Review of sustainable service-based business models in the Chinese truck sector

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Abstract

Growth of global sales of new trucks in emerging economies is substantial however, in China the growth of sales is expected to be only 1% for 2014-2024. The limited sales growth forecast and an intense market competition make it imperative for truck manufacturers in China to diversify their revenue earnings through service-based business models for the Chinese market. Typically, Chinese service based business model need to be sustainable by considering environmental and social factors in the manufacturer's business model. This paper reviews existing product-service systems (PSS) and service-based business models in the automotive sector to identify how truck manufacturers could reorient their current business model with respect to the Chinese context to enhance customer satisfaction, profitability and sustainability. The analysis indicates that most of the studies in the automotive sector have focused on product-oriented or use-oriented business models with respect to car segment specifically in the developed markets. Besides, sustainability issues related to vehicle end-of-life management are rarely considered. Our findings suggest that the Chinese truck sector needs an integrated result-oriented PSS business models which could be implemented in other developing countries.

Keywords: Result-oriented product-service system, sustainable business model, truck industry, China, sustainability

1 Introduction

The truck sector is cyclical and closely linked to the fluctuations of the gross domestic product which necessitates truck manufacturers to continuously strive to safeguard their turnover and profit margin (KPMG, 2011). After a decade of high growth of production and sales of new vehicles, the Chinese market for heavy-duty and medium-duty trucks, which includes commercial vehicles with a gross vehicle mass over 6 tons, grows at a slower pace. Actually the growth of sales in this segment is expected to be only 1% for the period 2014-2024 (Deloitte, 2014). In comparison, sales of heavy-duty and medium-duty trucks in India are estimated to grow by 9% for the same period (Deloitte, 2014). Besides, the Chinese domestic market for medium-duty and heavy-duty trucks is dominated by three state-owned companies who have a combined market share of over 75%, forcing other brands to gain customers by adopting a low-

cost strategy (KPMG, 2011). In addition, truck manufacturers in China struggle to capture value from the after-market business because they compete with a large number of authorized and unauthorized companies (Zhu, et al., 2015). As a consequence, Chinese truck manufacturers should modify their offering not to depend only on sales of new trucks, innovate to distinguish themselves from other competitors and conquer untapped after-sales business opportunities.

In addition to economic challenges, Chinese truck manufacturers have to find solutions to grow in a sustainable way. The rapid industrialization of the country was accompanied by an increasing demand for road transportation and logistics services to support manufacturing activities and domestic consumption (Fung Business Intelligence Centre, 2013). Consequently, the number of registered medium-duty and heavy-duty trucks has grown from 3.8 millions in 2003 to 7 millions in 2013 (National Bureau of Statistics of China, 2014). The tremendous growth rate of vehicle production causes road congestion and severe air pollution problems in major Chinese cities. These environmental and health issues raise increasing concerns and attention by many Chinese citizens and public institutions (Schroeder, 2014). Besides, despite the existence of environmental legislations, there is no effective solution in place in China to handle end-of-life or end-of-use trucks in a sustainable manner (Xiang & Ming, 2011). Remanufacturing in China is identified as a significant contributor in helping to meet sustainable development objectives but its implementation in China faces many challenges (Abdulrahman, et al., 2015). One major barrier is the lack of cores available for remanufacturing because most of used vehicles will never return to the original manufacturer (Xiang & Ming, 2011; Zhu, et al., 2015). Used vehicles are sold on the second-hand market to consumers living in Western provinces, being the poorer region of China. "New vehicles begin their life cycle in the east and end [it] in the west" (Chen, 2005). Only 40% of scrapped vehicles are taken-back to official end-of-life treatment centers (Wang & Chen, 2013; Zhang, et al., 2011).

Consequently, a sustainable growth of the truck sector is contingent to the establishment of revenue streams less dependent to market cyclicality and to the integration of environmental and social factors in the manufacturer's business model. One potential option for truck manufacturers is to offer a value proposition that includes services in addition to the product. It could be a mean of generating regular additional revenue streams independent of market conditions and a way to promote a circular economy. The shift to a value proposition including

additional services is defined in the literature as the phenomenon of servitization (Vandermerwe & Rada, 1988). The new value proposition is termed as a product-service system (PSS), which is a bundle of tangible products and intangible services designed to deliver more value to users (Goedkoop, et al., 1999).

Hence the objective of this review is to determine if existing product-service systems in the automotive sector or capital goods sector could be applied in the Chinese truck sector to reorient the current business model. This study addresses the following research questions:

i) Do existing product-service systems in the automotive industry enable to improve both the level of sustainability and the competitiveness of truck manufacturers?

ii) Are there existing sustainable service-based business models in the automotive sector or in the capital goods sector applicable to the Chinese truck sector?

The rest of the report is organized in six sections. The next section presents the background of the study. Section 3 explains the methodology including sample selection and analysis. In Section 4 and Section 5, we present the results by describing and by critically analysing existing PSS and service-based business models in the automotive and capital goods sectors. In Section 6, we evaluate quantitatively existing service-based business models in the automotive and capital goods sectors and assess how they can be applied in the Chinese context. Finally, in Section 7, we summarize the main findings of this study and suggest possible future research directions.

2 Background of the study

2.1 Product-service system (PSS)

Tukker (2004) classifies PSS in three categories, namely "product-oriented", "use-oriented" and "result-oriented", and defines each category as a function of producer's value offering, producer's involvement in delivering value-in-use and the allocation of property rights of the product (Table 1).

The product-oriented PSS is a product-centric offering composed of a tangible good sold with a set of services designed to support the customer during the consumption phase. In the two other types of PSS, there is no transfer of ownership of the product from the manufacturer to the customer. In a use-oriented PSS, the customer pays for the usage of the product during a fixed period of time but does not get support on how to use the product in the most effective

way. In a result-oriented PSS, the producer becomes responsible for ensuring that the product delivers the outcome expected by the customer.

Table 1: Main categories and subcategories of PSS (Tukker, 2004)

Characteristics	Product-Oriented	Use-Oriented	Result-oriented
PSS archetypes	Product related services Advice and consultancy	Lease Renting Pooling	Activity management Pay per service unit Functional result
PSS objectives	Sell a physical good and associated services needed during the use phase	Sell the usage of the good	Sell the product output or its function with performance guaranteed
Producer's involvement	Limited	Limited	High
Importance of goods	Products are the core of value exchange	Products are a mean to deliver value	Products are a mean to deliver value
Importance of services	Services are add-ons	Value is exchanged through services	Value is exchanged through services
Allocation of property rights of the product	Customer	Producer	Producer

PSS could be a source of competitive advantage for manufacturers because services are highly profitable and difficult to imitate (Vandermerwe & Rada, 1988; Oliva & Kallenberg, 2003). The primary motivation for servitization is to create additional financial gains by adding enhanced services to the product offering or by servicing the existing installed base of products (Vandermerwe & Rada, 1988). Services offer a new source of growth in saturated markets in which sales of new products are slowing or decreasing. In these markets, servicing the installed base of products is an opportunity for capturing substantial and stable revenues.

2.2 PSS linkages with sustainable dimensions in the Chinese context

In China, vehicles on the road constitute a market at least six times bigger than the market of new vehicles (Wang & Chen, 2013). By moving downstream in the value chain, Chinese automotive manufacturers could reach a market more profitable than the one of new products because customer expenditures during the entire product life cycle are around five times the vehicle purchase price (Wise & Baumgartner, 1999). In particular, a result-oriented PSS ensures a regular source of revenues independent of market cycles and enables to intensify customer relations because contracts are established for several years (Baines & Lightfoot, 2013). A result-oriented PSS raises customer loyalty and sets up barriers against other vehicle brands and other after-sales competitors such as automotive component wholesalers or independent maintenance workshops (Verstrepen et al., 1999).

Besides the economic benefits associated with the provision of services, PSS can be a solution for truck manufacturers to improve their sustainability performance in China. In particular, a result-oriented PSS is considered as a promising option of sustainable solution by dematerializing transportation needs and by modifying consumption patterns (Goedkoop et al., 1999; Mont, 2002). The literature indicates that a PSS offering is not inherently eco-efficient per se (Mont et al., 2006; Bocken et al., 2014; Liu et al., 2014). Servitization can cause rebound effects which are unintended and negative consequences resulting from the inappropriate consumption of PSS (Catulli, 2012). For instance, vehicle leasing promotes the dematerialization of the economy in the transport sector by selling vehicle usage but it could increase consumption because it gives access to private vehicles at a lower initial cost which otherwise may not be affordable to some customers (Mont, 2002). However, contrary to product-oriented and use-oriented PSS, a result-oriented PSS gives incentives to the manufacturer to implement fuel-saving solutions and to maintain the running vehicles in good conditions because fixed operating costs per km are set in the PSS contract. The lower operating costs are the more profits the producer can earn from this contract. By integrating the consumption phase and cooperating with customers to optimize fleet efficiency, the manufacturer delivers a solution less subject to rebound effects. Concerning the third dimension of sustainability, the social perspective, PSS secures employment for manufacturer's staff because services are labour intensive activities (Liu et al., 2014). Moreover, employees have the opportunity to acquire new technical and managerial skills in order to successfully deliver the servitized offering to their customers (Gebauer et al., 2005). For example, designers should adopt a holistic view and learn service engineering methods in addition to product engineering methods (Akasaka et al., 2012). In the case of use- and result-oriented PSS, these offerings provide social benefits for consumers because vehicle users do not have to invest upfront large amount of money to drive reliable and efficient vehicles (Mont et al., 2006; Williams, 2006).

2.3 PSS and closed-loop supply chain (CLSC)

The level of sustainability achieved by a PSS does not only depend on the type of services offered (product-oriented, use-oriented or result-oriented) but also on the existence of a closed-loop supply chain (CLSC), composed of the forward supply chain and the reverse supply chain (Guide et al., 2003). This argument echoes previous studies advocating in favour of result-oriented PSS in connection with product remanufacturing (Sundin & Bras, 2005; Mont et al.,

2006; Liu et al., 2014). For example, Liu et al. (2014) argue that existing studies consider only the effects of PSS on the environment during the production and consumption phases but they ignore the end-of-life phase. Reverse logistics activities should be integrated when designing a result-oriented PSS so the producer can maximize its sustainable performance (Liu et al., 2014). Remanufacturing is seen as the most economically profitable and environmentally conscious option because it restores the vehicle original function with a quality level equivalent to a new product (Fleischmann et al., 1997; Guide et al., 1999). Therefore a business model including a result-oriented PSS as value proposition and operating with a CLSC could be a promising option to improve the sustainability of the truck sector. Truck manufacturers could benefit from synergies between CLSC and result-oriented PSS to generate more value for them and their customers (Table 2).

Table 2: Synergies between result-oriented PSS and CLSC

	Vehicle manufacturers benefits	**Customers benefits**	**Automotive industry studies**
Marketing synergy	Mitigate customer concerns on remanufacturing	Be confident about the quality of remanufactured parts	(Zhu et al., 2015; Tian et al., 2014)
	Avoid risk of extended vehicle downtime by securing spare parts supply	Reduce truck downtime	(Seitz, 2007; Seitz & Peattie, 2004; Baines & Lightfoot, 2014)
Environmental synergy	Reduce consumption of energy and virgin raw material	Lower its environmental footprint during usage	(Amelia et al., 2009; Sharma et al., 2014; Sutherland et al., 2008; Sundin & Bras, 2005)
Social synergy	Deliver of cost-competitive PSS offerings	Access good quality vehicles at affordable prices.	(Sharma et al., 2014; Östlin et al., 2008)
Operational synergy	Facilitate product return management in terms of timing, quantity and quality	Be relieved of management of end-of-use/end-of-life vehicles	(Östlin et al., 2008; Thierry et al., 1995; Parlikad & McFarlane, 2010; Wei et al., 2015)

On the one hand, result-oriented services create additional value for producer and customer, optimize vehicle efficiency during the consumption phase and enhance employee technical and relational skills. On the other hand, CLSC enables to retrieve value from cores and to mitigate environmental burdens caused by end-of-life vehicles. Components recovered from used vehicles can be a source of affordable spare parts supply for the maintenance of the installed base and avoid extended vehicle downtime caused by a shortage of replacement parts (Seitz, 2007).

2.4 Sustainable service-based business models and China

In the Chinese truck sector, both manufacturers and customers can benefit from servitization and the implementation of a closed-loop supply chain. Medium and heavy-duty trucks are expensive and critical assets for logistics companies. Truck owners are primarily interested in maximizing efficiency of these key assets and in lowering fleet operating costs. An integrated PSS-based strategy could dematerialize the truck economy and create customized service-based business models that would yield more value for truck manufacturers and their users (Kindström, 2010). All the arguments above call for a shift of the Chinese truck manufacturer's business model towards a sustainable service-based business model. The business model includes how the firm creates, delivers value to its customers and captures value for itself (Shafer et al., 2005; Teece, 2010). A sustainable business model should meet the triple bottom line and provides social, environmental and economic gains for the company and the society (De Medeiros et al., 2014). Besides, the management literature uses the term sustainability to describe the ability of a company to generate long-term profits and to maintain its competitive advantage over the years (Bharadwaj et al., 1993). Therefore, a business model for the truck manufacturers integrating result-oriented PSS and CLSC concepts should provide a competitive advantage to the manufacturer while delivering economic, environmental and social advantages for the customers and the society (Bocken et al., 2014).

3 Methodology

3.1 Sampling procedure

This study consists of a systematic literature review which is used to rigorously map and assess the relevant literature. The review procedure carried out in this research is composed of three main stages as recommended in the literature: planning the review, conducting the review and reporting (Tranfield et al., 2003). In the first stage, an unstructured literature overview on the main themes such as product-service systems, business models and sustainability was conducted to identify the current state-of-the-art on these subjects, formulate the research questions and define relevant filter criteria to be used in this study. The second stage consists of data collection and data analysis. This stage is depicted in Figure 1. To identify the sample articles for our study, we conducted an in-depth research of three major databases (Proquest, Scopus, and Science Direct). These databases were selected because they cover peer-reviewed multidisciplinary academic articles so we could be certain to find studies on PSS, business models and sustainable business models using these sources. The period of our analysis was between 1st January 2000 and 31st December 2015. The search was restricted to journal articles,

reports and conference papers written in English, available in full-text and published in peer-reviewed journals in the field of business, management, marketing, economics, social sciences and environmental science. Using recent literature reviews on PSS and service-based business models, we identified the list of keywords to be used for the database search as indicated in Table 3. Due to limitations in the number of filtering criteria allowed in each database, we conducted two database searches, one for studies on PSS in the automotive sector and one for studies on business models in automotive or capital goods sector. The capital goods sector is a forerunner of servitization (Meier et al., 2010) and it presents similarities with the truck sector in term of criticality and cost of the manufactured products. Therefore, we believe studies related to this sector can provide insights on how to apply sustainable service-based business models in the truck sector. Manual screening of each article's title and abstract sections was then carried out to evaluate the relevance of each article to the subject of PSS or service-based business model and to eliminate modelling studies. This manual screening process reduced our sample to 83 articles, once duplicated articles were removed. The 83 papers selected were further filtered through a comprehensive analysis of their content. Only articles that provided a description of a PSS in the automotive industry or of a service-based business model in the automotive sector or capital goods sector were kept in our final analysis. In addition, for a given industrial sector, if more than one study exists for the same type of PSS business model, our review includes the studies which bring additional information on the business model elements. Finally, we added one book (Baines & Lightfoot, 2013) , four book chapters (Nieuwenhuis & Wells, 2003; Radgen, 2014; Visintin, 2014; Gaiardelli et al., 2014b) as well as four journal articles (Firnkorn & Müller, 2012; Wells & Orsato, 2005; Meier et al., 2010; Sundin & Bras, 2005) which were traced back from previous literature reviews but our search process failed to extract them. At the end of this process, our sample contained 22 studies. The third and last stage of the systematic literature review corresponds to report findings in a synthetic way and to formulate recommendations (Tranfield et al., 2003). The analysis of this paper is based on the 22 sample papers explained in the review framework described in the following section.

Table 3: Selection of keywords

Filtering field	**Database search on PSS related studies**	**Database search on business model related studies**
in abstract/title	PSS, product-service system (s), servitization, result-oriented services, performance-based contract, solution	business model (s), contract(s) AND service-based, performance-based, product-service system(s), PSS, solution(s)

in full text	automotive, car (s), vehicle (s), truck (s)	automotive, vehicle (s), car (s), capital goods OR sustainable, sustainability

3.2 Review framework

To answer the first research question of this study, we adopted the PSS classification presented in Table 1 and distinguished existing PSS in the automotive industry in function of the type of services included in the offering, namely product-oriented, use-oriented or result-oriented services and the allocation of product's property rights (PSS provider or customer).

To answer the second research question, we evaluated each business model by calculating the average of three rating criteria as depicted in Table 4. Firstly, we evaluated the level of sustainability of the business model by identifying if reverse logistics activities were driven by the customer or the manufacturer. Secondly, we attributed to each business model a servitization score ranging from 0 to 1 depending on the type of PSS services offered in the value proposition. Thirdly, we determined if the business model was completely defined using the Business Model Canvas as business model framework (Osterwalder et al., 2010). The Business Model Canvas is composed of nine building blocks: value proposition, customer segment, customer relationships, distribution channels, key activities, key resources, key partners, cost structure and revenue streams. The value proposition is the bundle of products and services offered to a specific group of customers called customer segment. Customer relationships indicate the nature of interactions with customers. Distribution channels describe the network used to deliver products and services. Key activities list the main operations to make the business model work. Key resources are the most important physical, human or organizational assets required to perform the activities. Key partners identify strategic stakeholders influencing directly or indirectly the execution of the business model activities. The cost structure describes fixed and variable costs of the business model. Revenue streams indicate the sources of financial gains for the manufacturer and the price mechanisms used.

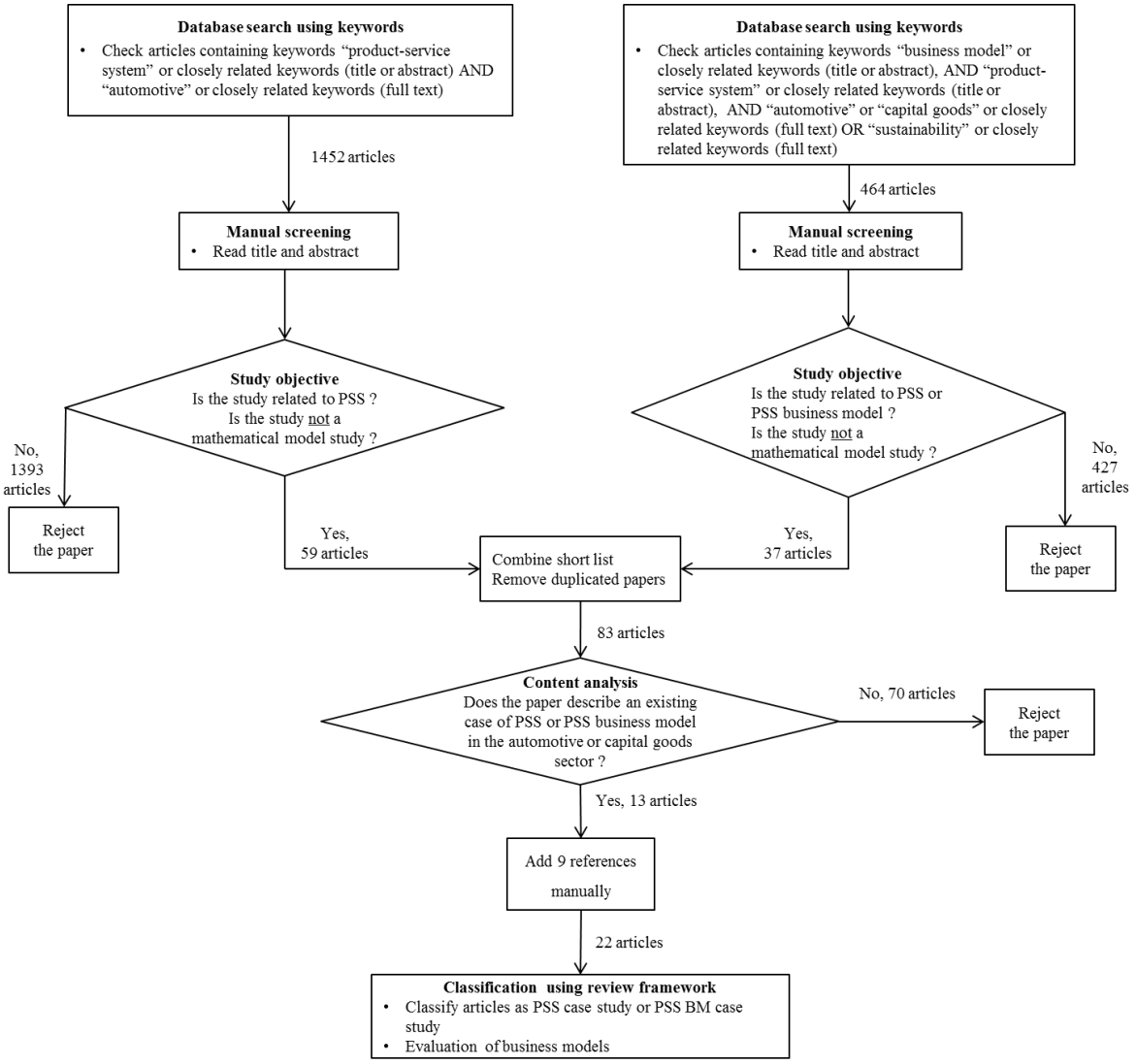

Figure 1: Process flow for data collection and analysis

Table 4: Scoring system for evaluating business models

Rating criteria	Definition of criteria
C1: Sustainability score	0 if open-loop, 0.5 if open-loop or closed-loop, 1 if closed-loop
C2: Servitization score	0 if only product-oriented services, 0.25 if product-oriented and use-oriented services, 0.5 if only use-oriented services, 0.5 if product-oriented services and result-oriented services, 1 if only result-oriented services.
C3: Business model score	Number of Canvas business model elements covered in the study/ 9
Final score	(C1+C2+C3)/3

4 Review of existing studies on PSS in the automotive industry

4.1 Product-oriented PSS

Presently, widely offered PSS in the automotive sector belong to the product-oriented category and five papers of our sample describe this type of offering (Cherubini et al., 2015; Budde

Christensen et al., 2012; Kley et al., 2011; Gaiardelli et al., 2014a and 2014b). Vehicles are sold to customers with a set of services such as a maintenance contract or take-back service. Product-oriented services associated with electric cars are described by several scholars who specially focus on battery charging services. The case of Better Place is frequently employed to describe an example of PSS composed of the sale of an electric car, the rent of the vehicle battery and the provision of battery charging services (Cherubini et al., 2015; Budde Christensen et al., 2012; Kley et al., 2011). Gaierdelli et al (2014b) offers a detailed description of the services offered by 36 Italian brands of automobiles and commercial vehicles. This study indicates that truck manufacturers are on average more servitized than car manufacturers and that truck owners of medium-sized fleet driving international routes have a high interest in product-support services.

4.2 Use-oriented PSS

Our sample contains five articles describing use-oriented PSS, in which the services provider retains ownership of the vehicle and sells its usage through leasing or rental contracts (Nieuwenhuis & Wells, 2003; Wells & Orsato, 2005; Williams, 2006; Laperche & Picard, 2013; Zhang et al., 2014). Traditional use-oriented PSS based on leasing or rental contracts are widely available in the passenger car segment and are studied by academics from a marketing perspective (Zhang et al., 2014) or from an innovation management perspective (Laperche & Picard, 2013). In these PSS, the service provider can be either the vehicle manufacturer or a rental company. In the latter case, from the perspective of the vehicle manufacturer, we can classify the offering under the category of pure goods or of a product-oriented PSS because the vehicle manufacturer does not directly provide services to the final user. An innovative use-oriented PSS results from applying the concept of micro-factory retailing. In the model of micro-factory retailing, small scale factories are located close to consumption points and produce vehicles based on a modular design facilitating customization, servicing and end-of-life management (Nieuwenhuis & Wells, 2003; Wells & Orsato, 2005; Williams, 2006). Vehicles are leased with a set of product-support services such as maintenance, refurbishing or technical upgrade (Williams, 2006). PSS associated with a micro-factory retailing are currently restricted to niche markets with low production volumes such as the "Air Car", a vehicle equipped with a compressed air engine and assembled by the French company Motor Development International (Nieuwenhuis & Wells, 2003).

4.3 Result-oriented PSS

Some examples of automotive result-oriented PSS exist and we could classify eight papers in this category (Catulli, 2012; Williams, 2007; Firnkorn & Müller, 2012; Baines & Lightfoot, 2013 and 2014; Baines et al., 2009, 2011 and 2013). However, cases presented in these papers do not fulfil all criteria of a result-oriented PSS as defined by Tukker (2004). In the car sector, Edinburgh CityCarClub (Catulli, 2012; Williams, 2007) or Daimler Car2Go system (Firnkorn & Müller, 2012) are two examples of pay per unit result-oriented PSS targeting individual customers. Yet, in a business-to-customer context, it is not possible for the producer to define the most adequate output target for each individual in function of the user specific needs. Therefore, in a business-to-consumer context this offering is equivalent to a use-oriented PSS. In the commercial vehicles sector, some manufacturers offer advanced services which are similar to result-oriented services (Baines & Lightfoot, 2013 and 2014; Baines et al., 2009, 2011 and 2013). For example, Baines and Lightfoot (2013) study the case of the truck manufacturer MAN and its services package called Trucknology. The advanced services offering "MAN Trucknology" is representative of the most developed services package provided by global truck manufacturers. MAN agrees with its customers on a fixed vehicle operating cost. The manufacturer is responsible for delivering capabilities to its customers cost effectively and to handle end-of-use products at the end of the contract. However, we cannot consider this offering as a true result-oriented PSS because the truck ownership can still be transferred to the customer (MAN Truck & Bus, 2015).

In addition, it can be seen in Table 5 that scholars conduct studies mainly in the context of developed countries. Only one study is exclusively focused on the service quality in the Chinese car rental industry (Zhang et al., 2014). Concerning research methods, scholars apply primarily qualitative research methods to study PSS in the automotive sector. The most commonly employed approach is the case study based on interviews. Studies conducted by Zhang et al (2014) and Firnkorn and Müller (2012) are two rare examples of quantitative survey-based studies related to a PSS offering in the automotive sector. In the former case, the scholars validate their research framework establishing relationships between customer satisfaction, customer loyalty and the five service quality dimensions of the SERVQUAL model (Parasuraman, 1998) based on survey data from 181 customers of car rental companies in China. In the latter case, the authors provide the distribution of car-sharing members in term of social and demographics factors and indicate the current and future usage profiles based on a survey conducted with 2060 German customers.

Table 5: Studies on PSS in the automotive sector

Model	PSS [1]	Product ownership	Automotive segment	Markets studied	Objectives	Research method(s)	Limitations	Examples	Authors
Electric car PSS	PO	customer	passenger cars	developed countries (Europe, USA)	Identify key characteristics and success factors for popularizing the use of electric cars	Framework with illustrative example, interview-based case studies	The concept is not a result-oriented business model and is not always operated by vehicle manufacturers. No indication on ELV[2] management practices.	Better Place	(Cherubini et al., 2015; Kley et al., 2011; Budde Christensen et al., 2012)
Product and process centric services	PO	customer	passenger cars/ commercial vehicles	developed economies (Italy)	Classify services offered by Italian automotive manufacturer.	Descriptive statistics based on publicly available data	The study focuses on the value proposition and the distribution channels.	CharterWay Services by Mercedes Benz	(Gaiardelli et al., 2014a and 2014b)
Micro-factory retailing	PO/UO	customer or manufacturer	passenger cars	developed economies	Describe the concept of micro-factory retailing	Case study, concept with illustrative examples	The concept is not a result-oriented business model and it targets car users living in urban areas.	MDI Air cars and vans	(Nieuwenhuis & Wells, 2003; Wells & Orsato, 2005; Williams, 2006)
Renting / Leasing by services company	UO	services provider	passenger cars	developing economies (China)	Evaluate service quality of Chinese car rental industry	Structure equation modelling, SERVQUAL scale	Rental car companies are separate entities from manufacturer. No indication on ELV[2] management practices.	First Rent A Car, Avis Car Rental, Hertz Car Rental	(Zhang et al., 2014)

Table 5 (continued)

Model	PSS [1]	Product ownership	Automotive segment	Markets studied	Objectives	Research method(s)	Limitations	Examples	Authors
Renting / Leasing by manufacturer	UO	manufacturer	passenger cars	developed countries (France)	Analyse PSS in French automotive sector and their impacts on innovation management	Interview-based case studies	No incentive for manufacturer to optimize outputs	Renault Z.E. Box, Mu by Peugeot;	(Laperche & Picard, 2013)
"Pay per service unit" model	RO/UO	manufacturer	passenger cars	developed countries	Describe pay per service unit result-oriented model for business-to-customer market.	Case study with descriptive statistics, focus groups using SERVQUAL, literature review	No performance target given to manufacturer. No indication on ELV[2] management practices.	Edinburgh CityCarClub, La Rochelle Autoplus, Daimler Car2go	(Williams, 2007; Catulli, 2012; Firnkorn & Müller, 2012)
Advanced services	PO/RO	customer	commercial vehicles	developed economies	Describe characteristics, benefits and challenges of advanced services	Interview-based case studies	Truck ownership can be transferred to the customer or a financial company. No indication on ELV [2] management practices.	MAN Trucknology	(Baines & Lightfoot, 2013 and 2014; Baines et al., 2009,2011 and 2013)

[1] PO= product-oriented, UO= use-oriented, RO=result-oriented

[2] ELV: end-of-life vehicles

5 Review of existing studies on servitized business models

By reviewing the literature on PSS, CLSC and business model, we identified eleven different types of servitized business models, six in the automotive industry and five in other manufacturing sectors.

5.1 Automotive sector

The business models related to the automotive sector are presented in Table 6 and Table 7. As mentioned earlier, the automotive industry is still strongly oriented towards product-oriented services. As a consequence, we could identify only one business model offering exclusively result-oriented services (Baines & Lightfoot, 2013 and 2014). Concerning the management of end-of-use vehicles, only two business models always operate with a reverse logistics supply chain driven by the vehicle manufacturer (Firnkorn & Müller, 2012; Laperche & Picard, 2013). The performance-based and micro-factory retailing business models do not exclude the option of transferring ownership to customers so the supply chain could be an open or closed one (Baines & Lightfoot, 2013 and 2014; Williams, 2006; Wells and Orsato, 2005). Regarding the description of the business model, the performance-based business model is the only model for which the nine elements of the Business Model Canvas are considered in the study (Baines & Lightfoot, 2013 and 2014). For the other business models, authors omit to define the cost structure (Cherubini et al., 2015; Firnkorn & Müller, 2012; Kley et al., 2011), the revenue streams (Wells & Orsato, 2005; Williams, 2006) or both (Gaiardelli et al., 2014b; Laperche & Picard, 2013). Some scholars mainly consider the business model elements located in the upstream of the value chain and explain the processes of value creation (Cherubini et al., 2015; Kley et al., 2011; Budde Christensen et al., 2012; Wells & Orsato, 2005). Six studies emphasize the importance of customer relationships in a PSS business models and offer some information about customer management practices (Williams, 2006; Laperche & Picard, 2013; Baines & Lightfoot, 2013 and 2014; Firnkorn & Müller, 2012; Gaiardelli et al., 2014b). Characteristics of targeted customer segments are provided in six studies (Cherubini et al., 2015; Gaiardelli et al., 2014b; Firnkorn & Müller, 2012; Williams, 2006; Baines & Lightfoot, 2013 and 2014). For example, the results of descriptive survey conducted with 2060 Car2Go members in the German city of Ulm enable manufacturers to build a detailed customer segmentation of current and potential car-sharing members (Firnkorn & Müller, 2012). Finally, we can observe that the studies primarily consider the business models designed for the passenger car sector in developed countries.

Table 6: PSS business models in the automotive sector

Business Model	Sources	Objectives of the study	Nature of supply chain	Nature of services (1)	PSS (1)	Methods	Automotive segment	Markets studied
Electric mobility business model - Better Place	(Cherubini et al., 2015)	Identify key characteristics and success factors for electric car business model.	Open-loop	PO	PO	Interviews and cognitive mapping	Passenger cars	Developed countries (Europe)
	(Kley et al., 2011)	Identify possible business models for electric cars using a morphological box	Open-loop	PO	PO	Concept based on literature review	Passenger cars	N/A
	(Budde Christensen et al., 2012)	Analyse Better Place business model and its likelihood of success	Open-loop	PO	PO	Case study	Passenger cars	Developed countries (Denmark)
Italian automotive business model	(Gaiardelli, et al., 2014b)	Define which and how aftermarket services are offered in the Italian automotive sector.	Open-loop	PO/UO/RO	PO/UO	Descriptive case study	Passenger cars / commercial vehicles	Developed countries (Italy)
Renting / Leasing by manufacturer	(Laperche & Picard, 2013)	Analyse PSS developed in French automotive sector and their impacts on innovation management	Closed-loop	PO/UO	UO	Case studies	Passenger cars	Developed countries (France)
Car sharing business model	(Firnkorn & Müller, 2012)	Describe the large scale car-sharing business model Daimler Car2Go	Closed-loop	UO	UO	Case study	Passenger cars	Developed economies (Germany)
Micro-factory retailing	(Wells & Orsato, 2005)	Describe the concept of micro-factory retailing	Open or closed-loop	PO/UO	PO/UO	Concept with illustrative examples	Passenger cars	Developed economies
	(Williams, 2006)	Explain why micro-retailing factory is a viable sustainable alternative for automotive sector	Open or closed-loop	PO/UO	PO/UO	Concept with illustrative examples	Passenger cars	Developed economies
Performance-based model	(Baines & Lightfoot, 2013 and 2014)	Describe characteristics, benefits and challenges of advanced services	Open-loop or closed-loop	RO	PO	Case study	Commercial vehicles	Developed economies

(1) PO= product-oriented, UO= use-oriented, RO=result-oriented

Table 7: Completeness of automotive PSS business models

Business Model	Sources	KP	KR	KA	VP	CR	DC	CSeg	CS	RS	% Canvas covered
Electric mobility business model - Better Place	(Cherubini et al., 2015)	X	X		X		X	X		X	67%
	(Kley et al., 2011)	X	X	X	X		X			X	67%
	(Budde Christensen et al., 2012)	X		X	X		X		X	X	67%
Italian automotive business model	(Gaiardelli et al., 2014b)				X	X	X	X			44%
Renting / Leasing by manufacturer	(Laperche & Picard, 2013)	X	X	X	X	X	X				67%
Car sharing business model	(Firnkorn & Müller, 2012)				X	X	X	X		X	56%
Micro-factory retailing	(Wells & Orsato, 2005)		X	X	X		X		X		56%
	(Williams, 2006)		X	X	X	X	X	X	X		78%
Performance-based contract	(Baines & Lightfoot, 2013 and 2014)	X	X	X	X	X	X	X	X	X	100%

Elements of the Business Model Canvas: KP: key partners; KR: key resources; KA: key activities; VP: value proposition; CR: customer relationships; DC: distribution channels; CSeg: customer segments; CS: cost structure; RS: revenue streams

5.2 Capital goods sector

Compared to the automotive sector, the servitization of the capital goods sector is more advanced and five use-oriented or result-oriented business models belong to our sample as described in Table 8 and Table 9 (Baines & Lightfoot, 2013; Meier et al., 2010; Sundin & Bras, 2005; Visintin, 2014; Radgen, 2014). Meier et al. (2010) emphasize on the internal resources and capabilities required to offer "Industrial Product–Service Systems'', IPS^2 but there is limited information on the key partners and distribution channels involved in this business model. Sundin and Bras (2005) partially describe the use-oriented PSS business model developed by a Swedish forklift manufacturer in which remanufacturing is identified as a key activity. The authors insist on operating this business model with a closed-loop supply chain in order to make the business model more sustainable. Contracting solutions offered by air compressors manufacturers are a typical example of a value proposition based on result-oriented services (Radgen, 2014). Manufacturers provide compressed air instead of selling their products. However, the study does not describe the key resources necessary to successfully deliver these offerings. The photocopier industry is a forerunner of servitization (Visintin, 2014). The literature on servitization frequently refers to the company Xerox and its transformation from a product-centric business model to a result-oriented PSS business model commonly named 'Pay per print' model (Visintin, 2014). Yet, distribution channels, key partners, key resources and cost structure are not described in Visintin's case study. In the aerospace industry, aircraft or engine manufacturers widely use result-oriented services business models and offer Total Care packages such as Rolls Royce TotalCare (Baines & Lightfoot, 2013). Baines and Lightfoot (2013) provide a complete description of the performance-based business model 'Power-by-the-hour' used by the aircraft engine manufacturer Rolls-Royce based on extensive interviews and field observations. The business model's value proposition includes result-oriented services similar to the ones offered in the commercial vehicles sector (Table 6) but, in the case of Rolls-Royce, the engine ownership is retained by the producer or an authorised third party.

Table 8: PSS business models in the capital goods sector

Business Model	**Sources**	**Objectives of study**	**Nature of supply chain**	**Nature of services [(1)]**	**PSS [(1)]**	**Methods**	**Sector**	**Markets studied**
IPS^2 model	(Meier et al., 2010)	Provide examples of high value-added services delivered in the machine tool sector	Open or closed-loop	PO/RO	PO/RO	Concept and case studies	Industrial equipment (machine tool)	n/a
Functional sales model	(Sundin & Bras, 2005)	Present the concept of functional sales and the advantages to combine it with remanufacturing	Closed-loop	PO/RO	UO	Case study	Industrial equipment (forklift)	Developed countries (Sweden)
Output-based model	(Radgen, 2014)	Describe contracting business models offered by 3 air compressor manufacturers.	Closed-loop	RO	RO	Case studies	Industrial equipment (air-compressors)	Global
Pay per unit Management Print Services (MPS) model	(Visintin, 2014)	Describe Xerox's business model evolution from pure product sales to MPS	Closed-loop	RO	RO	Case study	Photocopier machines	n/a
Performance-based model 'Power by the Hour'	(Baines & Lightfoot, 2013)	Explain key dimensions of serviced-based business models used by aircraft engines manufacturers.	Closed-loop	RO	RO	Case study	Aerospace industry	Developed countries

[(1)] PO= product-oriented, UO= use-oriented, RO=result-oriented

Table 9: Completeness of PSS business models in capital goods sector

Business Model	Sources	KP	KR	KA	VP	CR	DC	Cseg	CS	RS	% Canvas covered
IPS^2 model	(Meier et al., 2010)		X	X	X	X		X	X	X	78%
Functional sales model	(Sundin & Bras, 2005)		X	X	X			X			44%
Output-based model	(Radgen, 2014)	X		X	X	X	X	X	X	X	89%
Pay per unit Management Print Services (MPS) model	(Visintin, 2014)			X	X	X		X		X	67%
Performance-based model 'Power by the Hour'	(Baines & Lightfoot, 2013)	X	X	X	X	X	X	X	X	X	100%

Elements of the Business Model Canvas: KP: key partners; KR: key resources; KA: key activities; VP: value proposition; CR: customer relationships; DC: distribution channels; CSeg: customer segments; CS: cost structure; RS: revenue streams

6 Analysis and discussions

The review of the literature on existing service-based business models in the automotive and capital goods sectors leads us to evaluate eleven different business models and to compute the final rating score as described in Table 4. If one business model was described by several papers, we obtained the final score by calculating the average score for each criterion. For example, the business model of micro-factory retailing is presented in two papers which provide different levels of information regarding the elements of this business model (Wells & Orsato, 2005; Williams, 2006). The business model score of 0.67 is the average of 0.56 and 0.78 found in Table 7. The summary of the scores for each business model is presented in Table 10.

Table 10: Final score for selected business models

	Electric mobility business model - Better Place	Italian automotive business model	Micro-factory retailing	IPS^2 model	Renting / Leasing by	Functional sales model	Car sharing business model	Performance-based model for trucks	Management Print Services model	Output-based model	Performance-based model 'Power by the Hour'
Type of industry	A	A	A	C	A	C	A	A	C	C	C
Sustainability score	0	0	0.5	0.5	1	1	1	0.5	1	1	1
Servitization score	0	0.5	0.25	0.5	0.25	0.5	0.5	1	1	1	1
Business model score	0.67	0.44	0.67	0.78	0.67	0.44	0.56	1.00	0.67	0.89	1.00
Final score	0.22	0.31	0.47	0.59	0.64	0.65	0.69	0.83	0.89	0.96	1.00

(1) A: automotive industry, C: capital goods industry

6.1 Evaluation of existing sustainable service based business models

Six out of eleven business models have a sustainability score of 1, which indicate that existing service-based business models do not systematically integrate the question of reverse supply chain in their design. Two studies of our sample expressly emphasize the importance of considering the complete equipment life cycle at the early stage of product development to facilitate remanufacturing and recycling of used products (Meier et al., 2010; Sundin & Bras, 2005).

The sustainability level of the Chinese truck sector could be improved if used trucks are systematically returned to the original manufacturer or an official treatment centre so cores could be remanufactured, recycled or directly reused. In China, without contractual obligations between truck manufacturer and customer, most of used vehicles will never return to the original manufacturer or an authorised third party (Zhu et al., 2015; Xiang & Ming, 2011).

Sustainability can also be enhanced by capturing, analysing and exploiting life cycle information (Meier et al., 2010). During the execution of the result-oriented PSS contract, multiple contact points with customers create an opportunity to gather information from the field and to learn about vehicle real-life performance (Baines & Lightfoot, 2014). Customer feedback and inspection records on returned products could provide insights on product behaviour during the consumption phase and help engineers to elaborate more environmentally-friendly design for the trucks (Meier et al., 2010; Sundin & Bras, 2005).

Whereas all selected servitized business models in the capital goods sector include result-oriented services, the low servitization score for our sample of servitized business models in the automotive sector indicates that servitization in this industry is still at its premises. Existing PSS business models adopted by industrial or office equipment manufacturers are partially described in the literature but their analysis can still help to learn how to develop a sustainable result-oriented PSS business model in the truck sector. In the five articles related to the capital goods sector (Baines & Lightfoot, 2013; Meier et al., 2010; Sundin & Bras, 2005; Visintin, 2014; Radgen, 2014), authors emphasize the need to carefully understand customer expectations in order to design an attractive value proposition. The portfolio of result-oriented services integrated in the PSS should provide solutions which evolve over time to fulfil the variety of business customers' needs (Meier et al., 2010; Visintin, 2014). For example, the photocopier company Xerox started its servitization journey in the 1950s with leasing (use-oriented PSS) but modified its services offerings several times to better response to new market needs such as the implementation of environmentally-conscious printing policies and the control of document traceability (Visintin, 2014).

The results of the business model score, ranging from 0.44 to 1, indicate that existing studies offer a partial understanding of how a sustainable service-based business model should be designed and operated to maximize the creation of sustainable value for the manufacturer and its customers. However, a successful transition to a result-oriented business model requires the automotive manufacturer to overcome various challenges and to revise all elements of its business model (Barquet et al., 2013; Gebauer et al., 2005). To shift from a product-based to a service-based value proposition, the PSS provider should acquire skills and capabilities to be able to design, produce and deliver product-service systems. For example, engineers need to learn and apply "design for X" principles to develop products easy to maintain and to remanufacture (Baines & Lightfoot, 2014). Relationships with key partners are also affected

by the servitization transition. In the automotive industry, vehicle manufacturers usually outsource their downstream activities to franchised distributors (Baines et al., 2011). The role of these dealers is crucial in building strong connections with customers especially in a result-oriented PSS context. Yet, gaps in business objectives exist between manufacturers and their dealers. A study of 29 car brands and 7 heavy-duty truck brands in Italy indicates that dealers are not fully aware of all the services offered by vehicle brands and mainly promote product-oriented services because these latter provide immediate profits (Gaiardelli, et al., 2014b). To apply result-oriented PSS contracts in the Chinese truck sector, manufacturers should also develop an active marketing to become a reliable and trusted partner for customers (Verstrepen et al., 1999). It means to understand customer's processes, operational issues and needs by establishing a long-term relationship with customers instead of interacting with them only during the sale of a new vehicle. Impacts on the revenue model and cost structure should also be taken into consideration to mitigate financial risks associated with servitization (Barquet et al., 2013). New sets of cost accounting methods and metrics should be adopted to properly measure the financial performance of a servitized manufacturing firm (Lerch & Gotsch, 2014).

6.2 Chinese context recommendations

Among the business models applied in the automotive sector or in the capital goods sector, the performance-based business model based on result-oriented services presented by Baines and Lightfoot (2013, 2014) could be an interesting business model for the Chinese truck industry if identified limitations are overcome. A performance-based business model could be a suitable option to improve both the level of sustainability and the level of competitiveness of truck manufacturers in China under the conditions that the PSS provider keeps ownership of the vehicle and captures value from end-of-life vehicles through remanufacturing and recycling. Performance-based business models are theoretically designed to be sustainable result-oriented PSS business models because manufacturers keep ownership of the good and are responsible for delivering performance to users of commercial vehicles who pay a fixed fee per kilometre (Baines & Lightfoot, 2013). However, contrary to manufacturers in the capital goods sector, truck manufacturers which have adopted this business model, continue to sell their vehicles and offer result-oriented services as add-ons (Baines & Lightfoot, 2013; MAN Truck & Bus, 2015). Successful implementation of integrated result-oriented PSS business model would require truck manufacturers in China to keep ownership of the vehicle and to overcome possible cultural reluctance of Chinese consumers to loss of property rights. Truck

manufacturing firms should emphasize the benefits of dematerialization and educate their Chinese customers on the concept of total cost of ownership (Xiang & Ming, 2011).

In summary, existing service-based business models in automotive or capital goods sectors can be used as a baseline for truck manufacturers willing to move towards a more servitized and sustainable business model in China. Yet, a successful business model in a given industry and in a given market cannot be directly applied to the Chinese truck sector because of the specific geographic and sectorial conditions , such as the high price sensitivity of Chinese customers or the existence of informal market for spare parts (KPMG, 2011; Zhu et al., 2015). Truck manufacturers can successfully earn profits from servitization if they align their servitization strategy to the Chinese environment and if they carefully manage added risks and costs associated with the servitization transition (Visintin, 2014; Radgen, 2014).

7 Conclusions and future research directions

The review of existing PSS and service-based business models indicate that current solutions could not directly be applied to the Chinese truck sector because the concepts of result-oriented PSS and CLSC are not systematically integrated in a single business model or the definition of nine elements of the Canvas Business Model is incomplete. There is a lack of comprehensive and detailed analysis of all the business model elements and their contributions in the process of value design, value delivery and value capture. The understanding of how sustainable value is created, delivered and captured in an integrated PSS business model remains an under-researched topic. Moreover, the majority of the studies focus on the car segment and describe the deployment of business models in business-to-customer markets and in the context of developed economies. Based on these findings, future researches on sustainable service-based business models for the Chinese truck sector could address the identified literature gaps by conducting an in-depth analysis of each business model element and its role in the whole business model. More quantitative studies could be conducted to determine variables influencing financial, environmental and social outputs of the business model. Besides, scholars should explore how servitization could become a way to support the sustainable development of China or other emerging economies.

Despite its contributions, this study has some limitations linked to the methodology adopted for the review. Results of the sampling procedure are dependent on the selection of keywords, journal titles and the choice of industry (automotive and capital goods). The filtering process

to identify the selected papers and the analysis of their content could be judged subjective because these tasks were conducted manually by one researcher. Yet, by initially conducting an exploratory literature overview and manually adding key references to the sample, the selected 22 references should provide a reliable overview of the available PSS and service-based business models in the automotive and capital goods sectors. Besides, the scoring system used for rating the selected business models attempts to evaluate and compare these models but does not pretend to give an unquestionable value.

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8 References

Abdulrahman, M. D.-A., Subramanian, N., Liu, C. & Shu, C., 2015. Viability of remanufacturing practice: a strategic decision making framework for Chinese auto-parts companies. *Journal of Cleaner Production,* Volume 105, pp. 311-323.

Akasaka, F., Nemoto, Y., Kimita, K. & Shimomura, Y., 2012. Development of a knowledge-based design support system for Product-Service Systems. *Computers in Industry,* Volume 63, pp. 309-318.

Amelia, L. et al., 2009. Initiating automotive component reuse in Malaysia. *Journal of Cleaner Production,* Volume 17, pp. 1572-1579.

Baines, T. & Lightfoot, H., 2013. *Made to Serve : How Manufacturers can Compete Through Servitization and Product Service Systems.* 2 ed. s.l.:John Wiley & Sons.

Baines, T. & Lightfoot, H., 2014. Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services. *International Journal of Operations & Production Management,* 34(1), pp. 2-35.

Baines, T. et al., 2009. Towards an operations strategy for product-centric servitization. *International Journal of Operations & Production Management,* 29(5), pp. 494-519.

Baines, T., Lightfoot, H. & Smart, P., 2011. Servitization within manufacturing. Exploring the provision of advanced services and their impact on vertical integration. *Journal of Manufacturing Technology Management,* 22(7), pp. 947-954.

Baines, T., Lightfoot, H., Smart, P. & Fletcher, S., 2013. Servitization of manufacture: Exploring the deployment and skills of people critical to deliver advanced services. *Journal of Manufacturing Technology Management,* 24(4), pp. 637-646.

Barquet, A. P. B., Gouvea de Oliveira, M. & Román Amigo, C., 2013. Employing the business model concept to support the adoption of product–service systems (PSS). *Industrial Marketing Management,* Volume 42, pp. 693-704.

Bharadwaj, S. G., Varadarajan, P. R. & Fahy, J., 1993. Sustainable Competitive Advantage in Service Industries: A Conceptual Model and Research Propositions. *Journal of Marketing,* Volume 57, pp. 83-99.

Bocken, N., Short, S., Rana, P. & Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production,* Volume 65, pp. 42-65.

Budde Christensen, T., Wells, P. & Cipcigan, L., 2012. Can innovative business models overcome resistance to electric vehicles ?. *Energy Policy,* Volume 48, pp. 498-505.

Catulli, M., 2012. What uncertainty? Further insight into why consumers might be distrustful of product service systems. *Journal of Manufacturing Technology Management,* 23(6), pp. 780-793.

Chen, M., 2005. End-of-life vehicle recycling in China: now and the future. *JOM (Minerals Metals Materials Society),* 57(10), pp. 20-26.

Cherubini, S., Iasevoli, G. & Michelini, L., 2015. Product-service systems in the electric car industry: critical success factors in marketing. *Journal of Cleaner Production,* Volume 97, pp. 40-49.

De Medeiros, J. F., Ribeiro, J. L. D. & Cortimiglia, M. N., 2014. Success factors for environmentally sustainable product innovation: A systematic literature review. *Journal of Cleaner Production,* Volume 65, pp. 76-86.

Deloitte, 2014. *Truck Market 2024 Sustainable Growth in Global Markets.* [Online]
Available at: http://www2.deloitte.com/content/dam/Deloitte/tr/Documents/process-and-operations/truck-studie-2014-s.pdf
[Accessed 17 December 2015].

Firnkorn, J. & Müller, M., 2012. Selling Mobility instead of Cars: New Business Strategies of Automakers and the Impact on Private Vehicle Holding. *Business Strategy and the Environment,* Volume 21, p. 264–280.

Fleischmann, M. et al., 1997. Quantitative models for reverse logistics: A review. *European Journal of Operational Research,* Volume 103, pp. 1-17.

Fung Business Intelligence Centre, 2013. *Logistics Industry in China,* Hong Kong: The Fung Business Intelligence Centre.

Gaiardelli, P. et al., 2014a. A classification model for product-service offerings. *Journal of Cleaner Production,* Volume 66, pp. 507-519.

Gaiardelli, P., Songini, L. & Saccani, N., 2014b. The Automotive Industry: Heading Towards Servitization in Turbulent Times. In: G. Lay, ed. *Servitization in Industry.* London: Springer, pp. 55-72.

Gebauer, H., Fleisch, E. & Friedli, T., 2005. Overcoming the Service paradox in manufacturing companies. *European Management Journal,* 23(1), pp. 14-26.

Goedkoop, M. J., van Halen, C. J., te Riele, H. R. & Rommens, P. J., 1999. *Product Service systems, Ecological and Economic Basics,* s.l.: Pre Consultant.

Guide, V. D. R., Harrison, T. P. & Van Wassenhove, L. N., 2003. The Challenge of Closed-Loop Supply Chains. *Interfaces,* 33(6), pp. 3-6.

Guide, V. D. R., Srivastava, R. & Jayaraman, V., 1999. A closed-loop logistics model for remanufacturing. *Journal of the Operational Research Society,* Volume 50, pp. 497-508.

Kindström, D., 2010. Towards a service-based business model - Key aspects for future competitive advantage. *European Management Journal ,* Volume 28, pp. 479-490.

Kley, F., Lerch, C. & Dallinger, D., 2011. Kley, Fabian; Lerch, Christian; Dallinger, David;. *Energy Policy,* Volume 39, pp. 3392-3403.

KPMG, 2011. *Competing in the Global Truck Industry - Emerging Markets Spotlights - Challenges and future winning strategies.* [Online]
Available at: http://www.kpmg.com/LU/en/IssuesAndInsights/Articlespublications/Pages/competing-in-the-global-truck-industry.aspx
[Accessed 17 December 2015].

Laperche, B. & Picard, F., 2013. Environmental constraints, Product-Service Systems development and impacts on innovation management: learning from manufacturing firms in the French context.. *Journal of Cleaner Production,* Volume 53, pp. 118-128.

Lerch, C. & Gotsch, M., 2014. Avoiding the overhead cost trap: towards an advanced management accounting method for servitized firms. In: G. Lay, ed. *Servitization in industry.* London: Springer, pp. 277-294.

Liu, C. H., Chen, M.-C., Tu, Y.-H. & Wang, C.-C., 2014. Constructing a sustainable service business model. An S-D logic based integrated product service system (IPSS). *International Journal of Physical Distribution & Logistics Management,* 44(1/2), pp. 80-97.

MAN Truck & Bus, 2015. *Trucknology.* [Online]
Available at: http://www.trucknology.co.uk/
[Accessed 15 October 2015].

Meier, H., Roy, R. & Seliger, G., 2010. Industrial Product-Service Systems - IPS2. *CIRP Annals - Manufacturing Technology,* Volume 59, pp. 607-627.

Mont, O., 2002. Clarifying the concept of product–service system. *Journal of Cleaner Production,* Volume 10, pp. 237-245.

Mont, O., Dalhammar, C. & Jacobsson, N., 2006. A new business model for baby prams based on leasing and product remanufacturing. *Journal of Cleaner Production,* 14(17), pp. 1509-1518.

National Bureau of Statistics of China, 2014. *China Statistical Yearbook.* [Online]
Available at: http://www.stats.gov.cn/tjsj/ndsj/2014/indexeh.htm
[Accessed 15 October 2015].

Nieuwenhuis, P. & Wells, P., 2003. Micro factory retailing. In: P. Nieuwenhuis & P. Wells, eds. *The automotive industry and the environment. A technical, business and social future.* 1st ed. Cambridge, England: Woodhead Publishing Ltd and CRC Press LLC, pp. 227-236.

Oliva, R. & Kallenberg, R., 2003. Managing the transition from products to services. *International Journal of Service Industry Management,* 14(2), pp. 160-172.

Osterwalder, A., Pigneur, Y. & Clark, T., 2010. *Business Model Generation. A Handbook for visionaries, game changers, and challengers.* 1st ed. Hoboken New Jersey: John Wiley & Sons, Inc.
Östlin, J., Sundin, E. & Björkman, M., 2008. Importance of closed-loop supply chain relationships for product remanufacturing. *International Journal of Production Economics,* Volume 115, p. 336– 348.
Parasuraman, A., 1998. Customer service in business-to-business markets: an agenda for research. *Journal of Business & Industrial Marketing,* Volume 13, pp. 309-321.
Parlikad, A. K. & McFarlane, D., 2010. Quantifying the impact of AIDC technologies for vehicle component recovery. *Computers & Industrial Engineering ,* Volume 59, pp. 296-307.
Radgen, P., 2014. Air compressors or compressed airs: harvesting the benefits. In: G. Lay, ed. *Servitization in industry.* London: Springer, pp. 91-107.
Schroeder, P., 2014. Assessing effectiveness of governance approaches for sustainable consumption and production in China. *Journal of Cleaner Production,* Volume 63, pp. 64-73.
Seitz, M. A., 2007. A critical assessment of motives for product recovery: the case of engine remanufacturing. *Journal of Cleaner Production,* Volume 15, pp. 1147-1157.
Seitz, M. A. & Peattie, K., 2004. Meeting the closed-loop challenge: the case of remanufacturing. *California Management Review,* 46(2), pp. 74-89.
Shafer, S. M., Smith, H. & Linder, J. C., 2005. The power of business models. *Business Horizons,* Volume 48, pp. 199-207.
Sharma, V., Garg, S. K. & Sharma, P., 2014. Identification of major drivers and roadblocks for remanufacturing in India. *Journal of Cleaner Production,* Volume in press, pp. 1-11.
Sundin, E. & Bras, B., 2005. Making functional sales environmentally and economically beneficial through product remanufacturing. *Journal of Cleaner Production,* Volume 13, pp. 913-925.
Sutherland, J. W., Adler, D. P., Haapala, K. R. & Kumar, V., 2008. A comparison of manufacturing and remanufacturing energy intensities with intensities with application to diesel engine production. *CIRP Annals - Manufacturing Technology,* Volume 57, pp. 5-8.
Teece, D. J., 2010. Business models, business strategy and innovation. *Long Range Planning,* Volume 43, pp. 172-194.
Thierry, M., Salomon, M., Van Nunen, J. & Van Wassenhove, L., 1995. Strategic issues in product recovery management. *California Management Review,* 33(1), pp. 59-74.
Tian, G., Chu, J., Hu, H. & Li, H., 2014. Technology innovation system and its integrated structure for automotive components remanufacturing industry development in China. *Journal of Cleaner Production,* Volume 85, pp. 419-432.
Tranfield, D., Denyer, D. & Smart, P., 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management,* Volume 14, pp. 207-222.
Tukker, A., 2004. Eight types of product-service system: eight ways to sustainability? Experiences from SUSPRONET. *Business Strategy and the Environment ,* Volume 13, pp. 246-260.
Vandermerwe, S. & Rada, J., 1988. Servitization of business: adding value by adding services. *European Management Journal ,* 6(4), pp. 314-324.
Verstrepen, S., Deschoolmeester, D. & Van den Berg, R., 1999. Servitization in the automotive sector: creating value and competitive advantage through service after sales. *Global Production Management, Kluwer Publishers, Boston, MA,* pp. 538-45.
Visintin, F., 2014. Photocopier industry: at the forefront of servitization. In: G. Lay, ed. *Servitization in Industry.* London: Springer, pp. 23-43.
Wang, L. & Chen, M., 2013. Policies and perspective on end-of-life vehicles in China. *Journal of Cleaner Production,* Volume 44, pp. 168-176.
Wei, S., Cheng, D., Sundin, E. & Tang, O., 2015. Motives and barriers of the remanufacturing industry in China. *Journal of Cleaner Production,* Volume 94, pp. 340-351.
Wells, P. & Orsato, R. J., 2005. Redesigning the industrial ecology of the automobile. *Journal of Industrial Ecology,* 9(3), pp. 15-30.
Williams, A., 2006. Product-service systems in the automotive industry: the case of micro-factory retailing. *Journal of Cleaner Production,* Volume 14, pp. 172-184.
Williams, A., 2007. Product service systems in the automobile industry:contribution to system innovation. *Journal of Cleaner Production,* 15(11/12), pp. 1093-1103.
Wise, R. & Baumgartner, P., 1999. Go Downstream. The new Profit Imperative in Manufacturing. *Harvard Business Review,* Issue September-October, pp. 133-141.
Xiang, W. & Ming, C., 2011. Implementing extended producer responsibility: vehicle remanufacturing in China. *Journal of Cleaner Production,* 19(6-7), pp. 680-686.
Zhang, M., Xie, Y., Huang, L. & He, Z., 2014. Service quality evaluation of car rental industry in China. *International Journal of Quality & Reliability Management,* 31(1), pp. 82-102.

Zhang, T. et al., 2011. Development pattern and enhancing system of automotive components remanufacturing industry in China. *Resources, Conversation and Recycling,* Volume 55, pp. 613-622.
Zhu, Q., Sarkis, J. & Lai, K.-h., 2015. Supply chain-based barriers for truck-engine remanufacturing in China. *Transportation Research Part E,* Volume 74, p. 94–108.