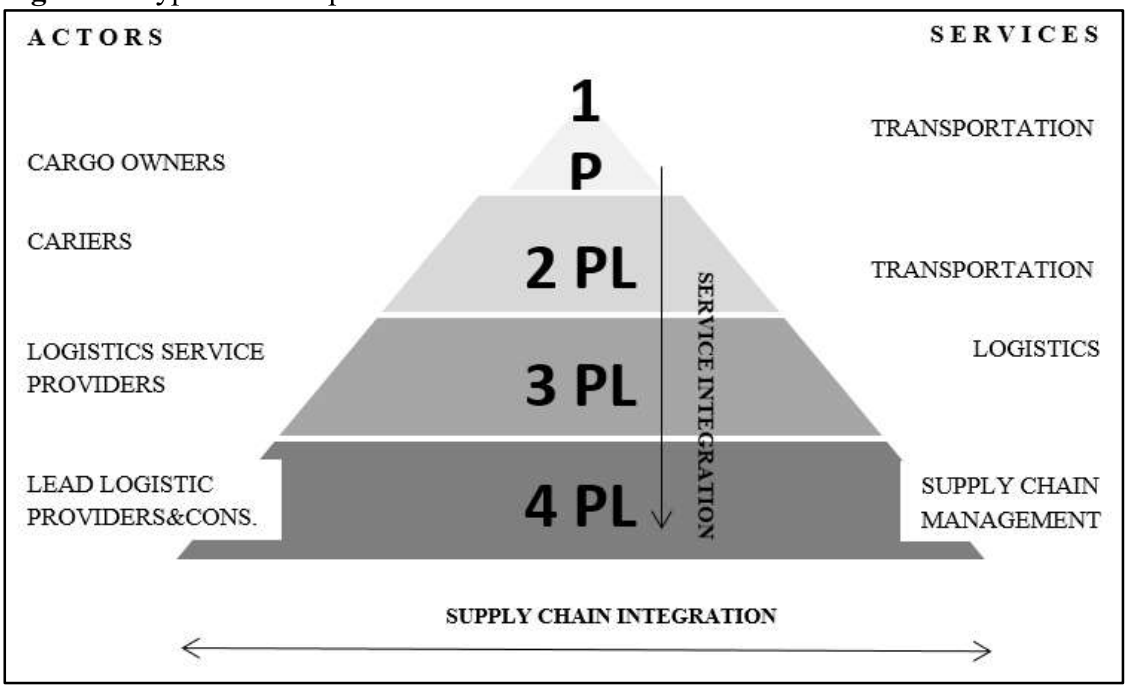
Fourth-Party Logistics (4PL) according to Supply Chain Management (2013), differ from third party logistics in the following ways:

1) 4PL organization is often a separate entity established as a joint venture or long-term contract between a primary client and one or more partners;
2) 4PL organization acts as a single interface between the client and multiple logistics service providers;
3) All aspects (ideally) of the client's supply chain are managed by the 4PL organization; and,
4) It is possible for a major third-party logistics provider to form a 4PL organization within its existing structure.

In outbound vehicle logistics, the 4PL service providers do not own any physical assets or only limited (such as information technology system) and play a different role, and that is the main difference with 3PL service providers (as shown in figure 2). According to Win (2008, p. 677), the main function of a 4PL provider is to implement and manage a value creating business solution through control of time and place utilities within the client organisation.

A Lead Logistics Service Provider is similar to a 4PL with a different business model in where the LLP manages the transport solution on behalf of the customer but where the actual contracting is carried out by the customer. Actually, LLP is a non-asset based 3PL provider which manages, designs and aggregates outbound supply chain in finished vehicle logistics.

Figure 2. Types of PL's providers



Source: International 3PL, 2015.

According to results of research of logistics service providers in Croatia (Bašić, 2015, p. 17 - 18), in finished vehicle logistics in y. 2014., 62,59% of brands (new vehicles) are distributed from production plants to Croatian vehicle logistics centers (VLC's) supported by LLP, 30,32% by 4 PL, and 7,09% by 3 PL companies. In the second part of this outbound vehicle supply chain (distribution of vehicles from vehicle logistics centers to Croatian dealers), 82,06 % of brands (new vehicles) are distributed by 3 PL's, 10,87% by 2 PL's and 7,09% by LLP's.

3. KEY PERFORMANCE INDICATORS (KPI's) – TOOLS FOR IMPROVING AND OPTIMISING OUTBOUND SUPPLY CHAIN PERFORMANCE

Logistics operations are complex and the parameters are difficult to measure. Whatever is monitored can be measured and whatever is measured can be improved. It means, areas for improvement can be easily revealed if there is any method that measures logistics function (Kumar, 2013, p. 2). Logistics performance measurement plays a vital role in today's business management. Supply chain performance indicators are key tools for monitoring and improving the supply chain performance to gain competitive advantage (Taylor, 2004, p. 173). Using indicators for the measurement of SCM performance creates an understanding of the supply chain's processes, guides collaboration efforts and optimises supply chain excellence (Fawcett et al., 2007, p. 409).

According to Cox et all. (2003, p. 142) KPI's help an organizaton define and measure progress toward organizational goals. KPI's are quantifiable measurements to examine the improvement in performing an innovation implementing activity that is critical to the success of a business. A KPI has a lifetime and requires continuous

updating. Sometimes, its replacement is also needed (Ghalayini & Nobel, 1996, p. 64). According to Sinclair and Zairi (1995, p. 50) KPI's use a metric for quantitatively assesing performance regarding the needs and expectation of stakeholders, the achievement of goals, and reflecting the critical success factors.

In finished vehicle logistics are often used key performance indicators (KPI's) in a post-ante context to evaluate past performance of logistics service providers related to deliveries of vehicles. Because of small margins in outbound vehicle logistics, LSP's continuously trying to find opportunities which can improve their profitability. The most important activities to achieve it, are planning and control for which is necessary to select appropriate indicators and metrics for measuring of performance.

The basic solution in SCM which consist of a lot of measures (factors) is the Supply Chain Operations Reference (SCOR) model. It is developed by the Supply Chain Council (CSCMP) in 1996 and focuses on the supply chain management function from an operational process perspective and includes customer interactions, physical transactions and market interactions. CSCMP (2013, p. 187) emphasize that SCOR model is built around six major processes: plan, source, make, deliver, return and enable. According to Zhou et al. (2011, p. 332) the benefits of implementing the SCR model included faster cycle times, less inventories, improved visibility of the supply chain, and access to important information in a timely fashion. Richey et al. (2010, p. 237) suggested that the supply chain governance which balances the self-interest and independency in supply chain can help improve performance.

The latest trend in automotive logistics, outsourcing require a holistic measurement of performance (Neto & Pires, 2012, p. 734), and provide a rationale for focusing on logistics performance measurement (Gunasekaran et al., 2005, p. 523), too, due to increasing relevance of logistics.

Performance indicators that have an impact on operational performance of logistic service providers in supply chain of outbound vehicle distribution are:

1. Transport performance
    a) Pick up performance (on time pickups /order to gate out) – calculation method: total number of vehicles picked up within the specified leadtime / total number of vehicles picked up.
    Pick up time = shipping date – notification date
    b) Transit time (gate-out to delivery) – calculated by the number of days or hours from the time when a vehicle leaves production plant to the time it arrives to destination
2. Quality performance
    Damage performance – calculation method: damage rate = total of number claims accepted by the carrier / number of vehicles transported
3. EDI performance
    EDI on time report – calculation method: number of reported vehicles sent in the lead-time / total of reported vehicles. Transportation lead time is the in-transit interval from customer order to delivery of vehicles to the requested destination.

Using KPIs in finished vehicle logistic ensures evaluating of outbound vehicle distribution against a static benchmark. In case of fluctuations they can indicate that performance moves in the wrong direction and which corrective action can be taken

to improve the situation. Therefore, KPI's are essential tools for improving and optimising performance of outbound supply chain. OEM's in automotive industry precisely define in contract with LSP's service level agreement (SLA) in which are contained performance measurement indicators and also penalties that being applied when performance falls below contracted levels.

4. DELIVERY RELIABILITY

One of the main parameter which defines the performance of a logistic system is its reliability (Blanchard, 2004, p. 102). Delivery reliability is defined as number of products delivered on confirmed delivery date divided by number of products ordered (Schönsleben, 2016, p. 46). According to Pegels (2005), delivery reliability is the ability of the company to deliver on or before the promised scheduled due date. A high standard of delivery reliability is crucial success factor in achieving customer satisfaction. According to Berry et al. (1991, p. 364), delivery reliability is sometimes referred to as dependability or on-time delivery and concerns the ability to deliver according to a promised schedule or plan. This sub dimension of operational performance is often regarded prerequisite.

Delivery reliability in outbound vehicle logistics means that vehicles are delivered on time. Commonly used measure of reliability is on-time delivery (OTD) that OEM's find by dividing of orders delivered on time by the total number of orders delivered which have goal to achieve ratio of 100%. For optimal performance of the outbound vehicle supply chain is very important that all vehicle logistics processes are harmonically synchronised because higher operating efficiency results in shorter lead time and improve on-time delivery performance that leads to decrease of delivery cost as well as total cost. When delivery is made on time, the costs incurred by the supplier are considered to be "normal costs" and no penalty cost is incurred.

One of the method related to reliability indicator methods which can be used to estimate the logistic system reliability is the "Perfect order fulfilment" method (Szozda & Werbinska, 2011, p. 149) where is used indicator OTIF (On-time, In-full, Error- free) that is calculated from the formula:

$OTIF = P_{o\text{-}t}P_{i\text{-}f}P_{e\text{-}f}$ where: $P_{o\text{-}t}$ - probability of on-time delivery;
$P_{i\text{-}f}$ - probability of in-full delivery;
$P_{e\text{-}f}$ - probability of error-free delivery.

CSCMP (2013, p. 134) define OTIF as sales order delivery performance measure which can be expressed as a target, say, of achieving 98% of orders delivered in full, no part shipments, on the requested date.

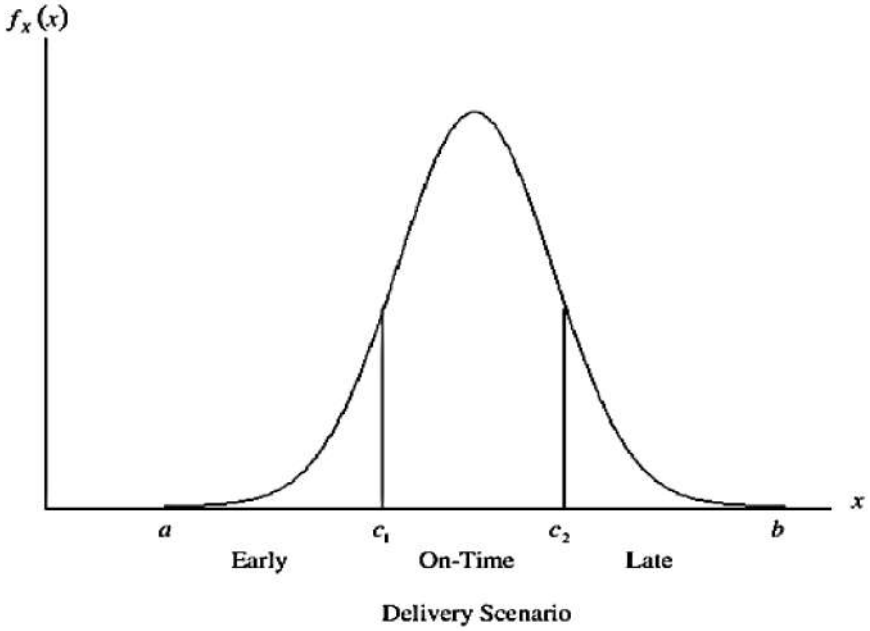
4.1. Delivery window – framework for managing delivery performance in the outbound vehicle logistics

One of the important goals of the supply chain in the outbound vehicle logistics is how to achieve delivery performance based on the customer's specification of delivery timeliness which is defined by delivery window. Under the concept of delivery window is possible to analyse the costs caused by untimely delivery.

According to Corbett (1992, p. 74) delivery windows are an effective tool for modelling the expected costs associated with untimely delivery. Johnson and Davis (1998), note that metrics based on delivery windows capture the most important aspect of the delivery process, which is reliability.

A delivery window is defined as the difference between the earliest possible delivery date and the latest acceptable delivery date. Delivery window is illustrated on figure 3; the OEM and customer contractually agree about the framework for managing delivery performance, which is between an earliest allowable delivery date (a) and a latest allowable delivery date (b). Within the delivery window, delivery can be early, on-time, or late. According to Guiffrida and Jaber (2008), delivery lead time, X is random variable with probability density function fX(x). The on-time portion of the delivery window is defined by c2_c1.

Figure 3. Illustration of delivery window



Source: Guiffrida A.L., Yaber M.Y., 2008, p. 2151

According to Shang & Liu (2011, p. 601) late deliveries frequently exist in many different industries and lead to a deteriorated delivery reliability to customers and will have a long-term negative effect on customers demand.

Usually in outbound vehicle logistics pick up time in which logistics company is obliged to collect the vehicles from the factory is between 24 and 72 hours from the day of the transport order. Transport time to the dealership depends on the distance from production plant to final destination. In case of late delivery in a outbound supply chain logistic service providers should be penalised with penalty costs that are incurred in addition to the normal operating costs. In case that a delivery is performed within the on-time portion of the delivery window, there will be no penalty cost.

In 2016 were produced 72 million cars produces worldwide. According to ACEA (2017), the volume of vehicles (first three brands) sold by selected luxury car brands in 2016 is: Mercedes-Benz 2,08 million units, BMW 2,00 million units and Audi 1,87 million units. The three German premium brands have increased their combined share of the European market to 17% from 10% two decades ago (Hetzner & Cifferi, 2015).

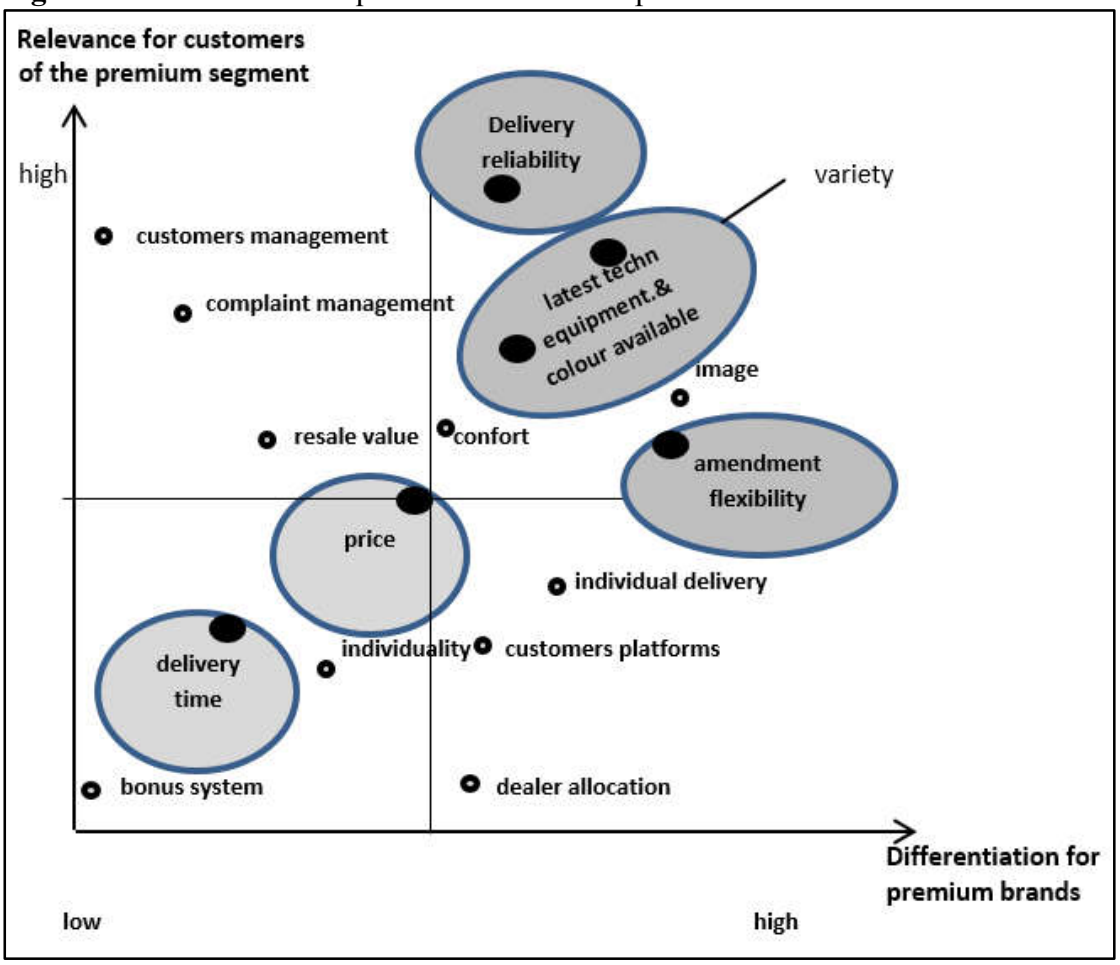
Mercedes-Benz connected in their outbound logistics approach, the degree of delivery date fulfilment with their performance related payment system for providers in which they motivate their partners with a bonus to exceed the agreed targets (Ludwig, 2013). Based on this concept of "self-adjusting system" they continuously improve promised delivery dates. Measuring of delivery times is focused on vehicle pick up accuracy and compliance with contractual transit times.

BMW outbound logistics is focused on process stability, data analysis and continuous improvement. Their project "Pro-Flex" includes critical features for vehicle logistics and ability to prioritise sold vehicles and expedite them through transport and accessory-installation.

4.2. The concept of „Liefertreue"

The concept of „Liefertreue" is explained on the case of Audi outbound supply chain and delivery reliability. Audi is one of the world's leading premium automotive brand. It continuously tries to build high quality and technologically progressive cars with philosophy „progress through technology" (*germ. „Vorsprung durch Technik"*) which has clear goal to bring high quality to their customer first. Also, one of the important concepts related to their outbound supply chain is the concept „Liefertreue" focused on delivery reliability. Based on analysis of the differentiation for premium brands and relevance for their customers, delivery reliability and amendment flexibility are the most important factors of success in the competition of premium brands (figure 4).

Figure 4. The customer requirements towards a premium brand



Source: Krog, 2016, p. 13

High relevance for customers of premium segment have: resale value, complaint management and customer management. Also, car prices and delivery times are not strong marks of differentiation in customer requirements towards a premium brands. In addition, for customers are very important latest technology, variety of equipment and availability of colours. Anyway, delivery reliability is most significant mark of differentiation.

Therefore, the functions of logistics are oriented on increasing of the flexibility in the order-to-delivery process which include monitoring of the release dates, sales planning and capacity planning. Buyers expect information about the estimated time of arrival (ETA) of the vehicle at dealers when vehicle orders are submitted. ETA actually turns order-to-delivery process and influence on the inbound and outbound supply chain. Audi measures mentioned process of delivery reliability (Liefertreue) which is on the 97% and customer orientated. Of course, target is always 100%.

For improvement of ETA accuracy is very important to have clear picture of the chain and not see the real customer as the next customer in the chain for eg. production is customer of logistics, because the real customer is only one that paying for car and therefore should be in focus (Ludwig, 2014, p. 1). High delivery reliability positively

influences on the customer satisfaction, reduction of lead time and reduction of the logistics cost.

5. CONCLUSION

Automotive supply chain (outbound vehicle distribution) is very complex activity because it is tied to the automotive industry which produce vehicles - the most complex products on our planet. From other side, process in finished vehicle logistics involves a large number of entities due to fact that vehicles constantly changing hands at various places and transportation modes what is very challenging for OEM's. Therefore, they outsource logistics and transport activities to specialised intermediaries, logistics service providers (third-party logistics service provider, fourth-party logistics service provider or lead logistics provider) which optimise supply chain performance, provide improving solutions and value added logistics service. Based on the scope of needed logistics service every automobile manufacturers decide which type of logistics provider is most suitable for their outbound supply chain. Also, finished vehicle logistics can be seen as a key competitive factor in the automotive industry due to the rising number of model variants and option in supply chain where is essential, continuously to pay attention on the evaluation of logistics effectiveness and efficiency.

The best tolls for improving and optimising outbound supply chain performance are key performance indicators which are used often in a post ante context, to evaluate a past performance of logistic service providers. The most important key performance indicators in vehicle distribution are: on time pickup, delivery reliability, transit time, lead time and damage-free delivery.

Delivery reliability is a crucial factor of successful finished vehicle logistics provided by logistics service providers. Indication of the delivery performance is the most important metric in outbound supply chain management that integrate the measurement of performance from car production plant to the dealers. Premium automotive brand is focused in their outbound distribution to create the most efficient concept of their supply chain which in maximally focused on the customer satisfaction, reduction of lead time and reduction of logistics costs. In top performing outbound supply chains of premium brands, delivery time met 97% to 100% of on time delivered vehicles. Therefore, continuously measurement of on-time delivery has a fundamental importance for quality evaluation of performed logistics service.

Considering analysis of delivery reliability in outbound vehicle distribution, future research should be directed to developing more detailed method, models and tolls which can improve design of whole supply chain.

Finally, it is important to emphasize the fact that outsourcing trend in automobile industry will increase relevance of finished vehicle logistics as a source of competitive advantages for OEM's on the way of achieving high customer satisfaction.

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