Using the Extended Product Concept to better Understand New Business Models along Product Life Cycles: The Case of E-Mobility

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Abstract: Concepts like extended products and product-service systems have been discussed for years. So far several publications have highlighted the relevance and showed examples. While taking services into consideration the focus is shifting from the realization phase of a product to its life-cycle. The changes of customer behavior as well as the trend towards new mobility paradigms are challenging manufacturers and service providers to come up with new solutions and new business models which better reflect the needs of the customer and the society. We believe that E-Mobility provides an ideal case to investigate how tangible and non-tangible products and services can be integrated using the extended product concept. In this paper the extended product concept will be analyzed and applied in the domain of E-mobility in order to better understand the development of business models along Product Life Cycles.

Keywords: E-Mobility; Extended Product, Business Model, Product Life-Cycle

1 Introduction

Electric mobility (E-mobility) is one of the big trends in the automotive field these days. For a more sustainable mobility electric powered individual transportation is a current subject for several players not only for automotive but also for energy and infrastructure providers. The German National Development Plan for E-Mobility aims on pushing research and development, market preparation and market launch for electric mobility. It stipulates to have one million electric vehicles on German streets until 2020 (Die Bundesregierung 2009). The focus of research is on the one hand by technical nature in means of developing new electric powered cars and infrastructure solutions. On the other hand the research is focused on developing and implementing new mobility services which are valuable mobility solutions for the customers. Developing new products and implementing new services based on these products is highly interdependent. To successfully provide a new mobility service a high degree of collaboration between the different market actors is necessary.
For a successful implementation of new and innovative products and services it is feasible to generate extended product concepts. We think that e-Mobility provides a playground to investigate how tangible products and intangible services can be interpreted using the extended product concept. With the extended product concept the two big constraints in the field of e-mobility like limited range and high price might be counterbalanced. We also want to map an extended product life-cycle on e-mobility. At the end we want to illustrate an exemplary usage of the extended product concept in order to state the linkages between the different actors providing several aspects of e-mobility.

In this paper the extended product concept will be analyzed and applied in the domain of E-mobility in order to better understand the development of business models along Product Life Cycles. It will be illustrated that E-mobility itself is a complex subject and that there is a need for the integration of various products and services. Consequently section 2 of the paper discusses approaches and challenges. Section 3 provides a short overview of the extended product concept used in the paper. This is followed by section 4 discussing e-mobility, a lifecycle concept and an exemplary usage in the context of e-mobility. Some conclusions finalize the paper.

2 E-Mobility: approaches and challenges

At this time almost every automotive OEM is investing significantly into developing electric vehicles and soon first models will be released to the market respectively are already available now. Numerous studies from investment banks, consulting agencies and research institutes tried to predict how the electric automotive market will develop the next ten years. Predictions differ in a wide range from 2 to 25 % (!) market penetrations in 2020. In automotive terms this is only one and a half model cycles from now (Arthur D. Little 2010).

2.1 Challenges in e-mobility

Electric vehicles not only have the big advantage of zero local emissions (zero emissions when using renewable energy sources); their power efficiency is higher, the components don’t need as much maintenance, environmental noise is lower and driving characteristics are better than conventional power train cars. But even though the advantages are clear and the first electric vehicles are released on the market now E-Mobility still has three major problems to face:

- Electric vehicles are expensive.
- The range of electric vehicles is quite limited.
- There is not yet an infrastructure implemented to “refuel” the vehicle like we are used to it today.

2.2 From selling to providing

The automotive industry is facing another challenge: the future customers not necessarily need to own a car. More than 80 percent of the 18 to 29 year old think that city inhabitants don’t need to own a car (Spiegel Online 2011). The urbanite of tomorrow is looking for more flexible models like leasing or car-sharing to satisfy his individual
mobility demands. In future markets more and more players like OEMs, leasing or service companies will be involved and fight for the mobility budget of the customers. Consultants from Arthur D. Little identified three so-called “mega trends” (global factors which set up the framework for all areas of business and society for 30 to 50 years), which will play a role in shifting business models and the uprising of electrified vehicles.

- **Neo-ecology**: Initially arisen from the environmental movement of the 80’s, society expects a corporate social responsibility. The rise of the oil-price and the CO2-discussion accelerated this mega trend enormously, and products which are not developed considering this trend are almost not marketable nowadays.

- **Individualization**: This mega-trend describes the release of the consumer from mass movements towards individualized solutions. Traditional lifestyle models are being left throughout all social classes and customers enjoy being not conformed but individuals.

- **Mobility**: In the 60’s and 70’s there has been a significant quantitative rise of mobility in triad markets and BRIC markets followed with a little delay. Limitations or harmful impacts of mobility for example traffic volume and CO2 emissions though were reflected in society much later.

Along with the mega trends social and consumer trends which affect demand and buying behavior of consumers with a time horizon of five to ten years have been identified as well. Trends as Downaging, New Luxury, Cheap Chic, Simplify, Deep Support, Family 2.0, Multi-Graphy, Neo-Cities and Greenomics will have an impact on the demand for mobility especially in triad markets (Arthur D. Little 2010).

These trends are leading not only towards an evolution of automobiles from conventional combustion engines towards electrified vehicles, but they will also lead to new business models respectively to an extension with intangible product related services.

Today’s automotive market is slowly drifting from the conventional model, where a car is bought and owned by the user towards models where cars are rented, shared or leased. The customer has a requirement for mobility but that doesn’t necessary mean that there is a demand for owning an automobile. Requirements describe the customer’s needs, while the demand describes a specific item that satisfies these needs. Walking along with the extended product paradigm, which will be shortly introduced in the second part, the focus of manufacturers and suppliers is moving from producing and simply selling tangible core products to providing solutions which satisfy the customer’s needs.

Within this paper we are introducing an approach to model future business models over the product life cycle of e-mobility by combining a lifecycle model with the concept of extended products presented next.

### 3 The Extended Product Concept

The change in customer demands is reflected by the Extended Product (EP) concept [Thoben, et al. 2001, p.429]. An EP is an integrated offer of a physical product “extended” by services aiming at the provision of a customer oriented solution. While taking services into consideration the focus is shifting from the realization phase
(Beginning of Life (BoL) of a product to the usage phase (Mid of Life (MoL)) as well as the recycling phase (End of Life). Baseline for the development of the EP concept was the need for a better understanding of the development of new IT-based business model supporting the entire life cycle (LC) of a product.

The EP concept can be illustrated in a model consisting of three layers, the kernel as a representation of the core functionalities of a product (core product or product in a narrow sense), the middle layer representing the overall product (packaging) and the outer shell describing the intangible parts of the offer (services) [Thoben, et al. 2001, p.435].

At the same time customer demands change, the focus of value generation moves from production towards the pre- and post-production phases in product development [Eschenbächer, et al. 2002, p.677]. For the conception and development of EP the complexity rises in the fields of product functionalities, production resources and the incorporation of the whole product life cycle (PLC). Taking into account the overall PLC of products the requirements for and definition of products change.

Being aware that a lot of added value can be generated with product assets, companies are consequently shifting their business focus towards the offering of solutions or even the provision of benefits as illustrated in Figure 1.

![Shift of Business Focus](image)

Figure 1: Shift of business focus: From manufacturing of parts to the provision of benefits

With the concept of Extended Products the business models for all stakeholders in e-mobility should be described. The authors do not describe the e-vehicle as an extended product, but a network of Extended Products from multiple stakeholders as a concept to offer e-mobility. In the following we will discuss the extended product life-cycle in the context of e-mobility.

4 E-Mobility in a Product Life Cycle Model

4.1 Interpreting E-Mobility in a business model related lifecycle

As described in the previous chapter the market for "mobility service solutions” is expected to change in the next years. Especially in big cities customers will demand mobility without owning a car. E-mobility services can be seen as a solution for the new requirements but several problems are not solved yet. “E-mobility service solutions” will be operated by several stakeholders like automotive OEM, infrastructure providers,
mobility providers or electricity companies. All of them will play a role within the transformation from fuel powered cars towards electric cars.

The aim of the approach presented below is to visualize the complexity of e-mobility to structure a value chain for multiple stakeholders over the full life cycle. This first iteration of the approach focuses on the automobile as a starting point of view.

4.1.1 The core product: Electric Vehicle

The core of the product is divided in the car components and the battery. It states all elements to fulfill the functionality of the product within the core. Car components in the field of e-mobility like chassis, interior, heating respectively air condition or power electronics will evolve (e.g. through light weight construction or higher grade of efficiency) and will have a high impact on product usage and business models, since the customer is most likely not willing to make any kind of cut backs in terms of comfort and usability of the vehicle.

E-mobility at this time is highly dependent from battery technology, as one could say today the battery might be the technical barrier which has to be breached for the success of electrified vehicles. The batteries available nowadays are heavy, big and expensive. This results in a limited range and limitations in storage volume which are directly dependent from size and capacity of the battery. The more For example a Li-Io battery for an electrified Smart, would need a capacity of 16 kWh for an operating distance of about 130 km. Production costs of this battery is between 7.000 to 8.500 Euros (75% for production costs in small batch series and 25% for raw materials) (Bain&Company 2010). This is almost the same price as for the rest of the car and the operating distance can’t even slightly compete with traditional power trains. With such a high price the battery seems to be not suitable for classical approaches which are based on selling and buying a product.

There are two essential drivers which can push E-mobility, either the cost of oil, gas and CO₂ emissions increase drastically or the cost of the battery decreases to a sellable level. Of course quality levels in cars such as technical interior (navigation, park assistant, etc.) customers know from present standard cars are also important - especially when they are not available at all. It’s obvious that the costs of batteries will drop, when using mass-production and further technology research (see the case of Li-Ion Laptop batteries, where the price decreased about 80% in the last ten years). Calculations predict that the cost of batteries in 2020 will be only 35-40% of the costs from 2009. Another recent study estimated a market volume for the battery of 20-22 billion euro alone in Europe (Bain&Company 2010).

The circle around the core product constitutes the overall product “electric-vehicle”, including the car and the battery. On this level the differentiation from competitors is in focus. Differentiation is taking place within design of the car, technical exterior/interior, brand conformity, etc. Today’s providers of this shell are the automotive OEM. Within these early phases of e-mobility other players are becoming providers of cars as well, especially suppliers of electricity. Mostly these companies provide first fleet tests with modified products from OEM and re-brand these (e.g. RWE).
4.1.2 Extended Product oriented Life Cycle model

The components and the overall product will have a life cycle divided in the Begin, Mid and End of Life. The different phases of the life cycle offer multiple opportunities for extended product concepts to the stakeholders in e-mobility. Mayor players for these new products and services are the car manufacturers (OEMs), battery developers, infrastructure providers, electricity providers and mobility providers. It becomes obvious that these players partly offer competitive but also complementary products. Moreover the life cycle of these offers differ massively from each other. In Figure 2 we converged the shell concept of Extended Products with the three different lifecycle phases of a product.

![Figure 2: EP oriented product lifecycle](image)

**Begin of Life**

Business models in the beginning of life phase can be the currently known ones for car manufacturers. It starts within begin of life (BOL) with the vehicle development, engineering and production (Pahl, et al. 2005). To match the future development requirements coming from the market of e-mobility solutions this phase will be constantly evolving as well as shifting from the involvement of OEMs only towards collaborations between the different players in the e-mobility field. The development of charging stations for example needs to be standardized and considered already during the vehicle development. At least players like battery developers and infrastructure providers need to be involved in the vehicle development. As every player wants to get a piece of the cake as big as possible it seems to be logical, that energy providers will not only focus on the revenue of electricity alone, especially due to the fact that the amount of additionally needed electricity for e-mobility will be quite small.

Charging stations with a monthly paid fee could be a solution for this issue, but the authors subsume that this model will not play any important role in the future. Certain extended product concepts presuppose cars which are specially designed for the needs of that specific concepts e.g. the model introduced by “better place” requires vehicles which
are designed with a changeable battery, compatible to their battery changing stations infrastructure (Better Place 2011). Many companies who want to become a player in the e-mobility field started strategic alliances with big car OEMs, for example Nissan Renault with the infrastructure provider “Better Place” (Renault 2009). There is a strong interdependency between the battery and the vehicle which necessarily leads to co-creation in the product development phase. Infrastructure providers also need to develop the charging stations in BOL.

**Mid of Life including sales, usage**

Within Mid of Life (MOL) car manufacturers traditionally offer spare parts and maintenance services as well as customer support and -service (Klimke 2008). In maintenance services replacement and modification of vehicle parts could be established as upgrade services e.g. replacement of engine or battery for higher performance respectively range. As technologies will evolve modernization services might be also feasible for the mid of life phase. If for example the fuel cell technology, reaches its break-through, battery powered vehicles could be equipped with a fuel cell as a so called range extender. Accompanying further services might be offered like e.g. own car sharing models, and fleet management for business customers.

**End of Life**

As car producers in the European Union have to take their cars back by law various recycling related activities can be seen as a source for new services and related businesses models during the End of Life (EOL) phase. Another service could be the replacement of the vehicles battery, as the batteries life might be shorter than the vehicles life. Old batteries need to be either recycled according to national laws or they could be used subsequently for other purposes, e.g. as Uninterruptible Power Supply (UPS) for Servers.

A niche in the end of life phase could be the refurbishing of used vehicles in a way which makes the vehicle more attractive for new potential buyers’ e.g. equipping the vehicle with a new battery or new upholstery etc. to bring the vehicle in a “as new” condition to sell them.

**4.2 Extended products in the context of -e-mobility -**

Meanwhile, many case studies (e.g. Deloitte 2009) in different branches illustrate the applicability of the concept - especially in the area of e-mobility. In addition to the electric car itself, maintenance processes regarding battery charging, loading infrastructures or energy management must be adapted to the customers.

Figure 3 can be understood as business opportunity matrix reflecting the most important components and the product life-cycle. In this matrix we have positioned the actors and their products. The four elements (stakeholders, product life-cycle, components and extended product concepts) have been brought together to demonstrate the ultimate need for integration in e-mobility. The product life cycle is shown on the top of the diagram. The phases indicate in which phase the various stakeholder can be positioned. Relevant stakeholders are the battery producer, the automotive OEM, power provider, infrastructure provider and mobility service provider.

**4.3 Illustrating the complexity of EP concepts for e-mobility**

The definition and specification of product and services for e-mobility is complex. Many different organizations need to combine resources and competencies to finally
enable new Extended Product concepts (Thoben et al 2002). In the following, we will provide an explanatory example demonstrating how potential collaboration requirements can be identified.

Figure 3: Stakeholders, product life-cycle, player and extended products

This case is based on the collaboration between some and/or all 5 company groups stated in Figure 3. The five identified most relevant organizations which share competences regarding the creation of extended products for e-mobility (battery producer, automotive industry, infrastructure provider, energy providing company and mobility service provider) are shown. The different colors indicate different potential services (tangible or non-tangible) around the core product. As a guiding example, we will use the maintenance and spare part service to demonstrate needed collaboration activities to provide extended products. In the following we will briefly introduce 3 examples:

1. The spare part and maintenance business is very important for automotive OEM and is a part of their general business. In addition to the general services, new products will be offered. For B2B oriented battery producers, spare part or maintenance business is less important, because the direct contact with the end customers is outsourced to the OEMs and garages. Energy providers also enter the market with their core product electricity for driving, but cannot build upon traditional business concepts. Currently, diverse power firms work on new products and services in the context of e-mobility, such as smart grids, green energy for mobility and car leasing (RWE 2010).
2. An interesting area with probably several links between the five main participants is automotive leasing of electric cars. For automotive OEMs, automotive leasing can be seen as standardized offer. Likewise, more and more mobility service providing companies offer such services. For power firms, leasing offers are completely new and gain in importance. New leasing concepts can be seen as mobility enabling service. Many types can be differentiated such as distance, pool- or full-service leasing packages (Braess and Seifert 2007). So far, leasing offers for electric cars are generally very expensive (MiD 2008). Power firms will have problems to acquire significant market shares, because they have to focus solely on electric cars (Strommagazin 2009).

3. The last example refers to the definition of a battery charging service. This is a completely new service in e-mobility, meaning that none of the companies has positioned itself properly. Consequently, all players might have an interest to enter the market. The power firms begin to offer such services just as a complement to their regular business processes. As already calculated, the additional revenue for charging batteries until 2025 is very low (Mora 2008). The battery charging service is currently not of great interest for the automotive industry, so, no specific offers have been made by those companies. The providers of infrastructure are currently seen as suppliers of the needed equipment. Nevertheless, the infrastructure providers of charging stations could extend their business by operating the infrastructure and selling rights of use.

If the respective interfaces described before are connected by edges, a very complex diagram results. After a more careful analysis, most of the relationships found include the extended products of automotive companies, power firms and mobility service providers. The battery providers play an important role, because their extended products are difficult to connect to the others. Of course, this is a very initial analysis.

Figure 4: Nodes and edges between the extended products
At this point of time, it’s not possible to predict which players will take the lead in the e-mobility market. Nevertheless, we assume that automotive manufacturers will still play a leading role due to their many interconnections and their large market power. The automotive industry faces one of the most difficult transitions in history. The paradigm shift from fossil fuel combustion engines towards electric cars is tremendous (Rothfuss 2009, WIWO 2010). Most of the extended product concepts focus on mobility without ownership, e.g. car sharing. Companies such as BMW experiment with new vehicles in combination with in a car sharing solution (Reithofer 2010). Other companies like Toyota promote combined technologies such as Hybrid (combination of combustion and electrical engines), but also invest heavily in electric cars. It is indeed difficult to foresee if the automotive OEM will lose their competitive position, however, mobility service providers, power firms still depend on the vehicle itself.

The extended product concept shown before, the links between the extended products also identify other areas and cooperation partner options. The use of the business model canvas approach will illustrate one way of identifying new business models.

5 Summary and Outlook

Within this paper the concept of extended products has been introduced. It has been adapted for e-mobility to state the complexity in terms of participating stakeholders and their related business models. The EP model has been slightly modified in order to illustrate services in the different product life cycle phases.

Future work need to be performed on the one hand side in the development of these business models and on the other hand side on the interrelation of business models and their product life cycle impact. As soon as several business models from the MoL phase reach a relevant and critical size they will have influence on the development of vehicles respectively an influence on the BoL phase. A good example is “Better Place” as an infrastructure provider which provides a service with changing stations for electric vehicle batteries (Better Place 2011). If this becomes one of the future infrastructure providers and operators car manufacturers need to take the switch technology for a battery and the battery itself (size, form factor, interface) into account. Also car sharing or mobility services influence the vehicles due to different requirements of owning a car.

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