

The Current Situation and Future Trends of Marketplaces for Mobility Services: Findings From Qualitative Expert Interviews

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Abstract: The number of marketplaces for services in the mobility domain is growing which makes it difficult to assess these systems according to their capabilities, designs and operational approaches. Research has shown that the current state of the art for the mobility service marketplace domain lacks information about current capabilities as well as future trends. Therefore, qualitative interviews with various experts from the field have been conducted to obtain up-to date and relevant information about the currently ongoing efforts and achievements of marketplaces for mobility services. The interviews covered topics like marketplace architecture, functional capabilities, business relationships, communication and data exchange as well as protocol standardization and future trends. The paper presents the obtained information, contributes to the current state of the art as well as illustrates future trends and requirements of service marketplaces. Based upon the obtained information, a comprehensive Morphological Box has been developed which serves as a design framework and facilitates the development of future service marketplaces.

1 INTRODUCTION

Service marketplaces are the trading environments for all kind of services which provide advantages for citizens, commuters or the city itself. A service marketplace is the environment which offers capabilities to register participants, enable them to create service quotations, to contract and consume services as well as to do the payment for the B2B service consumption. Services published within a marketplace can provide access to information or data refinement functionalities. A service marketplace is therefore a pivotal point for participants to conduct business and to exchange all kind of information or functionality and ushers the interoperability among the participants (Guo and An, 2014). A disadvantage of today's service marketplaces is that they have a strict domain focus, like parking¹, sharing² or charging³. Even worse, service marketplaces with the same domain focus ap-

ply proprietary protocols (see Section 3.3.1). The differences between the available solutions are not all publicly available. This is just one of the reasons why the comparison of service marketplace and therefore the identification of the current state of the art is a cumbersome task. Problematic is also that multiple visions but no elaborated big picture for the final implementation of the current domain exists. Lessons learned are rarely exchanged and incorporated into just launching projects. The current state of the art has to be known to proceed with the requirement engineering process for the later service marketplace realizations (Nuseibeh and Easterbrook, 2000).

The paper proceeds as following. Section 2 briefly introduces the current state of the art. Section 3 presents the conducted qualitative interviews as well as the derived current state of the art for mobility service marketplaces. The section furthermore discusses the future trends and requirements which have been particularized by the experts. In Section 4 the elaborated morphological box is presented and discussed. It serves as a design framework which demonstrates

¹For example: Parkopedia: <http://en.parkopedia.co.uk/>; ParkU: <https://parku.ch/?lang=en>

²For example: Car2Go: car2go.com; Multicity: <https://www.multicity-carsharing.de/en/>; DriveNow: <https://de.drive-now.com/en/>

³For example: Green eMotion: <http://www.greenemotion-project.eu/>; CROME: <http://crome-project.eu/>;

Hubject: <http://www.hubject.com/?lang=en>;
e-clearing.net: <http://e-clearing.net/>;
Gireve: <http://www.gireve.com/en/index.html>

possible solutions and outlines relationships as well as potential contradictions among service marketplaces' characteristics and properties. The paper ends with a summary in Section 5 and an outlook on future work in Section 6.

2 CURRENT STATE OF THE ART

Service marketplaces are environments where service operators (for example infrastructure operators for charging, parking or sharing capabilities) and respective service consumers can conduct business to business (B2B) service trades (Grieger, 2003; Albrecht et al., 2005; Renna, 2010). At the present date, various mobility service marketplaces are available but detailed information about their design, capabilities and implementation are rare and not easy to obtain. Due to competition aspects, commercial solutions do not provide detailed insights into their operation and design at all. Research projects on the other hand provide a lot of information but it is difficult to differentiate between i) what they intend to achieve, ii) what they tried to achieve and iii) what they really have achieved and how. Research solutions like CROME (CROME, 2011) and Green eMotion (Green-eMotion, 2011) disappear soon after the project comes to an end, thus they are unlikely to attract the attention of business participants. Getting detailed information about the solutions without personal contact is nearly impossible. No matter what business orientation a marketplace follows, the lack of information makes their comparison a difficult and time consuming task. However, information is needed by participants to decide whether a service marketplace satisfies their requirements or not. Thus prospective participants have to conduct substantial research to get an overview of available service marketplaces and their capabilities. Missing standardization in the connected mobility domain (Rossbach et al., 2013) regarding protocol and service description as well as inconsistent wording and types (Martens et al., 2011) makes the assessment and comparison process a complicated task.

3 EXPERT INTERVIEWS

3.1 Outline

The work rests upon an empiric research as well as systemic literature review. The expert interview as accepted research method is conducted and the qualitative approach chosen over the quantitative. This

is because the field of interest is infant and still a niche, thus acknowledged statistics, numbers and other quantitative information are limited. The goals of the interviews were i) to obtain detailed and contemporary information, ii) to elaborate a comprehensive knowledge base, iii) to analyze the differences and similarities of the marketplaces in respect to the design, capabilities, approaches and implementations, iv) to deduce advantages and disadvantages of the current solutions as well as v) to elaborate an overview of requirements and potential solution approaches which actively facilitates marketplace realizations in the future.

The interviews have been undertaken during July and August 2015. The interviewed experts who volunteered to participate in the interview are shown in Table 1. The interviewees have been chosen based on their experience. They have gained deep knowledge due to their contribution in various national and international service provisioning projects. These projects are all tightly related to service marketplaces, mobility services, service provisioning and fragmented service systems. The set of interviewees is international and their projects' are either commercial, research or a mix of both. This diversity ensures a broad overview of efforts, achievements and ongoing work which is put into service marketplaces for mobility services.

3.2 Proceeding and Approach

The questions which were asked have been sent to the interviewees in advance for preparation issues. The questions were used as a guideline throughout the open discussion and were asked when they fitted or when the discussion came to a stop. In addition, further supporting questions were asked when applicable. The open discussion allowed to gain a deep insight into the experts experience. It is believed that this approach is more efficient and obtain more and detailed information compared to a pure answer-response approach. The experts shared information about their achievements and visions as well as obstacles and problems they have experienced in the relevant projects. The list below briefly summarizes the major topics which have been discussed with the interviewees to obtain a comprehensive and, even more important, an up-to-date insight into currently ongoing research and commercial projects. The order of the listed topics does not reflect the topics priority or importance.

- Architecture for interconnectivity
- Protocol and template standardization
- Contracting approaches
- Service and domain diversity

Table 1: Experts who participated in the qualitative interview.

Sector	Sector Roles	Actors	Interviewees
Economy	e-Mobility Startup	Gireve	Rives, Jean-Marc
		Smartlab	Hinrichs, Hauke
			Schilling, Simon
	Conglomerate	Siemens AG	Dr. Koberg, Hendrik
	Consulting	Bridging-IT	Schuhmann, Detlef
		MRK Consulting	Keltsch, Thomas
	Energy Supplier	EnBW	Karakoc, Ertan
	IT Company	Bosch SI	Chen, Nigel
			Hörseljau, Till
			Weber, Kai
Weiner, Nico			
T-Systems		Christ, Peter	
	IBM R&D	Fricke, Volker	
Politics	State Level	Department of Traffic and Infrastructure (BW)	Erdmenger, Christoph
Science	R&D	University of Applied Science, Ludwigshafen	Prof. Dr. Bongard, Stefan
		Federal Highway Research Institute (BASt)	Dr. Rittershaus, Lutz
		Flemish Institute for Technological Research (VITO)	Mol, Carlo
Society	R&D	eMO (Berlin Agency for Electric Mobility)	Eisele, Johannes

- Data security and privacy
- Legal regulations

The interview was conducted as follows: It started that the experts introduced themselves and then moved on with their vision about future mobility and connected mobility. The open discussion moved towards the issue of interconnectivity between service marketplaces and what architecture might be feasible for achieving that goal. Network architectures, e.g. client-server or peer-to-peer based approaches have been considered and their advantages and disadvantages discussed. The *Good e-Roaming Practice* guide (Christ et al., 2015) was used as a foundation for the discussion. The interview lead over to service contracting approaches to establish relationships between two participants but also between different marketplaces in an ad-hoc fashion via automated contracting. Furthermore, topics like service descriptions, condition negotiation and payment have been well reviewed and possible legal regulations discussed. An important part of the interview was the question of domain specific protocols, protocol standardization and protocol adaptation. Another point of interest was the involved roles and their relationships and responsibilities in the service marketplace scenario. An additional discussed topic was what kind of services should be offered via a service marketplace and which should be offered by the participants and which by the marketplace itself. The interview concluded with the ques-

tions about what are the reasons for the little achievements and why do organization and companies hesitate to invest.

The gained information is unique and beyond comparison because it is unbiased and unadorned. The qualitative interview approach in combination with the guaranteed anonymity created a trustee environment. The interviewees were encouraged to talk about their personal experience, opinions and visions of mobility services and service marketplaces rather than reflecting project disseminations.

3.3 Observation and Findings

The results presented in this section have been derived from the qualitative expert interviews but have been summarized appropriately. If appropriate, the results are enriched with existing literature.

3.3.1 Current Marketplace Situation

The experts observe that the number of service marketplaces for mobility services increases contentiously. A marketplace is recognized as the central service provisioning entity to trade services among providers and consumers. However, the experts point out that current solutions operate in isolation even though there is a general agreement that interconnectivity between the marketplaces is a key requirement. The interviews also showed that almost all currently

available marketplace solutions focus on one particular service domain only. This implies that the marketplaces are closed systems and prevent prospective participants to register in case they do not suit the marketplaces' target domain. This limits the possibilities for new business models which may influence participants in their decisions whether to join a marketplace or not. However, the number of providers which offer the same services is not limited. Another point which concerns the experts is that present solutions use most of the time proprietary protocols⁴. Due to these proprietary protocols, even the marketplaces which focus on the same mobility domain⁵ differ in their wording, functionality and scope. The difference in the protocols is just one of the experts' emphasized obstacle which prospective participants come across during the connection process.

One expert refers that there is slight movement towards a standard in the charging domain but it is still a long way to go. This is kind of contradicting with Grathwohl (Grathwohl, 2015) who has already referred to a charging standard promoted by *Huject* and *e-clearing.net*. A controversial opinion among the experts exists whether a trend for a standardized protocol in the parking and sharing domain exists or not. The experts have a coherent opinion about standards in mobility domain when they agree that there will be a standard for each mobility domain alike the mobile phone, credit card or ticketing standard. The ultimate but open question is, according to the experts, whether the standard will be defined due to general acceptance or due to legal regulations.

The interviews have shown that no common concept exist which manages how the participants establish business relationships among each other. A business relationship is required to represent the participant's agreement to conduct business with each other. The relationship establishment should follow the paradigm and actions known from other B2B marketplaces⁶. According to the experts, currently two closing approaches for service marketplaces exist. The first approach requires that each participant, without exception, has to establish a business relationship with all other participants. This approach is similar to a fully-meshed network and requires a lot of effort from the participants. This enforcement and the

required effort might chase away (prospective) participants. The second approach applies an individually relationship establishment where participants close contracts in respect to suitable service quotations. Both approaches rely upon a pre-negotiated paper contract which specifies the terms and conditions of the service usage and the business relationship. Two experts emphasize that the paper contract is, in theory, not longer needed and a digital representation could replace it. One expert points out that a digital contract would have a legal binding and thus would represent an approved business relationship.

According to the interviewees, every business relationship is established either due to a suitable service offer or service search quotation. An offer quotation describes the functionality (effect) of the provided services along with its price, availability and other supportive information. A search quotation describes what functionalities are requested and to what condition it should be offered to become accepted. The experts recognize the need for a standardized service quotation structure and wording. The obstacle of ambiguous service descriptions is also recognized in the literature (Martens et al., 2011). Without a standard, the comparison and interpretation of quotations is difficult for human and even more for machines. It is emphasized that certain marketplaces allow to create different service offer quotations for the same service.

The experts point out that Service Level Agreements (SLAs), if they exist at all, experience little notice in research projects. There is uncertainty about which SLAs should be specified by the marketplace and which by the participants. Even though SLAs are important, one interviewee argues that SLAs for marketplaces are considered far too important. He particularly emphasizes that the unpleasant factor according to availability is the underlying mobility infrastructure rather than the service marketplace. For commercial service marketplaces sophisticated SLAs have to be in place.

Another uncertainty exists about how to handle terms and conditions and how to realize clearing (billing) between business partners and across marketplace boundaries. These issues become even more complicated when service requests are roamed between marketplaces which have a different domain orientation. Gagnol et al. (Gagnol et al., 2013) say that a payment functionality has been implemented in the CROME project⁷. However, CROME realized the business to customer (B2C) clearing rather than the B2B. The latter is deemed to be more complicated and is not yet implemented at all. The interviews showed

⁴For example: *Huject*: Open InterCharge Protocol (OICP), *e-clearing.net*: Open Clearing House Protocol (OCHP), *Bosch*: Open Mobility Neutral Interface (OMNI), *Gireve*: Electric Mobility Interface Protocol (EMIP)

⁵For example: Charging, Parking or Sharing

⁶Relationship establishment is discussed by (Goldkuhl, 1998; Strasser, 2015).

⁷<http://crome-project.eu/>

that concepts about i) how to use foreign services, ii) how to establish a business relationship between unknown business parties in respect to contracts and service delivery, iii) how to do clearing across marketplaces and iv) how to establish a connection to other marketplaces are not yet elaborated in detail and thus have not been implemented.

Research has proven that achievements for mobility service marketplaces are low compared to other sectors like banking, telecommunication or shipping. These sectors combine services from different providers which is exactly what connected mobility also requires. Nearly all experts argue that this situation is due to the missing mass market for mobility services. They claim that the young market requires time to develop properly. The current situation is similar to a death spiral: Without a mass market the requirements are uncertain and uncertainty leads to low investments. This reduces the effort put into the development of new functionalities and services. This chases away potential end-customers which abates the market's growth straight from the very beginning.

Nevertheless, the experts forecast a change in people's individual mobility. The transportation mean will not be of importance anymore. The importance in future for individual mobility is i) how to get to the destination (using different transportation types), ii) be there on time, iii) having as little trouble as possible and iv) with acceptable costs. Using different means of transportation to complete a journey is called *intermodality*. Nobis (Nobis, 2014) considers intermodality as a potential trend towards sustainable individual transportation. Intermodality can only be achieved once the different mobility services are connected with each other and service marketplaces are predestined to establish this connectivity.

3.3.2 Future Trends and Requirements

The interviewed experts did not only discuss the current state of the art of service marketplaces in the mobility domain but also went into detail regarding future service marketplace realizations. Insights into ongoing efforts have been presented as well as their personal opinions about future capabilities and requirements discussed. The qualitative answers have been gathered, compared, if applicable merged and then transformed into a quantitative representation. The quantitative results are presented in Figure 1.

The legend on top of Figure 1 shows the number of experts who have actually discussed a particular topic. The topics are presented on the left and grouped into four categories, namely *Standardization*, *Centralization*, *Capabilities* and *Miscellaneous*. The categories arrangement serves only a good illustration

rather than any particular prioritization. The experts did either *agree* or *disagree* upon a discussed topic. If they did not completely agree or disagree their answers have been ranked as *conditional*. Table 2 provides a brief summary of the numbers presented in Figure 1. Only those topics are presented which have been discussed by at least three experts to ensure the incorporation of all three agreement level.

These interviewees who responded to interconnectivity between service marketplaces agree unconditionally that it is necessary to connect service marketplaces. They furthermore agree that the connection should rely on a standardized protocol as well as the elaboration of such a protocol is possible. Regarding the marketplaces' interconnectivity, only two-third of the experts believe that it will be achieved by applying a central architecture approach where every marketplace has only one single connection to a central management entity. This architecture is similar to the star-topology in networks. The remaining third of the experts suppose that the marketplaces are either directly connected to each other alike a full-mesh-topology or that a mix of both approaches prevails. This statement is contradicting because these experts have already agreed that a central marketplace is necessary to avoid multiple connections between service providers and consumers. But for the higher level (marketplace interconnectivity) they think that the fully connected approach is more feasible or that it should be realized first and then modified towards the central approach.

The minority of experts is convinced that the European Union or any government will soon pass a bill to regulate the marketplaces' development. Only two experts believe that the costs for transactions or roaming, the protocol to be used and the connecting to the marketplace itself should be regulated somehow. Three experts claim that no regulations should act upon the young domain. Three other respondents point out that regulations will take place if i) the overall progress of the mobility domain is too slow, ii) the competition among the marketplace operators is on the end-customers' expense or iii) the end-customers face too many difficulties while using connected mobility services.

Unlike the full approval for the standardized marketplace to marketplace protocol, only 93% of the respondents think that a standardized protocol for each service domain is possible. A majority of 84% of the experts argue that a semantic approach for service descriptions is too complicated to realize. It would require too much effort - either from the participants or the marketplaces. One interviewee emphasizes that semantic requires, for being even able to develop a common domain language model, a lot

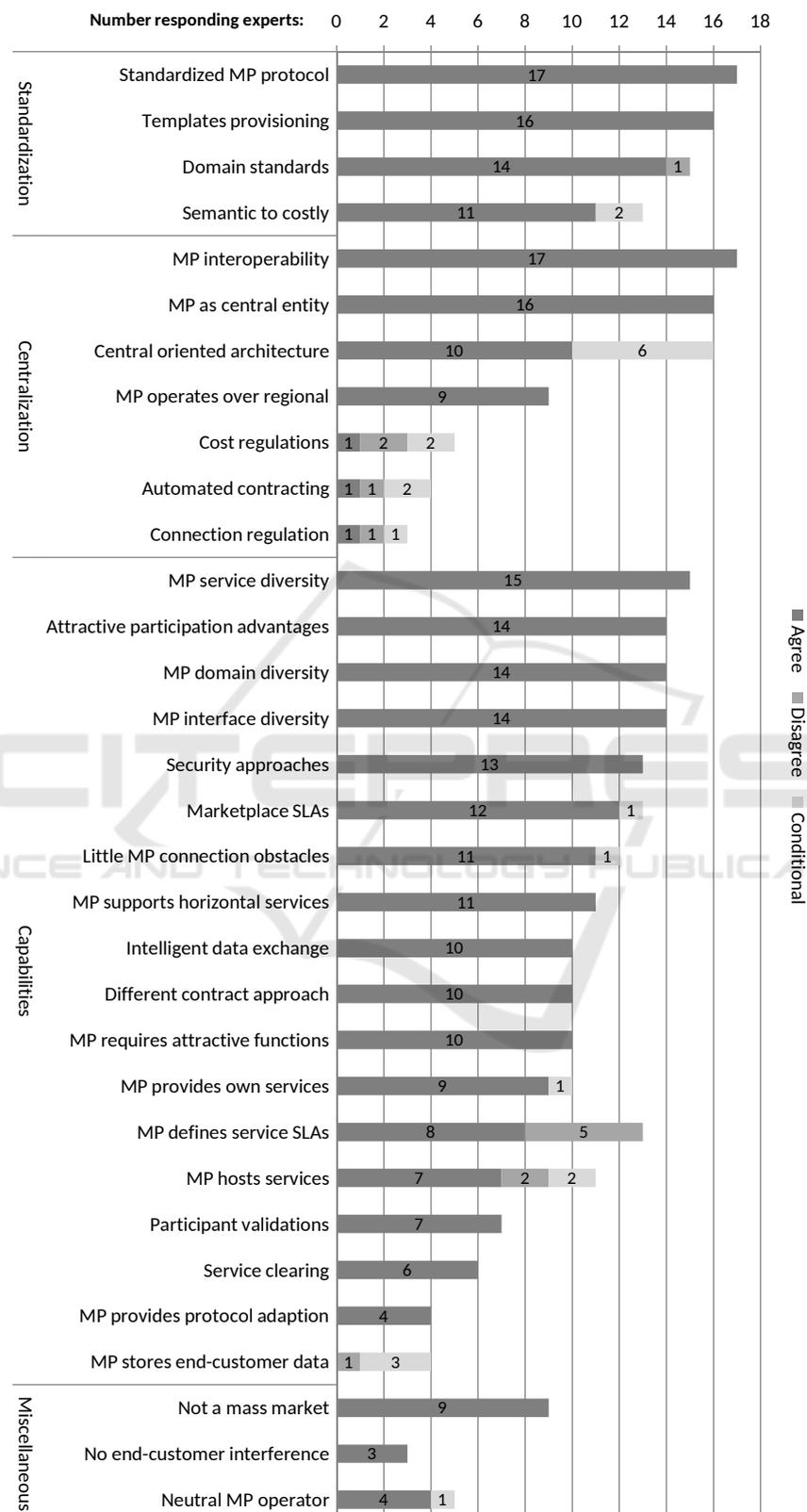


Figure 1: Future Trends and Requirements of Service Marketplaces (MP).

Table 2: Interview Results in Numbers.

Category	Topic proportion	Avg. number of experts responding per Topic	Agree-Disagree-Conditional ratio
Standardization	12.5 %	15.25	57 \ 1 \ 2
Centralization	21.87 %	10.00	55 \ 4 \ 11
Capabilities	56.25 %	10.61	171 \ 8 \ 8
Miscellaneous	9.37 %	5.67	16 \ 0 \ 1

of knowledge about the existing objects and characteristics. He emphasizes that this knowledge is still missing. Semantic would probably lead to a situation where service descriptions are rather different to each other than similar. Overall, semantic is generally deemed as a obstacle for the success of service marketplaces, even in the mid-term future. The remaining 16% of the experts share these concerns but emphasize that in the future, once semantic moves from the academic to the commercial usage, semantic service descriptions enable software agents to discover, to aggregate and to invoke services automatically. And all this without further human interactions. Alternatively, service templates for service descriptions gain full encouragement. The marketplace should define the structure and the wording to ensure overall quality. Templates simplify and accelerate the service quotation creation as well as the service quotation evaluation process, for human and machines. The discussed topics in the capabilities section experience most of the time a general agreement. The experts' majority point out that the marketplace itself should have sophisticated SLAs. However, the definition of the SLAs for the published services is a controversial topic. Only 61% of the experts support the idea that a marketplace should define the minimum SLAs to which the participants' services have to comply to. The remaining 39% believe that the service providers should define the SLAs for their services. The reason for this clash is that the given minimum SLAs would prevent the offering of expensive services with high SLAs and cheap services with low SLAs. The proponents of cheap and expensive services argue that the SLAs are exposed in the service quotation where the service is described in detail. This would imply that the SLAs have to be mandatory in the description which in turn favors the approach of applying precisely defined templates. The opponents, however, point out that low quality services have a negative impact on the marketplace's reputation. A bad reputation might influence the decision of prospective participants whether to join a marketplace or not. Another issue which the experts minority deliberate is that the marketplace itself should adjust its SLAs according to the service with the highest defined SLAs.

This means that the marketplaces' SLAs have to be at least as high as the highest service SLA.

The experts agree that a service marketplace should be able to handle different services from different mobility or mobility related domains. They also support horizontal services like clearing service (considered necessary by 100% of the respondents), service refinement or protocol adaptation (full agreement). Furthermore do the respondents agree that the registration has to have a certain validation. 90% of the experts who answered think that the marketplace itself should provide supporting services too (e.g. B2B clearing, monitoring or service hosting). In contrast, 10% of the respondents are convinced that service offerings by the marketplace might interfere with the participants' business and thus should be avoided. Service hosting is a capability which six out of elf experts consider as a supportive capability. Two other experts suggest that service marketplaces should not host services as it increases their complexity. The two leftover experts point out that it might be a benefit for small service providers but not an option for bigger service providers.

The respondents agree that service diversity, standardized protocols, access to many potential business partners, a sophisticated security concept, various supportive capabilities as well as a simple, fast and effortless connection process increases the marketplace's attractiveness and competitive opportunities. Even though all experts agree that data security and end-customer privacy is important for all kind of service marketplaces, only 72% have specific suggestions about how the marketplaces should handle it. Some interviewees claim that security starts with the transportation layer, thus the communication has to be encrypted. Other experts recommend that the transmitted content needs to be encrypted too. To ensure confidentiality, it is proposed to maintain a Public Key Infrastructure (PKI). The certificates can support the differentiation of public and private (user-driven) data access via various interfaces. Common fears in respect to Denial of Service (DoS) attacks, power interruption and storage failure are mentioned alike data confidentiality, integrity and confidentiality.

Regarding privacy, the experts emphasize that the

service marketplace should not store end-customer data nor maintain an active relationship with end-customers. The latter statement harmonizes with Pfeiffer and Bach (Pfeiffer and Bach, 2014) who point out that the end-customer remains with the service consumer. This implies that the marketplace processes end-customer requests only via anonymous identifiers. Two experts point out that if it is necessary to process personal data the principle of data economy has to be applied. Adapting the security level in accordance to the specific data is recommended by two interview partners which they assume a better approach than applying the highest security level at any time. The latter might turn away prospective or already registered participants. The former decreases the effort, the investments as well as the obstacles and possible inconveniences which come with security and privacy regulations.

Only 50% of all interviewed experts share their personal opinion about the possible reasons for the still low achievements in connected mobility services and mobility service marketplaces. However, those who respond identify without exception the missing mass market as the major constraint. The missing mass market, as a logical consequent, has an impact on further investments. One expert additionally identifies the missing collaboration among the marketplace operators as another obstacle for further achievements. Due to the market situation and the uncertainty about how the market will develop, it is feasible to assume that marketplace operators try to establish themselves on the market first before they start to collaborate. Another respondent disagrees and points out that competitive operators are already in contact with each other. What kind of data and how much data is shared is not said. Whatever statement is true, it is general assumed that as soon as the demand for mobility services increases, the investments will increase too. And then there will be a tangible progress.

A remaining topic is who operates a service marketplace or the interconnected marketplace ecosystem. Only four experts, which corresponds to a rate of 22%, had an answer to this topic. Three of them suggest that a neutral operator like a city, a company, an organization or a consortium should run it. They point out that a marketplace should be free of discrimination and therefore the operator should not provide services that are in conflict with those of the participants. The remaining expert thinks that the biggest participant should be in charge for the operation. The disadvantage of this is that it empowers this particular participant to enforce its own interests on the expense of the other participants. Therefore the marketplace is no longer free of discrimination and conflicts of inter-

est may occur. Based on the number of responses in addition with the controversial suggestions, one can conclude that the marketplace operation is a difficult topic which needs a closer consideration.

4 MORPHOLOGICAL BOX - POTENTIAL MARKETPLACE SOLUTIONS

To analyze the complex field of service marketplaces with all its interrelated characteristics and potential contradictions, a morphological analysis has been conducted which follows Zwicky's morphological analysis⁸. The morphology of service marketplaces is derived from the data deduced from the interviews. It illustrates major characteristics of service marketplaces which have to be considered while designing new service marketplaces, not only for mobility services. These characteristics, along with possible properties, have a significant influence on the marketplace's final implementation. The chosen implementation approach affects the practicability of a service marketplace and thus its acceptance. The latter consequently has an impact on its success on the market.

Based on the applied morphological analysis a morphological box is developed. Morphological boxes help to generate new ideas (Aurich et al., 2010) because they facilitate the identification process of possible relationships between the characteristics and properties of the considered problem domain. It furthermore supports the detection of potential contradictions among them. The morphological box enables to set the dimensions against each other to create unique states of the system. Each of these possible states can be a representation of a new marketplace solution. The finally elaborated morphological box is a two dimensional matrix and is shown in Figure 2. The left outer side presents the leading characteristics of a marketplace while the corresponding properties are organized in the dimension on the right side. To mark out a particular state, only one property per characteristic can be selected.

The presented characteristics and properties are in alignment with the topics presented in Figure 1. Some topics have been consolidated and are represented in the cells by a single entry. The following description explains exemplary how the Morphological Box has to be read and understood. The chosen properties in the description represent the experts' expectations on future marketplace solutions.

⁸Further information provided by (Ritchey, 1998).

Characteristics	Properties					
	Public	Private	Consortium	Community		
Ownership						
Type of business	B2C	B2B	miscellaneous			
Business focus	charging	sharing	parking	miscellaneous		
Service categories	horizontal	vertical	miscellaneous			
Domain focus	specialized	diverse	diverse but with focus			
Architecture	P2P	client - server	SOA	miscellaneous		
Openness	closed	half-open	open	open-managed		
Relationships	none	1 to 1	1 to many	many to many		
Participants	service provider	service consumer	service aggregator	miscellaneous		
Number of participants	one	more than one				
Registration	not applicable	online	online with basic validation	offline	offline with extensive validation	
Internal connectivity	not applicable	pair-wired	broker system	on-demand		
Communication protocol	proprietary	own default	de-facto standard	standard	harmonized	
Domain protocol	not available	adaptation	own default	de-facto standard	standard	harmonized
Service Level Agreements (SLA)	not available	participant driven	own level is minimum for all participant services	participants' max level is own minimum		
Contracting	not available	short term	long term	one-time usage		
Service condition type	not available	partner specific	default (all other)	miscellaneous		
Service descriptions	free text	keywords	template for parameters and wording	semantic web / ontology		
Interfaces categories	public	private	role dependent	miscellaneous		
Interface type	maschine	human	miscellaneous			
Interfaces purpose	informative	particular	miscellaneous			
Utility services	not available	participant driven	own driven	miscellaneous		
Service hosting	not available	internally hosted	externally hosted	miscellaneous		
Data configuration	not available	basic participant data	service quotations	complete		
External communication (interoperability)	not available	pair-wired	central managed	decentral managed	on-demand	
External protocol	own default	adaptation	de-factor standard	standard	harmonized	
Support	not available	technical	business	different support levels		
Security	not available	encrypted communication	encrypted communication and content	certificates, encryption and roles	security depends on data / context	ISO 27001 continuous
End-Customer data	not applicable	data set stored	Only via IDs			
Routing tables	not applicable	sometimes exchanged	frequently exchanged			
Data accuracy	not applicable	lists sometimes exchanged	lists frequently exchanged	real time		

Figure 2: Morphological box: characteristics of service marketplaces.

The first characteristic in the box is about the marketplace's *Ownership*, thus asks who operates the marketplace. Possible values (properties) are that it is operated by, for example, a city (*public*), the biggest participant or a company (*private*), that it is a mix of the former two (*consortium*) or by a group of individuals with the same interests who volunteer to contribute (*community*). This question is not yet solved properly. On the other side, the discussion about the marketplace's business orientation (*Type of business*) concluded that the marketplace should not be in contact with end-customers. Thus the selected property for the business type is *B2B*. As the experts emphasized, marketplaces should not focus on particular services and therefore the property for the *Business focus* is *miscellaneous*. Service diversity is considered as necessary and thus *miscellaneous* is selected for the *Service categories*. On the other side, diversity should not lead to uncontrolled service publishing. Thus the *Domain focus* is *diverse but with focus*. This means that the services have to have a focus on mobility or represent a benefit for the entire marketplace. The marketplaces should be open systems and there-

fore should not discriminate prospective participants. However, the interviewees pointed out that some kind of validation has to be in place to identify a prospective participant's seriousness and willingness to conduct business. Thus the *open-managed* property is in favor for the *Openness* characteristic. Even though most marketplaces use a proprietary protocol, the experts forecast that a *standard* protocol is always the first choice. This property is thus selected for the internal *Domain protocol* but also for the *External protocol*. The latter is the protocol for the communication between service marketplaces.

The Morphological Box is elaborated based on the interviews' output. Even though the interviews yield upon service marketplaces for the mobility service domain, the characteristics and properties presented in Figure 2 are of such generic nature that they are applicable, to certain extend, for all kind of service marketplaces. According to Stryja et al. (Stryja et al., 2015), a Morphological Box facilitates the identification of possible contradictions in the values of the property dimension. Once the characteristics and the corresponding properties are known the complexity of

the marketplace's design is reduced. The Morphological Box does not claim to be complete, but serves as a design framework for service marketplaces which can be developed further in respect to the characteristics and properties.

5 SUMMARY

The authors identified the lack of information about the currently ongoing efforts and achievements for service marketplaces in the mobility domain. Therefore, comprehensive interviews with experts from the particular field have been undertaken. The experts' opinions have been gathered which enabled the authors to propound the current state of the art for service marketplaces in the mobility domain. The interviews have unambiguously shown that current service marketplaces suffer various gaps and limitations regarding their implementation and functional capabilities. Due to the comprehensive interviews, the authors also presented the identified future trends and requirements for service marketplaces. The experts believe that these factors have to be incorporated into future realizations. Additionally, these factors have been transferred into a qualitative overview which simplifies the evaluation process. Based on the resulting overview it can be concluded that certain topics experience high attention while others are not really on the experts' agenda. Therefore, this overview reflects the current situation for mobility service marketplaces solutions - they are complex and differ in their design, approach, implementation, orientation and scope. Based on the findings a morphological box has been elaborated which presents the characteristics and properties of service marketplaces. This box is the first which depicts the complexity of the partially contradicting objects that constitute a service marketplace. The box incorporates the findings from the interviews and provides a design framework which facilitates the development of future service marketplaces.

6 OUTLOOK ON FUTURE WORK

Even if the design of future marketplaces has considered the elaborated Morphological Box, its final implementations can still differ. The differences in the solutions provide difficulties when assessing a marketplace's maturity. It is even more difficult to assess and evaluate the marketplaces against each other. Therefore, the next research step will be the definition of an ideal service marketplace based upon the

experts' requirements and suggested solutions. This ideal marketplace will be used as a reference system on which a maturity model will be developed. This model will facilitate the assessment of the maturity level of service marketplaces.

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