Mobility Service Platforms
Cross-Company Cooperation for Transportation Service Interoperability

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Abstract: The growing number of modes of transportation with diverse characteristics and situational suitability would allow a multifaceted mobility behavior. Unfortunately, the usage of a combination of heterogeneous modes of transportation – specifically during a complex travel chain with multiple changeovers – is hindered in various ways. Users have to query, compare, combine, book and use multiple specialized mobility service individually which results in inefficiencies both on demand and supply side. Centralized mobility service platforms can form a technological bridge to deliver service interoperability. In cross section between competition and cooperation, the need for suitable, profitable, and sustainable market forms to provide complex service configurations arises. As a result of interdisciplinary workshops with domain experts, we describe a role relationship model and identify relevant market forms. To do so, we present a conceptional tool to analyze, characterize and differentiate various mobility service platforms and apply it to set of platforms currently beeing developed.

1 INTRODUCTION

Nowadays, in the modern transportation service sector, people can choose and combine manifold transportation services with different characteristics. Traditional public transportation modalities, e.g., trains or buses are being complemented with car- or bikesharing services. In (Huwer, 2004; Himmel et al., 2016) promising synergy potentials concerning mode combination are shown. With the help of information and communication technology, barriers due to the utilization of mode combinations can be reduced.

In the last decades, there is a rising trend to create interoperability between heterogeneous transportation services via IT systems. Advanced travel information systems provide encompassing information and assistance in relation to complex travel chains (Beutel et al., 2016). In addition, modern fare management systems foster especially cross company payment and accounting integration. As another step forward, systems are able to integrate whole service chains of different providers, starting from travel information to ticket booking and even an integrated travel assistance. We call these systems *mobility service platforms*. Beside the technical feasibility of these systems, important questions arise concerning forms of suitable provider collaboration and sustainable business models.

As a basis of this work, we define a fundamental role relationship model to describe cross company cooperation scenarios. Core part of this contribution is the analysis, characterization and the comparison of existing mobility service platforms. To achieve this, we identify crucial system characteristics in constitutive workshops with domain experts and form a conceptual tool for analysis and design. For validation purposes, we apply this tool in a survey across members of relevant German research and development projects and present the results.

This work is structured as follows: Section 2 describes relevant theoretical foundations in the research area. Afterwards, Section 3 presents a role relationship model for the area of mobility service platforms. Then, Section 5 describes the conceptional tool to characterize mobility service platforms. Therefore, we focus on transactions phases, business models and

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structures of platforms. Section 6 presents survey results and Section 4 describes selected platform scenarios. Finally, Section 7 reflects this work critically and concludes the work.

2 THEORETICAL BASIS

The analysis and characterization of different mobility service platforms is based on the following foundations.

2.1 Systems to Foster Interoperability in Urban Transportation

Nowadays, travel information systems provide extensive travel information concerning various different modes of transportation. The assistance goes beyond the pure information provision and enables handling the complexity of planning, booking and utilization of intermodal travels (Beul-Leusmann et al., 2013). These systems have the possibility to optimize flows in transport networks (McQueen et al., 2002). Besides travel information systems, electronic fare management systems foster service interoperability by integration of payment and transaction procedures.

There is a rising amount of integrating solutions. One example is the system Mobility Broker[1], which combines public transportation services with car- and bikesharing in the German region of Aachen on a centralized system. Focus is to integrate large parts of the entire service chains to foster service utilization free from barriers. Additional prominent examples in Germany are Moovel[2] and Qixxit[3], which provide integrated services partially supra-regional or nationwide. In addition, there are cross-border software solution, e.g., AMADEUS[4].

2.2 Types of Economical Cooperation

In (Lesourne, 1992) the authors define coordination as an overall target compliant alignment of interdependent tasks via participating task-carriers. The actual interaction of the task-carriers with the purpose to coordinate and execute tasks is called cooperation (Benger, 2007). Company networks are a specific form of cooperation, where formally independent companies follow a unified goal (Siebert, 2003). They build themselves in or across branches of industries as a result of diversification and integration of economic activities (Benger, 2007). Besides possible potentials of cooperation like synergy effects or cost reduction, communication, adjustment and control cost occur. Moreover the competitive position might even worsen. Hence, information and communication technology widens the spectrum of cooperation possibilities (Benger, 2007).

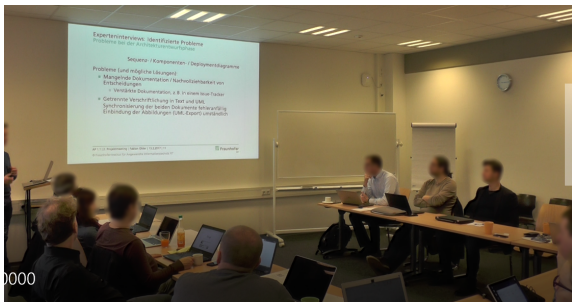

Figure 1: Impressions of an expert workshop.

2.3 Electronic Marketplaces

Information and communication technology eases the market entry and fosters competition on supply side. On demand side, search costs are lowered, price comparison is facilitated and transparency becomes increased (Clement and Schreiber, 2016). The usage of information and communication technology in the coordination mechanism market guides to electronic markets. Electronic markets are marketplaces that are realized via telematics (Schmid, 1993; Fischer, 2008).

3 EXTENDED ROLE RELATIONSHIP MODEL

The following clarifications are based on standard ISO 24014 (ISO 24014-1, 2015) as well as the role relationship model of the VDV-KA (KA BOM-SPEC, 2016) and are intended to be published in a document of the Association of German Transport Companies (VDV-Schrift-series). To develop the role relationship model, we conducted several expert workshops, as depicted in Figure 1. The approaches mentioned are primarily related to fare management. However, advanced travel information systems and complex mobility platforms offer functions compassing the entire service chain (Beutel et al., 2016), of which fare management is only one part. For the comprehensive modeling of the roles in context of travel information systems and their inter-dependencies, extensions are needed on the travel information side. During development of the model, we focused on the information,

[1] https://mobility-broker.com
[2] https://www.moovel.com
[3] https://www.qixxit.de
[4] http://www.amadeus.com

agreement, completion and service phase of system usage.

Figure 2 depicts the extended role relationship model for mobility platforms. The loops denote relevant interactions between several (hierarchical) instances of the role. Compared to the role relationship model of fare management presented in (KA BOM-SPEC, 2016), the most striking changes are the following: The roles Informant, Information Manager, Mediator and Payment Provider are added. The role of the user is split into multiple individual roles: Booker, Payer and Mobility Service User. Furthermore, the roles known from fare management are expanded to undertake tasks to support a broader spectrum of (mobility) services.

In the subsequent sections, the newly defined roles are described in more detail and the extensions to the relationship diagram of VDV-KA (KA BOM-SPEC, 2016) are presented.

User / Customer

The role user / customer is considered in a refined way when compared to the VDV-KA and is therefore split into three roles: Booker, Payer and Mobility Service User. All of those three roles can fall onto a single customer, but also on different persons. A typical example for the latter case would be the travel department in a company: A person chooses the journey and performs the booking, a different person from the finance department is responsible for the payment and a third person from the customer service department finally goes on the journey as Mobility Service User.

For further explanations, e.g. with respect to the transactions with the customer, please also refer to (KA BOM-SPEC, 2016).

Mobility Service Operator

The Mobility Service Operator (MSO) *delivers mobility services* in a narrow as well as a broader sense. Mobility services in a narrow sense are transportation services, e.g., public transportation or vehicle sharing. Examples for mobility services in a broader sense are provision of parking space or insurance services.

In the area of public transportation services, a transportation contract is created between a Mobility Service Operator and a customer by entering the public transit. In case of vehicle sharing, a permission for use contract is used. The configuration and formation of a contract can vary concerning other services.

The tasks of a Mobility Service Operator are the provision of a mobility service, an appropriate *customer service* and the *inspection of tickets*. These tasks are complemented by tasks w.r.t. data collection: He collects planning, real-time and usage data for his services.

The task *Collection*, which was already part of the model in (KA BOM-SPEC, 2016), was specified further to *Collection of Usage Data* to distinguish it from the other (new) collection tasks. The task *Collection of Planning Data* refers to the collection of all planning data of the provided service, e.g., timetable information in public transportation, routes, locations of stops and parking spaces, etc. The task *Collection of Real-time Data* refers to the collection of all real-time data concerning the provided service, e.g., recent vehicle positions, recent availabilities of sharing vehicles, recent availabilities of parking spaces, status interruption of escalators and lifts, etc.

Informant

The Informant (INF) *provides travel information* to the end customer using intermodal trip options. For this purpose today's technical systems are interacting with the end customer. The systems request start and destination of the trip, as well as further options and desires of the passenger. These interactions can be done in browser-based applications, mobile applications, voice-directed systems or in any other possible interaction system. Thereby data is gathered to allow personalization for the passenger.

The Informant offers the following sub-tasks to the end-user: trip calculation from start to destination point, fare calculation or fare estimation, current departures/arrivals at stops/stations, locations and availabilities of sharing vehicles, locations and availabilities of parking spaces and charging stations, display of routes on maps for routing and indoor routing (interchanges) and more. These sub-tasks are embraced by the term travel information. For the fare calculation or estimation, the Informant first has to employ the task of product determination. For the suitable products identified, the resulting price (estimation) is determined.

The data which is required by the Informant to fulfill his tasks, is sourced from the Information Manager and other (distant) Informants. Using real-time data like train delays is an example for this case. The real-time data is not present to the Informant itself but provided by another Informant.

Moreover, the Informant is responsible for the annotation of prices to travel chains (*product determination*). For trip calculation the Informant tries to optimize the result, which has to fulfill the criteria of the end-user (or a combination of several criteria). Typical criteria of optimization are: fastest connection,

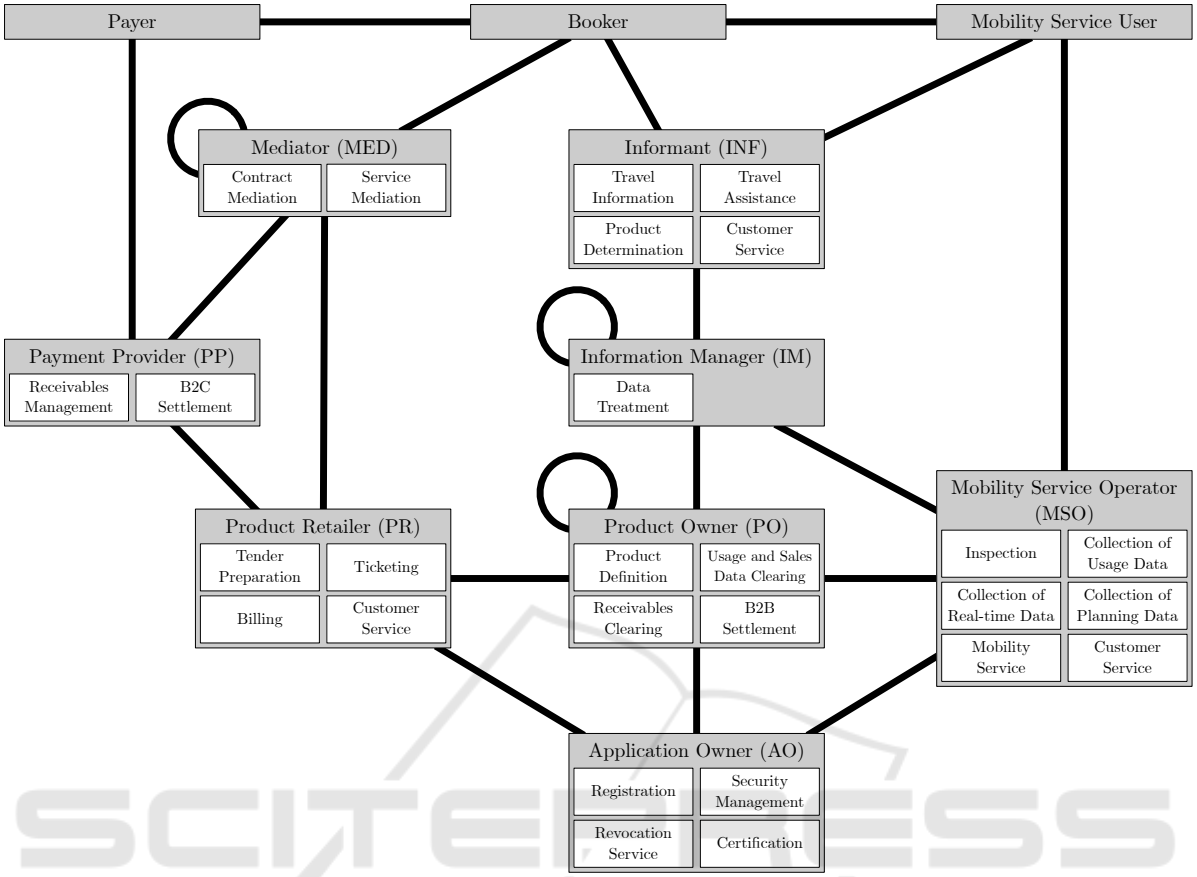

Figure 2: Extended role relationship model.

shortest distance, cheapest connection, shortest footpath, least interchanges etc. Especially for handicapped persons (e.g., wheelchair users, baby carriage) further criteria can be taken into account (e.g., floor-level access, avoidance of stairs, etc.).

During the trip, the Informant provides information (relevant for the trip) to the passenger (*travel assistance*). This can be navigation assistance or notifications about disruption which might concern/influence the trip. If necessary, the Informant provides an alternative trip, which helps the passenger to bypass the disruption.

Additionally, the Informant *provides a customer service* to help end-users utilizing his services concerning information provision.

Information Manager

The Information Manager (IM) *collects and treats all data* which is necessary for a comprehensive, integrated, intermodal trip and fare calculation. This includes timetables, real-time data, locations of stops, parking spaces, sharing stations, vehicles, charging stations, product definitions and fare data, maps etc.

These data come from the responsible Mobility Service Operators or from the Product Owner (in case of fare and product data). The Information Manager monitors the data with regard to currentness, correctness/plausibility, completeness and consistence. For quality improvement, the data collecting Mobility Service Operator or Product Owner receives feedback.

The Information Manager also checks if the data is unique and eliminates double deliveries, for example regarding stops served and used by several transport authorities, for which several Mobility Service Operators provide those data (which might be inconsistent) to the Information Manager. After receiving the data deliveries from the Mobility Service Operators, the Information Manager harmonizes the data and forwards this integrated database to the Informant. In Germany, for the area of public transport data, this task is e.g. done by the DELFI data pool.

Mediator

The main task of the Mediator (MED) is the *mediation of contracts* between Product Retailer and

Booker (possibly via further Mediators). Here, information about the Payer and account receivables are forwarded to a Payment Provider. The Mediator also *mediates service inquiries* to the customer service of the responsible Product Retailer (possibly via further Mediators).

The organization that acts as a Mediator can additionally act as an Informant and/or service retailer or operate independently. The mediation can occur across electronic channels or via stationary forms (e.g., ticket machine, branch office).

Product Retailer

The Product Retailer (PR) organizes sales towards customers under consideration of contractual dependencies between the Application Owner and the Product Owner. In particular, the Product Retailer is responsible for tender *preparation, ticketing* and *billing*. These tasks are distinguished aspects of the task Sales in (KA BOM-SPEC, 2016). In general, he serves as an instance for the conclusion of contracts. Additionally, the Product Retailer provides a *customer service*.

Product Owner

The Product Owner (PO) *defines the products*, which are intended to be issued/sold as authorizations and provides them to the Product Retailer in form of product definitions and templates to be sold (KA BOM-SPEC, 2016).

A product is as standardized range of services, defined by the characteristics of an entitlement to benefits, type, transport law conditions and price (Association of German Transport Companies (VDV), 2015). The products can be composed of several heterogeneous services possibly using the product definitions of other Product Owners.

Furthermore, the Product Owner is responsible to map and to manage the effective costs after the execution of a travel chain (*usage and sales data clearing*). In a follow-up step, he *processes the accounts receivables clearing* and *manages the B2B settlement*.

Application Owner

The Application Owner (AO) is responsible for the management of (participation) permissions, as well as the identification for users of the system. (KA BOM-SPEC, 2016) provides a detailed specification of the role.

Payment Provider

The Payment Provider (PP) organizes the *financial settlements* between Payer and Product Retailer. In addition, he is responsible for the *administration of accounts receivables*, including for example dunning processes. An information exchange with the Booker is possible via the Mediator.

3.1 Interaction Analysis

In the following, we validate the roles by describing the interactions between them and the responsibility assignment during our focus activities.

Preparations Concerning Electronic Fare Management

The AO registers all actors participating in the electronic fare management (EFM) system in their participating role, including product definitions of the Product Owners. The AO certifies the correctness of implementations of components and interfaces of the EFM system. The AO manages the public key infrastructure (PKI) and serves as certificate authority for keys used to sign tickets. The AO manages the certificate revocation list as well as the list of blocked tickets and applications and provides them to the actors participating at the EFM system.

Travel Information / Travel Assistance

The MSOs record planning and real-time data and provide them to IMs. POs provide a digitized definition of their products to IMs. IMs treat this data and forward it to other IMs as well as INFs. INFs provide travel information (including price product determination) to Bookers and travel assistance to Mobility Service Users.

Booking

Products defined by POs are provided to PRs and other POs (e.g., to define other products on their basis) in digitized format. PRs become induced to sell by POs. Product Retailers inform MEDs concerning products on offer. Bookers inform MEDs concerning desired products (based on travel information by INFs). If necessary, MEDs ask Product Retailers via other MEDs for offers to the desired products and mediate corresponding contracts between Bookers and Product Retailers. Bookers inform Mobility Service Users concerning concluded contracts

Table 1: Roles in Mobility Platform Scenarios.

Archetype	Reseller Platform		Broker Platform		Mobility Market		Information Portal	
Role \ Actor	Platform Provider	Cooperating Service Provider	Platform Provider	Cooperating Service Provider	Platform Provider	Cooperating Service Provider	Platform Provider	Cooperating Service Provider
Informant	x		x		x		x	
Information Manager	x	x	x	x	x	x	x	x
Mediator	x		x		x			x
Product Retailer	x		x	x		x		x
Product Owner	x	(x)	(x)	x		x		x
Payment Provider	x		x			x		x
Mobility Service Operator	(x)	x	(x)	x		x		x

and Payers about the resulting amounts receivables. PRs inform POs about sales.

Utilization

Mobility Service Users use the services provided by MSOs. MSOs record this utilization and forward the resulting data to POs. POs calculate the distribution of earnings by reference to the usage and sales data. For products invoiced depending on utilization, MSOs record the individual utilization by the Mobility Service Users and provide this to the POs. POs calculate consumption data on basis of individual utilization data and the resulting amounts of receivables. These are provided to PRs. PRs inform Bookers via MEDs. Bookers inform Payers concerning amounts receivables. Bookers and Mobility Service Users match consumption data with each other.

Payment

Payers authorize Bookers to legitimize themselves as Payers concerning conclusions of contracts with PRs. During bookings, Bookers inform MEDs about corresponding Payers. MEDs forward this information to PPs. PRs inform PPs concerning resulting amounts receivables. These can occur by conclusions of contracts between PRs and Bookers as well as by conclusions of contracts in combination with consumption data. The PP responsible for the receivables settlement for a contract is determined already at conclusion of contract. PPs execute the settlement between Payers and PRs as well as corresponding receivables management.

Ticketing (Including Inspection)

PRs provide tickets to Mobility Service Users, using the PKI of the AO. For blocking of tickets, the AO gets informed correspondingly. Tickets become forwarded via MEDs and Bookers to Mobility Service Users. For inspection purposes, Mobility Service Users show their service authorization towards MSOs. During inspection, they use the PKI of the AO and consider his lists of blockings.

Service

All roles with contact to Payers, Bookers or Mobility Service Users provide customer service concerning their specific services. The customer service of PRs is provided to Bookers via MEDs.

4 COOPERATION SCENARIOS

Based on the experts workshops, we can define four archetypes of platform scenarios. Table 1 depicts the configuration of roles in these scenarios. The role of Application Owner is not listed because it can be assigned to an independent instance. These scenarios are intended to describe possible options. In principle, several mixed forms and modifications can occur in a real life setting.

The *information portal* is restricted to the mere provision of information for the user. Therefore, only the roles of the Informant and the Information Manager can be assigned to the platform provider. Other roles and tasks lie with cooperating service providers.

The *mobility market platform* is a mobility platform that focuses especially on a centralized mediation of services. Hence, the role of the Mediator is assigned to the platform provider deviating from the setup of the *information portal*.

A *broker platform* aims to provide combined mobility oriented services and a correspondingly optimized travel assistance as a higher-level instance. In ge-

Table 2: Morphological Box: Characteristics and Values.

			Platform
			Actor
		Provided Services	Bus, Train, Carsharing, Bikesharing, Rideselling, ...
Transaction Phases	Information	Travel Information	Description
		Price Information	
	Agreement	Registration	
		Booking	
		Cancellation	
	Completion	Unlocking	
		Ticketing	
		Payment	
		Accounting	
	Service	Travel Assistance	
		Customer Care	
Pricing Policy		Price Formation	Separated Prices, Aggregated Prices, Price Bundles
		Product Definition	Actor
Business Model		Revenue Model	Description
		Value Proposition Platform	
		Platform Customer Segments	
		Platform Financial Flows	
Structure		Customer Interaction (UI)	Actor
		Market Side	Sell Side, Buy Side, Third-Party
		Coordination	Hierarchy, Market, Mediator
		Type of Platform Mandator	One Provider, Many Providers, Independent Instance
		Geographic Focus	Local, Regional, Supraregional, Nationwide, Cross-Country
		Access	Open, Limited

neral, all market transaction phases are supported. In this scenario, it is possible that cooperating service providers define their own products and a platform provider can combine them and form his own products by supplementing them with additional services. Therefore, both actors can serve as Product Owners as well as Mobility Service Operators.

A *reseller platform* aims at selling services in a combined way to the end user that were bought by the reseller platform beforehand. A *reseller platform* is able to support all phases of market transaction (information, agreement, settlement, service).

The product formation for the end user is done by the *reseller platform* (based upon a previously bought quota/ products of other providers). Again, platform as well as cooperating service providers can serve as Product Owners and Mobility Service Operators. In contrast to the broker scenario, the platform provider of a *reseller platform* is the only Product Retailer towards the customer.

5 MORPHOLOGICAL BOX TO CHARACTERIZE MOBILITY SERVICE PLATFORMS

For further research concerning platform (cooperation) scenarios we developed a morphological box to characterize mobility service platforms (see Table 2). The described morphological box is based on approaches concerning electronic marketplaces (Fischer, 2008; Clement and Schreiber, 2016) and has been extend due to the research context. This work is also intended to be published in a document of the association of German traffic companies (VDV-Schriftseries).

Before explaining the characteristics of the morphological box, we shortly describe the way the morphological box is depicted. On the left hand side of the table, the identified characteristics of mobility service platforms are listed. The right hand side lists meaningful values for the corresponding characteristics. In the applications of the morphological box in this

paper, we depict several columns per platform, one for each relevant *Actor* bearing the actor names in the second row from the top. Using these columns, we describe which actor provides which of the characteristics to what extent. This is especially the case for the rows that just contain *Description* as value and can be done using check marks for the rows containing *Actor*.

Transaction Phase

In (Fischer, 2008), the author identifies four transaction phases for virtual marketplaces: information, agreement, settlement, and service. During the information phase, market participants procure information about goods and services, potential providers and consumers as well as about their terms and conditions. Especially in the area of mobility platforms the information phase is of special importance. Depending on the way the user interface is designed, the functionality of travel information systems has to be incorporated. Here, we distinguish between the services travel information and (product and) price information. The travel information service can support the planning of intermodal journeys or of multimodal mobility behaviour, but can also be restricted to unimodal transportation. When considering the price information, we can differentiate – as with many services – whether the information and offers of the various mobility providers are provided in a combined (in terms of integration) or in a separated way.

During the agreement phase, the relevant providers and consumers are selected and concrete conditions are agreed upon. In the mobility context, the services registration, blocking, booking, and cancellation of services can be ascribed to the agreement phase. Blocking describes the temporary reservation of services for a user. Among other things, this prevents situations, in which, during a combined booking of several products, only some of the products can be bought, while others cannot, leaving the user without a continuous mobility service chain.

The settlement phase comprises of the services unlocking (e.g. shared vehicles), ticketing, and accounting. Travel assistance and customer care belong to the service phase. In contrast to travel information, which provides information before the journey, travel assistance offers information during the journey and supports the user in using the mobility services. In the context of classification, the services identified serve as attributes.

Moreover, we added the payment phase to the box.

Pricing Policy

The category pricing policy comprises of the attributes price formation and product definition. Price formation refers to the methodology of generating a price between provider and consumer.

In general, this can occur via auction, aggregated prices, unit prices, or price bundles. Additionally, in the context of aggregated prices, there are further forms as the flexible best price method, which determines an (approximately) cheapest price for an (intermodal) journey with the possibility of ex-post adjustments, e.g., by transforming individual coupons into day tickets. On the other hand, price bundles are understood as tariffs for previously determined (and timely bound) service combinations possibly including a variable component, e.g., for sharing services.

To include a variable component means that the price depends, e.g., on the actual duration of usage or comparable metrics such as kilometers driven. In any case, the user is informed about the price schema beforehand.

Furthermore, this category describes where in the mobility platform the product definition is taking place.

Business Model

We supplemented the revenue model (Clement and Schreiber, 2016) by additional factors of business model concepts (Osterwalder et al., 2005; Osterwalder and Pigneur, 2011) to cover more important aspects. Hence, we identified the value proposition, customer segments and financial flows as important factors to characterize mobility service platforms.

Structure

The structural description of mobility platforms was performed using the attributes product retailer, customer interaction, market side, coordination, type of platform mandator, geographic focus, and access. One of the main aspects here is the question, who acts on the role of the product retailer from a user's perspective. On the one hand, this can be the platform mandator selling his own products. On the other hand, this can be every single mobility provider for himself. Even the entity that interacts with the customer does not exclusively have to be the mobility platform. There are forms, in which a platform forwards the user to the web site of the mobility provider to book a service, such that further customer interaction changes over to this provider.

6 APPLICATION

For evaluation and validation purposes we conducted an online survey, intended for domain experts with the following structure: In the first part, we asked for demographic details and domain expertise. The main part was structured correspondingly to the morphological box. We asked one question per platform characteristic subsequently.

The following section describes the sample and presents the qualitative evaluation results.

6.1 Sample

The questionnaire took place from October until November of 2017. It was provided especially to experts of the urban transportation sector who were working on research and development projects funded by or related to the German Federal Ministry of Transport and Digital Infrastructure (BMVI). In total, we received 12 responses, five responses were usable for further analysis. The group of experts consisted of specific project employees and project leaders with responsibilities such as app development or project management.

6.2 Results

Table 3 presents the evaluation results. In the survey, five experts characterized four individual mobility service platforms. These platforms might have a different development status (from (conceptual) prototypes to deployed systems). All platforms covered a broad range of transportation services, including public transportation and sharing services. One platform was characterized by two different experts. Because some of the answers were complementing or even contradicting each other, we decided to present both answers in the table. We consolidated evaluation results with the same or similar meaning. In case of empty parts of the table, respective questions were not answered or the answers did not fit the topic/question.

Concerning the transaction phases, the platforms showed a different degree and design of integration. More remarkable differences could be shown concerning underlying business models. Platform I operates with brokerage fees. In contrast, Platform II uses a reseller business model where a major provider buys services from cooperating providers for reselling purposes. One concept relies on an independent instance without having a profit intention.

7 CONCLUSIONS

By means of the role relationship model on the one hand and the morphological box on the other hand, different platform (cooperation) scenarios can be described. To show organizational dependencies and responsibilities, we described an fundamental role relationship model. Based on (ISO 24014-1, 2015) and (KA BOM-SPEC, 2016) we extended the model especially on the information side by adding respective role definitions and descriptions. Our role relationship model is intended for an organizational view and maybe needs to be specified even further for software development purposes.

For further analysis, we created the morphological box to characterize mobility service platforms. Therefore, we combined characteristics of electronic marketplaces and travel information systems. Moreover we supplemented them with additional characteristics that are relevant in the field of interest. The application of the morphological box in a survey showed interesting results by comparing the sample platforms. Whereas platform value propositions are similar, differences in degree and design of service integration as well as concerning the business models could be shown.

An integrated provision of heterogeneous transportation services offers synergy potentials on demand and supply side. Through an increase of service interoperability of complementing services, obstacles regarding intermodal travel chains might be reduced. Taking crucial questions of market transparency and competitor neutrality on provider side into consideration, sustainable market and business models are of essential importance.

7.1 Limitations and Future Work

In principal, the level of detail varies in the presented approaches, because we tried to describe important aspects explicitly. For specific cases, another degree of detail might be suitable as well and future work could focus on aligning these descriptions.

In addition, performing a study with such complex and interdisciplinary questions via an online survey hold some limitations, such as the explicitness of wording. In the survey, we provided various explanations to support test persons, but at some parts there might still be room for interpretation. For future studies, expert interviews with an direct interaction could be a promising research setup.

These approaches might need to be adjusted due to special or future technological and regulatory conditions as well.

Table 3: Survey Results: Platform Characteristics.

			Platform I		Platform II		Platform III		Platform IV	
			Platform Provider	Cooperating Service Provider	Platform Provider	Cooperating Service Provider	Platform Provider	Cooperating Service Provider	Platform Provider	Cooperating Service Provider
		Provided Services	Bus, Train, Carsharing, Bikesharing, Taxi, Flying, Ridesharing, Additional Services, …		Bus, Train, Carsharing, Bikesharing		Bus, Train, Carsharing, Bikesharing, Rideselling/Ridesharing		Bus, Train, Carsharing, Bikesharing, Taxi	
Transaction Phases	Information	Travel	Intermodal		Multimodal		Intermodal		Intermodal	
		Price	Combined		per Mode		Separated		per Mode	
	Agreement	Registration	Centralized		Centralized		Public Transport: Centralized	Sharing Services: via Provider	Centralized	
		Booking	Combined		Separated		Public Transport: Centralized	Sharing Services: via Provider	Combined	
		Cancellation	Combined		Separated per Service		Separated per Service		Separated per Service	
	Completion	Unlocking	Combined		Combined			Separated / not supported[a]		Separated
		Ticketing	Combined		Combined		Combined		Combined	
		Payment	Centralized		Centralized		Public Transport: Centralized	Sharing Services: Directly	Combined	
		Accounting	Combined		Combined		Public Transport: Combined	Sharing Services: Separated	Combined	
	Service	Travel Assistance	Combined		Partly		Separated / not supported[a]		Partly	
		Customer Care	x			x	x	x	x	x
Pricing Policy		Price Formation	Aggregated (best price)		Aggregated		Separated (best price)	Sharing Services: Separated	Aggregated	
		Product Definition	x		x	x	x	x (additional actors)		
Business Model		Revenue Model	Brokerage	Brokerage	Margin Reselling Bundling	Growing Customer Base	-	Brokerage / Own Margin	Brokerage	Brokerage
		Platform Value Proposition	"One travel chain in Germany from one hand and optimized corresponding to guidelines."		"One solution for all ways - one registration, one app, one booking platform, one invoice"		"Inform, price and sell intermodal and inoperable travel chains"		"Extension of the mobility service spectrum"	
		Platform Customer Segment	All Customer Segments		Occasional Users, Students		Occasional Users		All Customer Segments	
		Platform Financial Flows			Customer → Local Transport Company → Service Provider		Public Transport: Customer → Payment Provider → Product Retailer → Operator. Sharing services: Customer → Operator.		Single Payment Service Provider Organizes Accounting.	
Structure		Customer Interaction (UI)	x		x		x	x		
		Market Side	[b]		Sell-Side		Third-Party		Third-Party	
		Coordination	[b]		Hierarchy		Mediator		Mediator	
		Type of Platform Mandator	Various Service Providers		One Service Provider		Task-carrier without Profit Intention		Instance 1: Service provider Instance 2: Independent	
		Geographic Focus	Supraregional		Supraregional		Supraregional/Regional[a]		Regional	
		Access	Limited		Depending on Cooperation		Open/Limited[a]		Open	

[a] Participant answers were contradicting.
[b] Not answered.

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