TECHMIND RESEARCH
ISSN: 2291-2118
International Journal of Research in Business and Technology
Volume 8 No. 2 June 2016

Towards Servitization of Mobility – Mobility as a Service

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Abstract- *Servitization and digitalisation are current trends that are influencing many areas, including mobility and transport sectors. Although these areas have been slow to start, they are now rapidly being transformed by a large number of novel technologies, services and business models. The growth of Uber has brought these changes into public knowledge. There are many trends facilitating and driving mobility services into more multimodal and digitalised era. One of the ideas is to provide turn mobility into a service bundles combining several transport modes into one package. This mobility-as-a-service (MaaS) has gained momentum. This paper focuses on looking into servitization of mobility and transport services and defining the key elements of mobility-as-a-service.*

General Terms- *Services; mobility*

Keywords- *servitization; mobility; mobility-as-a-service; traffic; business models*

1. INTRODUCTION

Servitization is one of the most important recent trends, which started from business, and is now expanding to public organisations. It has its roots in outsourcing non-essential tasks, when businesses focus on their core activities, and decide to buy services from outsiders. Closely connected to outsourcing is the idea of service dominant logic ((Vargo & Akaka, 2009[**31**]; Vargo & Lusch, 2004[**32**]) which emphasizes services as a key in all activities in society, and the role of services in modern business. Indeed, today there are double the number of service jobs in the world (40%) than manufacturing jobs (20.4%) (Spohrer & Kwan, 2009)[**25**].

Despite this background, and the examples of many other industries, transportation has remained relatively little affected by this trend. Most transport operators from small to large still own their own fleets, manage their maintenance and have a large staff of personnel. In addition, the offering to customers has seen little changes. Similarly, owning and using a private car has been the main mode of transport for consumers in many countries. If we apply the principles of servitization to mobility, we find that there are questions to be raised, such as: is it necessary to own a car to have door-to-door mobility? Consequently, it is no wonder, that the idea of servitization of mobility has also been raised, and there is huge interest in the servitized model of mobility, i.e. mobility-as-a-service (MaaS).

Digitalization has profoundly and radically transformed many industries, and has also to some extent entered transport and mobility areas. Particularly, tourism has been changed due to common access to internet, when purchase of travel services has moved from brick-and-mortar travel agents to digital malls, with a wide range of services. Typically consumers buy travel tickets, reserve hotels and rent cars in digital channels. The next steps are connected to mobile services, as consumers are carrying their smart phones at all times and places, and have access to networks ubiquitously. This provides new opportunities for tourism, and also for mobility services. Many cities already have local digital services to assist public transport users to find the best routes and avoid congestion. Therefore, digitalization provides the facilities for novel mobility services.

The advanced sensors in continuously connected smartphones have led to the emergence of crowd-sensing systems (Ganti, Ye, & Lei, 2011)[**9**]. These systems collect and combine data from large number of users to generate an overall view of e.g. traffic in an area. The data is connected to other types of data to create relevant information to travelers. This facilitates provide real-time analysis of traffic, and to give instructions for system users to avoid bottlenecks and estimates of travel times in different routes and vehicle-types. Crowd-sensing systems are either automated systems based on crowds sending information without any effort on the part of individuals, or they can combine traveler feedback to the automated data.

If there are already the means, we also recognize the needs. In the increasingly urban world, where the population in city areas has passed the number of non-urban dwellers (Banister, 2011)[**1**], and the expectations are that this will increase to 70% by 2050, there is clearly need for new solutions and services of mobility. Urbanisation has turned many cities, and even more megacities, into continuous traffic jams with low service-levels in mobility and increased pollution.

Mobility-as-a-service

Given the large number of development efforts connected to servitization of mobility, there are plentiful descriptions

of the vision of mobility as a service. However, the state-of-the-art has largely remained at descriptive level (see e.g. (Heikkilä, 2014[**11**]; Kallio, Raulas & Tinnilä, 2015[**14**]; Kulmala & Tuominen, 2015[**17**]). However, systematic descriptions of the MaaS structure and activities are still missing.

MaaS has been presented as a vision, where there mobility services of different kind, such as public transportation, taxis, DRT, etc., are provided as a service package, making it unnecessary to own or use a private car. As such it is a fine vision. However there are many missing links and open questions, such as pricing schemes, financing of new services, societal control of city traffic, etc. It can be maintained that many steps to realisation are still absent. The argumentation for the need to servitize mobility services is convincing, and many future trends connected to transport services clearly support these needs (for a summary, see e.g. (Tinnilä & Kallio, 2015)[**28**]

Recently, many new digital services, technologies and novel business models have been introduced, that can be regarded as parallel to the MaaS visions, and can thus form a part of a future MaaS service bundles. Uber is perhaps the best-known novel service, using digital technology, and a new approach to using resources. Instead of owning, the business model uses crowdsourcing to engage required resources, such as cars and drivers. However, this very novel approach has created huge controversy, as it is radically changing existing service structures and labour market. The Uber business model elements include crowdsourcing drivers, using private cars as vehicle resources as they typically have a low utilization rate. A key element of Uber is the role of orchestrator of outside resources, and extensive use of mobile and wireless devices in ordering, paying, rating both drivers and customers, etc. The controversies are of particular interest, as they include several that also a MaaS service will face. These consist of regulatory and legal issues, privacy, taxation and labour market relations. However, despite the controversies, the Uber service has spread into dozens of cities in a few years' time, pointing out the potential of completely new servitized mobility solutions.

This paper focuses on recognising servitization trends in different research areas connected to mobility, including public and private transport services, and particularly focusing on digital services. This is done through a literature review. Furthermore, we propose a definition and description of Mobility-as –a-service MaaS, and its key elements. Finally, a discussion of the outlooks connected to servitization of mobility is provided.

2. LITERATURE REVIEW OF RESEARCH AREAS LEADING TO SERVITIZATION OF MOBILITY

Although the term Mobility-as-a-service or, MaaS, is in itself is novel, there are several existing research and development paths leading into it. Particularly the development and research on the expanding range of mobility services, as well as, on multimodal and seamless transport chains, can be regarded as preliminary stages on the road toward full-scale MaaS services. Several of the research and development areas can be regarded as building blocks of MaaS, i.e. different types of MaaS services are based on them.

Increasing the share of services is a trend in many manufacturing and other industries. It consists of increasing both the range and share of services and is referred to as servitization (Vandermerwe & Rada, 1989) [**30**]. It can be regarded as a road from products to services (Oliva & Kallenberg, 2003)[**21**] . The introduction of the idea of service dominant logic (Vargo and Lusch, 2004)[**32**] emphasises the importance of the role of services in value creation. Consequently, many industries have integrated services in their product range. Through servitization, manufacturing companies aim to lock out competitors, lock in customers and increase the level of differentiation (Vandermerwe & Rada, 1989)[**30**]. The drivers behind this trend is to achieve financial, strategic, and marketing benefits by introducing services successfully in the offering.

To summarise, servitization can be illustrated as a transition path from products to services so that the importance of services increases while the share of pure products decreases. Transportation industry has typically been very focused on products, be it private cars or buses. The aim has been to provide households with superior cars for private use, as well as, buses and other equipment to transport operators. The main business model has been sales of products, i.e. the buyer owns and operates the vehicle. The role of other business models, such as leasing has increased, but remained relative low and regarded as a side path. Servitization of transport means departure from this model, where the main way to use private car for transportation, is to own it. The novel ideas in this area are multiple, ranging for car sharing schemes and demand-driven transport services to MaaS-type solutions. Consequently, also transport and mobility business are being servitized, and as pointed out by (Vargo and Akaka, 2009)[**31**] services are at the basis of all exchanges, and "all economies are service economies, and all businesses are service businesses".

Next, we will review the literature for trends and development directions connected to servitization of mobility and transportation. The main connected areas of research include mobility and traffic, business, technology, as well as, consumer research. This does not exclude other research areas having impact on mobility.

In the area of *mobility and traffic*, there rather naturally are multiple research topics connected to MaaS. Of particular importance are linked and seamless mobility chains and systems providing increased range of mobility services. These are connected to multimodal diversification of the service range. The range of mobility services has for decades been stationary in most cities, consisting of private cars and taxis to public transport services ranging from trains to buses. *Business* research of servitization and new business models and services are also of particular interest.

New *technology* provides innovations, such as new vehicles, but increasingly also mobile and wireless services and devices connected to mobility. Particularly, these are used for finding best routes, information about timetables and bottlenecks and similar traffic connected information. Finally, *consumers* have a vital role in acceptance of new services. Individuals as consumers and citizens have the final word on using the services, while they can as masses provide crowd-based novel possibilities for realisation of services.

2.1 Mobility and Traffic

The range of mobility services has been fixed for decades in most cities, consisting of private cars and taxis at the other end of the range, and public transport services such as trains and buses, at the other end. Lately, the portfolio of services has been increasing due to many reasons, such as car owning attitudes (Winterhoff, 2009)[**35**]. The portfolio of services has also been expanding by novel business models, such as advertisement-based services providing shared cars and bikes (Wang, Zhang, Liu, & Duan, 2010)[**34**].

Another type of servitized traffic service are the many pilots of demand responsive transports (DRT), with many experiments (Brake, Mulley, Nelson, & Wright, 2007[**2**]; Nelson, Wright, Masson, Ambrosino, & Naniopoulos, 2010[**20**]). The introduction of new technology has also facilitated automated ordering and dispatching systems based on mobile phones (Jokinen, Sihvola, Hyytia, & Sulonen, 2011[**13**]). The increased interest in these services has been driven by the increased size of cities and need for door-to-door mobility, also for non-car owners. DRT is not a comprehensive answer to all mobility challenges, but will complement existing route-based public traffic with more flexible point-to-point services (Daniels & Mulley, 2012)[**6**].

One trend in creating seamless transport services is the connection of multiple modes for smoother mobility. Consequently, this has been a direction of development also in public transport. These may include also public-private partnerships, as well as, market-based services (M. Tinnilä & Jukka Kallio, 2015)[**14**]. In addition, real-time information facilitates creation of seamless transportation. One particular type of driver is the environmental viewpoint aiming at lower emissions and pollution for transports (Heiskala, Jokinen, & Tinnilä, 2016)[**12**].

2.2 Business models and servitization

The traditional business model in traffic services has been to offer timetabled route transport service. The earnings have come from sales of tickets, and in the case of public transport, also from subsidies from society. In digital services, other types of business models, including advertisement-based, are common. Elements from these business models appear also in mobility services, where new players provide e.g. their bike-rental services free of charge, but based on advertising. Similarly, route planning and service search services are flowing into the market.

Travel and tourist services are an area, which has been completely transformed since millennium, with first internet-based travel, ticket sales, and later on with mobile tourist services. In the actual travel services, budget airlines offer cut-down service level with reduced prices, and have forced traditional airlines into retreat (Tinnilä, 2012a)[**26**]. Similar business models are entering into domestic travel services where budget bus-lines offer tickets starting from 1 euro. The revenue model is based on yield management focusing on increasing use of capacity enabling reduced pricing. Novel business models connected to new technology are one key to new services (Budde Christensen, Wells, & Cipcigan, 2012)[**3**]. For example, electric vehicles are not stand-alone products, but require services, such as charging stations, and battery maintenance and leasing. These are provided as services by networked business models to provide service packages to users (Kley, Lerch, & Dallinger, 2011[**16**]; San Román, Momber, Abbad, & Sánchez Miralles, 2011[**23**]). These in turn are often provided as services with different earning models. For example, the initial high costs of battery packs can be alleviated by leasing or renting them from specialised operators, providing them as services.

2.3 Technology

Technology is a major facilitator and enabler of servitization and new services. In mobility, many of the new services are connected to information of travellers location, vehicles and routes used. There are plenty of these mobility services today, as consumers use and carry their smart phones everywhere and at all times. Consequently, the access to digital services is almost ubiquitous and facilitates real-time information. This "informational mobility" combines mobility and information services (Hannam, Sheller, & Urry, 2006)[**10**], including best routes using multiple transport modes, "routines of flexibility" (Ruhrort, Steiner, Graff, Hinkeldein, & Hoffmann, 2014)[**22**]. This ubiquitous availability of digital services allows access to services and information at all places and at all times (Tinnilä, 2012b).

Crowdsourcing is one area which in facilitated by new technology, and smart phones. The idea of using data generated by large crowds of users has gained impetus, and many applications, such Waze and Moovit (Heiskala et al., 2016)[**12**] are being used in many countries and cities world around. Furthermore, the idea of crowd-sensing (Ganti et al., 2011)[9] or participatory sensing ((Burke et al., 2006[**4**]; Liu, Feng, Wang, Liu, & Tang, 2013[**19**])) is to use the data from smartphones to create a real-time description of traffic. This approach will enable many novel services. Environmental concerns and pollution in cities has given motivation to reduce emissions, and electric vehicles are one option (Faivre d'Arcier & Lecler, 2014)[**7**].

2.4 Consumers and behaviour

Consumers have a vital role in acceptance of any novel service, either as individuals or as a mass. Among the traffic and mobility-related challenges of today there is the need to

reconsider the traditional division of tasks of public and private transport. The previous dichotomous division to "public or private" is being replaced with a wider range of choices, where the transport vehicles are owned, leased, rented, shared and jointly owned. Consequently, individuals as consumers and citizens have the final word of the success of any new mobility service, and as crowds can facilitate new service types based on crowd-sourced information.

One of the recent consumer trends are the changes in attitudes toward ownership. The previous idea of owning a private car are in the younger generation changing toward using services. This altered role of ownership exists principally in younger generations (Ruhrort et al., 2014)[**22**], and is not only limited to vehicles. Several studies point out that, at least in industrial countries, the will to own a car has reached peak-level, if not already passed it. It appears that car ownership has reached its peak. The so-called "generation Y", does not even keep the possibility of driving a car, as the share of people taking driving licences is lower in younger people (Viehnicki, Khuperkar, Fishman, & Eggers, 2015)[**33**]

These shifts in consumer behaviour mean that there are more opportunities for servitized mobility services with business models differing from traditional. This is not only limited to car rental, but extends to sharing vehicles, such as cars and bikes (Shaheen & Cohen, 2013; Wang et al., 2010)[**24**][**34**]. The threat of lower car sales has encouraged also car manufacturers to consider novel services, such as car-sharing schemes (Lindloff, Pieper, Bandelow, & Woisetschläger, 2014)[**18**]. Sharing economy is also entering into services between consumers, including ride- and car-sharing connecting drivers and travellers (Cohen & Kietzmann, 2014)[**5**].

Connected to changed attitudes toward ownership, are the changes in lifestyles. In large cities a growing share of household are single and double, instead of the traditional core families. Connected with this trend are changes in lifestyles preferring urban environment to suburbs and accordingly, other mobility options than private cars. The range of lifestyles being wider than previously facilitates novel services connected to new business models. The preference on convenience boosts options providing servitization, rather than ownership. These include e.g. carpooling systems connected to mobile services, where users can find and locate vehicles, or even find people going into same direction (Liu et al., 2013)[**19**].

3. MOBILITY AS SERVICE – DEFINITION AND KEY ELEMENTS

Despite the interest in mobility-as-a-service, there is no commonly accepted definition, resulting in different interpretations of content of the term itself, and more particularly, the scope of MaaS. MaaS is seen to consists of a group of mobility-related services forming a bundle for consumers. The difference to traditional public traffic services is sometimes vague, but MaaS integrates a larger range of different traffic services into packages for un-interrupted and connected, often multimodal travel chains within a common payment system. The service providers include both public (metro, bus, tram, DRT) and private (taxi, shared taxi, car club) traffic services, as well as, digital information services connected to mobility. Also crowd-based services, such as car pooling, package delivery and information sharing (e.g. traffic jam) services can be included. As the value promise of MaaS is to provide the users integrated mobility services, the role of operator organizing and managing the service range is crucial. However, this does require centralization of coordination to "city traffic department"-type organization, but rather coordinating an array of services provided by many players into suitable service bundles for travellers. Some examples of these MaaS packages have already been proposed, e.g. in London (Kamargianni, Matyas, Li, & Schäger, 2015)[**15**].

The key elements and activities connected to MaaS include:

- Single payment system where all types of trips can be payed by the same way. However, this does not necessarily include similar pricing for all services. Consequently, taxis or DRT can be more expensive than metro-rides.
- Service packages consisting of several types transport modes connected into a multimodal transport service system. The packages typically are e.g. monthly bundles or flat rates
- Advanced use of digital services, both for vehicles and travellers. Vehicle services include navigation, GPS-based information of vehicle locations, congestion information and route selection assistance. For travellers, the services include multimodal route planning, timetables, and assistance in navigation.
- Inter-linked and connected multimodal travel chains by connecting several types of vehicles, including walking, bike, car, bus, metro, etc.
- The key role of operator or orchestrator coordinating the range of services. The travel services can be operated by different players, such as transport companies.
- Extensive use of outsourcing and use of the resources of a network. This differs from the traditional mode of owning and operating everything within companies, such as depots, vehicles, maintenance, personnel, etc.

4. DISCUSSION AND CONCLUSIONS

There are several development paths into servitization of mobility and MaaS. Obviously launching a full scale MaaS with all services is challenging, while starting with too modest package would not reveal the real benefits. Already there exist some proposals for realization of MaaS, with relatively detailed descriptions of the elements of "minimum MaaS". These can fairly be regarded as starting points for developing an adequate package for consumers and involving the key players of a larger scale "full MaaS".

After a long stagnant period, the mobility market seems to overflow with new services, often introduced by players outside the traditional ones. These actors typically take a leaf from development in other industries, by introducing new business models (Uber), new technology (google cars), or e.g. pricing schemes (budget priced buses). While the success models of e.g. tele-operators cannot be directly copied, the experiences should be taken into account.

Introducing larger networked innovations involving many players and multiple integrated services, instead of single innovations (e.g. novel cars), faces different challenges. These so-called systemic innovations require building up a whole network of services at an early stage for the service-package to operate. For example, while electric car is a single innovation, it requires a network of new services, such as charging infrastructure, to be practical. As MaaS requires undoubtedly a large network, the challenge of "jump starting the network" (Fjeldstad & Sasson, 2010)[8] should be recognized.

Looking at the network required for Maas, we can recognise different types of players. The transfer operators of MaaS are those directly connected to mobility services, including public transports, private cars and other modes. The infrastructure and resource activities include those connected to facilitating mobility, such as roads and rails, but also parking facilities, bus stations, as well as, the sensors and devices for managing traffic. While this sector has been traditionally largely managed by public sector, many novel actors have entered. Similarities to other sectors include e.g. facility operators managing shopping malls and office buildings. These types of outsourced operations have been a fast growing area, as few organisations find it in their core to own offices and other facilities.

The analysis of activities connected to servitization of mobility reveals a wide range of organizing services from booking, reserving and paying services to facilitating real-time information infrastructure. This in turn enables e.g. wireless and place-independent applications for individuals. The main potential of organizing services lies in their digital nature. Digital services differ in their cost structure fundamentally from traditional ones, as developing and building a service requires investments, while operations incur very low costs. Similarities can be found in banking services, where the cost of a single payment is in the range of 1 cent, while the traditional over-the-counter payment costs several euros (Tinnilä 2013). This is in direct contradiction to traditional traffic services, where personnel costs are typically 50% of total. In addition, these services are scalable to a large degree. Subsequently, developing e.g. a city- or country-specific DRT systems, does not make sense, as its digital elements (navigation, travel time, dispatching, etc.) can be duplicated with little costs to multiple cities. Similar scalability can be found in many of the digital services. Examples of realised services, include particularly Uber which has spread into dozens of cities in the last few years.

This work was supported by the Aalto Energy Efficiency Research Programme as part of TrafficSense research project.

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