ISSN 1816-6075 (Print), 1818-0523 (Online)
Journal of System and Management Sciences
Vol.12 (2022) No.1, pp.383-405
DOI:10.33168/JSMS.2022.0126

"Who Will Be the Orchestrator in An Autonomous Driving (AD) Business Ecosystem?" - The Position of the Internet of Things Platform Providers (IoTPPs) Versus Traditional Original Equipment Manufacturers (OEMs) of the Automotive Industry

Zinan Wang, Reinhard Meckl

International Management, University Bayreuth, Bayreuth, Germany

zinan_wang@msn.com

Abstract. As one of the most strategically significant and financially promising developing industries, autonomous driving (AD) ecosystems are facing challenging technical obstacles, organizational barriers, and financial requirements. The crucial question is which companies are most qualified to be the leaders of such ecosystems: to define the rules, and ultimately to reap the highest financial returns? This study defines a framework of an AD ecosystem, determines the needed capabilities for the orchestrator of an AD ecosystem, implements four qualitative interviews to make a first preliminary evaluation for the required capabilities of an orchestrator. Furthermore, hypotheses are derived and a questionnaire for the conducted pretest is developed which may also be used in a large quantitative empirical study asking what challenges the IoTPPs and AI-OEMs face in taking the dominating role compared to other referencing participants.

Keywords: business ecosystem; autonomous driving; automotive industry; Internet of things

1. Introduction

In order to improve the efficiency and safety of the transportation system, to prevent traffic accidents, to meet drivers' assistance needs, and to optimize the traffic flow, autonomous vehicles will actively participate in road traffic as a central feature as part of a mobile innovative revolution (Maurer et al., 2016, p. 2-4).

There is no doubt that the resources of multiple participants will be combined to jointly develop and implement such a technologically challenging innovative autonomous driving (AD) ecosystem (Maurer et al., 2016; Datta et al., 2016; Wang and Meckl, 2020). From a strategic point of view, one of the crucial questions is, who is going to take the orchestrating role?

The answer is not obvious, since especially two types of companies of the new AD-value chain have the ambition and the means to compete as the "orchestrator." In the currently automotive business ecosystem, there are many papers which have already stated the huge complexity of the orchestration such as complex supply chain risk management and total quality management (Scannell et al., 2000; Sinha et al., 2016). The AI-OEMs are having the strongest position who design the quality standards such as IATF 16949 and VDA including the implementation process as well as define the customer specific requirements to orchestrate the automotive hardware suppliers and software suppliers for the innovation development as well as the high technical reliability in the automotive industry (Ding et al., 2019; Thun, 2018). From the other perspective, several researches have explored that in the future, cars could be defined as a smart movement centre on wheels while several leading IoTPPs are focusing to become the standard of applications (Beiker et al., 2016). IoTPPs like Google, Apple, Tencent, or Alibaba, who have already taken the core role by the smart mobile phone ecosystem to orchestrate the IoT infrastructure provider as well as software and app providers, could also take the same role in the AD ecosystem (Hyrynsalmi et al., 2012). Furthermore, targeted to the incumbents from the car industry, the answer to this question will determine whether they remain the dominant players in the car business or whether they will be degraded to suppliers of the core companies in this new constellation. For IoTPPs, this strategic window gives them the chance to enter a new era in their growth story with unprecedented possibilities to expand their dominant role in one of the most important industries.

In general, to manage and orchestrate an innovative ecosystem is not a new issue from different research perspective (Gardet and Mothe, 2011; Ritala et al., 2012). In the present paper, we focus on the the associated needed capabilities (Hurmelinna-Laukkanen and Nätti, 2018; Dessaigne and Pardo, 2020; Perks et al., 2017; Möller et al., 2005; Mitrega et al., 2012; Sullivan and Weerawardena, 2006). Our objective is to explicitly elaborate the orchestrator role in the AD-business ecosystem and to contribute to an industry framework based on this concept. In addition, as one of the best elements to avoid misunderstanding and the misuse of

the survey process, especially for a very innovative, i.e., unstructured field of research, a pretest using qualitative technical interviews is implemented, firstly for gaining knowledge of a necessary adaptation of the hypotheses and secondly to generate the comprehensive questionnaire before entering into a large quantitative analysis (Presser and Blair, 1994; Buschle et al., 2021; Chigbu, 2019; Wang and Meckl, 2020).

2. Autonomous driving as a business ecosystem

A business ecosystem constellates different actors, including customers, suppliers, other partners, even competitors, whose resources are combined to create values through both competition and cooperation (Dessaigne and Pardo, 2020; Munksgaard and Freytag, 2011; Möller and Rajala, 2007). According to Wang and Meckl (2020), AD can be defined as an ecosystem which comprises five layers (see Figure 1): the cloud infrastructures, the IoTPPs, the applications and software developers, the trusted authorities, and the AI-OEMs including the system suppliers (see also Datta et al., 2017; Maurer et al., 2016; for a more detailed technical analysis see Pizzuto et al., 2019).

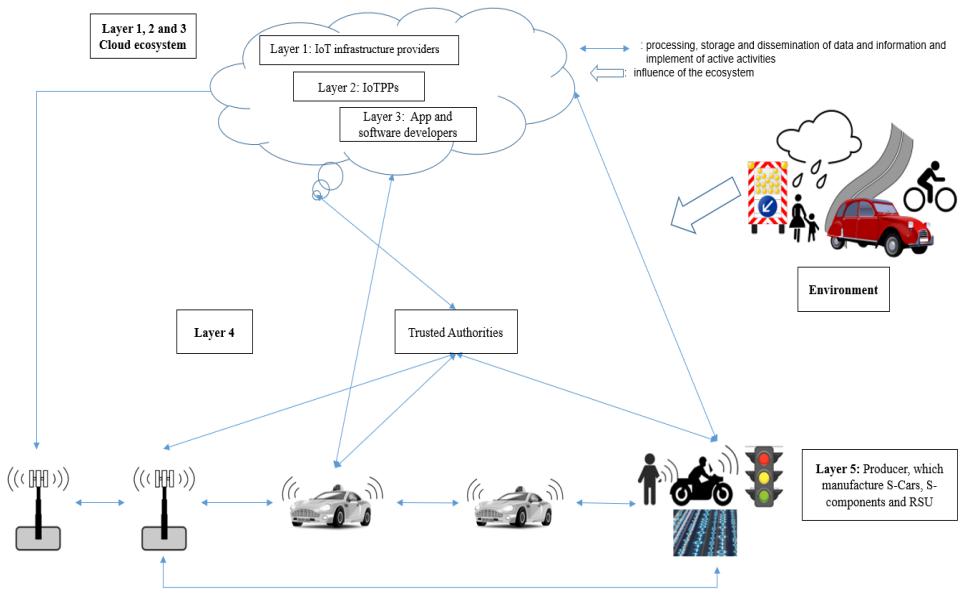

Fig. 1: The ecosystem of autonomous driving (Wang and Meckl, 2020)

Cloud infrastructures as Layer 1 provide computing ability and storage capacity. The processing, storing, and disseminating in near-real time of Big Data in the ecosystem must be implemented in use (Lüers et al., 2016; Rauen et al., 2017; Datta et al., 2017; Lima et al., 2016).

The IoTPPs as Layer 2 enable the digital connections of physical objects, as

well as the transactions over the IoT via a coordinating platform (Lüers et al., 2016; Rauen et al., 2017).

The applications and software developers (ASDs) as Layer 3 provide services and solutions on the Internet of Things platforms which is provided by IoTPPs (Lüers et al., 2016; Rauen et al., 2017).

The trusted authorities (TAs) as Layer 4 are public and private organizations which certify the Road Side Units (RSUs), autonomous cars (S-cars), and autonomous components (S-components) in order to provide the institutional framework (Lüers et al., 2016; Rauen et al., 2017; Datta et al., 2017; Lima et al., 2016) consisting of the rules and regulations, including system-suitable ethical standards (Wang and Meckl, 2020).

The AI-OEMs and the suppliers as Layer 5 manufacture the S-cars, S-components, and RSUs with active sensors and actuators (Lüers et al., 2016; Rauen et al., 2017; Lima et al., 2016; Wang and Meckl, 2020).

3. Theoretical grounding: the needed capabilities in orchestration

Orchestrators are the central network actors who coordinate purposeful actions to create and extract value from the ecosystem with explicit goals and timetables (Dhanaraj and Parkhe, 2006; Dollet and Matalobos, 2010; Hurmelinna-Laukkanen and Nätti, 2018). Orchestrators define standards and rules to organize the continuous improvement process (CIP) of the ecosystem. In addition, self-organizing and shared resources, protocols, processes, and infrastructures which enable collaboration should be implemented, allowing for the function of individual contributors and orchestrators as a loose network (Adner 2006; 2017; Fjeldstad et al., 2012; Lorenzoni and Lipparini, 1999).

In few academic articles such as Mitrega et al. (2012) and Sullivan and Weerawardena (2006), there are already discussions of the needed capabilities in an ecosystem orchestration (Hurmelinna-Laukkanen and Nätti, 2018). Although the challenge is still that “the Orchestrator capabilities have remained largely untapped” (Hurmelinna-Laukkanen and Nätti, 2018), the main focus of the present paper is to deal with who can and should be the orchestrator in the new technological AD-ecosystem instead of to research the general proposition of the capabilities needed as orchestrator. Therefore, the basis of the theoretical grounding are the existing described needed capabilities according to the few examples in the literature which have discussed orchestrators (Mitrega et al, 2012; Sullivan and Weerawardena, 2006; Ritter and Gemünden, 2003; Ritter et al., 2002):

1. Development capability (understanding, organization, and adaptation between cooperating organizations)
2. Initiation capability (search for new partners systematically to implement

the benefits)

3. Proactive and innovative capability with high risk-taking abilities (readiness and openness to develop innovative products and solutions without clear marketing previews)
4. Decision capability (have the resources and powers to make decisions)

AD-ecosystems are theoretically a bundle of multiple alliances among participating organizations. The next topic to deal with, therefore, is the way multiple alliances are governed in an efficient way based on the needed development capability.

Establishing organizational standards and interfaces for communication and decision-making are main norms for the orchestrator to "govern" the ecosystem and exert its influence (Jacobides et al., 2018, pp. 2259, 2269-2270; Davis, 2014; Baldwin, 2012; Dakak and Alkhen, 2021). In some academic papers, the concept of "collaboration" is used as an organization of diverse interest groups that invest their resources to reach a common purpose which they are unable to deliver alone (Heuer, 2000; Lai, 2011). Thus, it is essential to determine the ability of the contender for the focal position to achieve structural management, i.e., to take all the five layers as a coalition in the AD-ecosystem.

One of the fundamental challenges is also the resolve (compared to the other ecosystem players) to implement those ruling structures. This is a time when another theoretical stream, the resource-based view (RBV) comes into play, which has also been used as the theoretical basis in a reference paper on needed capabilities in orchestration (Sullivan and Weerawardena, 2006).

The RBV is probably one of the most employed concepts in management theory (Mahoney and Pandian, 1992; Priem and Butler, 2001; Rugman and Verbeke, 2002; Brusoni and Prencipe, 2013). It is based on the idea that the quality and quantity of the resources in a company is the basis for its competitive advantage.

That the different resources of the players in an AD-ecosystem could combine to form a joint resource base allowing innovative serviced production is a promising view on value creation. Since an AD-ecosystem with problem-solving features and innovation survives only with its stable resource base, a dynamic approach is essential. Literature extended this static view by introducing the dynamic capability view (DCV) as an expansion of the RBV (Götz et al., 2020; Ambrosini and Bowman, 2009; also compare Teece et al., 2016; Teece et al., 1997; Teece, 2018). Dynamic capabilities are often characterized as those resources "that enable firms to create, extend and modify how they make a living, including through alterations in their resources (tangible and intangible assets), operating capabilities, scale and scope of business, products, customers, ecosystems and other features of their external environments" (Helfat and Raubitschek, 2018, p. 1393).

The subsequent question is, which dynamic capabilities are relevant to ensure

the leading role of the orchestrator in an AD-ecosystem? How can the dynamic capabilities be synchronized with the needed capabilities in orchestration?

Considering resources like brand recognition and long-term customer loyalty are relevant for the competitive environment. The identification, assessment, and development of technical and business features satisfying customer needs is a pre-condition for the success of the ecosystem (Retkutė and Davidavičienė, 2021). This view is supported by, e.g., the marketing concept theory (Brady and Cronin, 2001). Hence, reputation would be classified as a "marketing competence" in an AD-ecosystem brand which can be synchronized to the theoretical basis "initiation capability."

Based on proactive and innovative capabilities, the central role of a working and innovative technology, the notion of "technological core competence" is essential to initiate and manage innovation. "Technological core competence" defines the key technological component for a current ecosystem which is competitive among the alliance-network and hard to imitate or replicate (March, 1997; Danneels, 2007).

Furthermore, to implement the decision capability, which requires extremely high upfront and regular capital investments necessary for building up, operating, and developing an AD-ecosystem, a solid ability in raising and providing capital seems to play an important role among dynamic capabilities. Moreover, the investor cannot expect a fast return and should make continuous large investments to compensate for an on-going negative cashflow. Regarding the AD-ecosystem as an innovation network, this assumption is very applicable and gives evidence for this "capital core competence" (Kupfer, 2019, pp. 11-40, p 253).

4. Derivation of the framework for the preliminary hypotheses

Based on the needed capabilities in orchestration after adaption, we identified four main factors concerning the preconditions and challenges which are necessary and have to be overcome to take the central role in AD-ecosystems:

1. Collaboration abilities ("organizational core competence") based on development capability
2. Customer orientation ("marketing core competence") based on initiation capability
3. Technological core competences based on proactive and innovative capability
4. Long-term investment motivation and resource capacities ("capital core competence") based on decision capability

4.1. Collaboration abilities ("organizational core competence")

In order to have a leading position in the collaboration, the contender should be able to integrate all the participants to agree to work together for building up a successful AD ecosystem in following aspects (Lai, 2011; Ordonez-Ponce et al., 2021).

1. Developing the relationships with every layer.
2. Resolve the conflicts of interest of different layers.
3. Win the respect, recommendations and support of other layers.
4. Be able to maintain the arranged lines, goals and relationships on a long-term basis.
5. Show the appreciation of the success of other layers.

Because of the successful collaboration experience of IoTPPS by the smart mobile phone ecosystem as well as the experience of OEMs by current automobile industry, the framework with the following two contrasting hypotheses-possibilities emerges can be defined with a view to the collaboration abilities:

1.1. The IoTPPs do have a stronger position with a view to collaboration abilities than the OEMs in AD-ecosystems because of their already long-term successful experience in other related digital business ecosystems.

1.2. The OEMs do have a stronger position with a view to collaboration abilities than the IoTPPs in AD-ecosystems because of the high technical complexity of automotive systems as well as the proven long-term successful experience of the current automobile industry.

4.2. Customer orientation ("marketing core competence")

The player in the business ecosystem who has the best customer orientation will determine the value creation and dominate the system.

The IoTPPs have a high brand recognition, even in the relevant sector of digital services. With their established customer access in other digital business ecosystems like search engines (Alphabet) or e-commerce (Alibaba), they are regarded as reliable providers of digital services among the large majority of potential customers. The capacity of the digital services provides them an edge in customer acceptance when buying AD-services for their vehicles.

Nevertheless, AD car driving will be to an extent a different "business transaction" than simply downloading a piece of music. End customers' (i.e., the drivers') expectations are similar to those in the non-AD car business. Vehicle ownership is not obsolete (Maurer et al. 2016, 633-634; Hajek and Hohensee 2020). In addition, repairing and maintenance services, emergency assistance, or advice on

the secure handling of the technology of the "system car" (an intensive customer care) will still be expected by the large majority of the customers. The most effective customer care is done via direct contact.

The OEMs have a broad international physical sales network, where customers can easily get technical help and general assistance. Because of their long history, the OEMs have collected a huge quantity of contact data on potential customers. Consequently, OEMs are currently identified as the experts and contact partners with everything in connection with cars. Their brand recognition is indubitable.

Therefore, the framework for the preliminary hypotheses concerning customer orientation as an influencing variable for reaching the orchestrator position can be formulated:

2.1. The IoTPPs do have a stronger position with a view to customer orientation than the OEMs, since they are operating the digital platforms and have direct and well-established digital access to the AD-customers.

2.2. The OEMs do have a stronger position with a view to customer orientation than the IoTPPs since they provide direct, i.e., physical customer support as they use their large service systems.

4.3. Technological know-how ("technological core competence")

The player in the business ecosystem who contributes the most important technical component will be the orchestrator.

According to Krasniqi and Hajrizi (2016), the most important core competences for the AD-ecosystem can be found in a sophisticated software, accurate maps, and high-performing sensors (see also Figure 1).

The IoTPPs provide the algorithms, which represent the "intelligence" of the system for enabling the cars to find their way autonomously. In addition, the IoTPPs create and operate the Cloud soft- and hardware infrastructure in storing the real-time data. Furthermore, maps and mobility orientation services in general are also already established in the present service program. In current cooperation agreements, IoTPPs even share those technologies with traditional OEMs such as Baidu (Apollo) with FAW, and Google (Waymo) with Jaguar and Land Rover. For this reason, the IoTPPs´ technical know-how can cover at least two of the three most important core competencies in an AD-ecosystem.

Even more, complicated technology in the automotive industry such as massive production, lean management, and supply chain management should not be underestimated. It could be more difficult to integrate the hardware by the IoTPPs than for the OEMS to integrate software programming capacities. Under such

conditions, the framework for the preliminary hypotheses- possibilities may be defined as:

3.1 The IoTPPs do have a stronger position with a view to technological core competences than the OEMs, because their technical know-how as software and algorithm providers can cover the most important core competency needs of an AD-ecosystem.

3.2 The OEMs do have a stronger position with a view to technological core competences than the IoTPPs, because their technical know-how is in development, mass lean production, and the assembly of huge quantities of hardware/physical parts which can´t be learned simply and quickly.

4.4. Long-term investment motivation and resource capacities ("capital core competence")

The building up, operating, and continuing development of an AD-ecosystem requires a large and sustainable capital base. The player in the business ecosystem who has both a long-term investment motivation and the corresponding resource capacities has therefore a good chance to become the orchestrator (see Chapter 3).

The market capitalization of the referencing IoTPPs such as Google and Apple are at least five times larger than the referencing OEMs such as Toyota and Daimler. We believe the IoTPPs could have more power and more opportunities to raise funds from public capital markets or private investors to finance capital expenditure in the future potential capital acquisition (equity or loans).

Nevertheless, the OEMs' capital expenditure could be generated to a positive cashflow from the traditional car business. Besides, governments in traditional strongholds may be tempted to infuse money into OEMS to accelerate their transformation as important players in the AD-ecosystem because of the strategic asset. Furthermore, the potential for OEMs to raise the necessary funds may be elevated to an adequate level by forming coalitions, e.g., with (big) automotive industries.

Therefore, the framework with two corresponding hypotheses-possibilities is defined as:

4.1 The IoTPPs do have a stronger position with a view to long-term investment motivation and capital resource capabilities because of the huge market capitalization and excellent experience for raising funds.

4.2. The OEMs do have a stronger position with a view to view to long-term investment motivation and capital resource capabilities by using the cashflow from the traditional car business and by forming strategic alliances.

So far, the main frameworks with opposing hypotheses have been formulated. By using the qualitative technical interviews, the hypotheses are generated and the questionnaire is developed in the following sections.

5. Pretest to generate the hypotheses and develop the questionnaire

5.1. Long-term investment motivation and resource capacities ("capital core competence")

The necessity for pretesting, especially for new concept development, has already been demonstrated by dozens of papers (Presser and Blair, 1994; Nelson, 1985; Reynolds and Diamantopoulos, 1998; Buschle et al., 2021):

1. To avoid misunderstood and misused elements of the survey
2. To evaluate and improve the questionnaire before the main fieldwork
3. To increase the response quote in a further large quantitative study with the design of an understandable questionnaire

The qualitative technical interviews have been developed as the main approach to implement the pretest method (Willis, 2004; 2015; Bethmann et al., 2019). In the present paper, there are three reasons why this method is an appropriate core (Presser and Blair, 1994; Mensah et al., 2012; Niu and Fan, 2015). Firstly, a standardized, questionnaire-based, anonymous study is not able to involve all the expert know-how and to elaborate on certain attitudes and new information. Secondly, since the topic is still sensitive and strategically "private" in the industries, the respondents may not have the willingness to share relevant information and knowledge without a well-established relationship network to the respondents. Thirdly, the expert interview can help the researchers to identify unrealized potential interdependencies (Mellahi and Eyuboglu, 2001; Beatty, 1995).

One main success factor in guided interviews is knowledge of the interviewees, i.e., the expert status of the persons interviewed (Niu and Fan, 2015). A number of authors have already commented on respondent characteristics with the general propositions (Martinez-Mesa et al., 2016; Hensher, 2006; Diamantopoulos et al., 1994; Terhanian and Bremer, 2012):

1. The respondents should have direct knowledge of the questionnaire topic.
2. The pretest sample size is suggested as "small" generally

In the present paper, more specifically based on the characteristics, the respondents should possess general strategic industry know-how and have direct project experience with both IoTPPs and OEMs of AD-ecosystems. Four experts

have been selected to implement the first pretest procedure to keep the "small" sample size. In addition, the interviewees should hold a position at least at senior management level, such as Chief Executive Officers (CXOs) and have the responsibility to implement the strategic development direction of their organization. Two CEOs, one Chief Marketing Officer (CMO), and one Chief Technology Officer (CTO) have agreed to participate in an interview. The profile of the interviewees and their organizations are reported in Table 1.

With the approach "Qualitative Pretest Interview (QPI)", the interviews lasted between one to two hours and were tape-recorded. Guided interviews with pre-formulated questions were conducted (Buschle et al., 2021). Vague answers or new aspects have been discussed in more detail. The results are presented in the next chapter.

5.2. Pretest results and discussion

Based on the Gioia Method (Gioia, 2004), we have grouped the records into categories (open coding) as the first order (Van Maanen, 1979). As second procedure, we have analyzed the correlation of the records from one category and defined the second order themes. As the last process, we have generated similar themes from the second order categories and derived the aggregate hypotheses.

For the framework concerning the "collaboration abilities," an interesting aspect, or, in other words, a new "pattern" (for details of "flexible pattern matching" see e.g., Bouncken et al., 2021; Bouncken et al., 2021; Sinkovics, 2018), was presented by all the four experts concerning the definition and implementation of legal regulation. Legal questions like who should take the responsibilities for accidents, ethical questions like what would be the priority of the decisions in algorithm when it comes to contradicting life-saving decisions, and more down to earth questions like how the insurance system should be implemented, are of central importance. Neither executive can nor will take the responsibility for such sensitive legal questions alone, and without those, the AD-ecosystem cannot and will not be implemented. Thus, an important consideration would be whether other participants, such as governments (trusted authorities), need to take the coalition role because of the authority of the final definition in laws.

Therefore, the preliminary evaluation for the collaboration capability, also see as the hypothesis for future quantitative empirical studies should be defined as:

- **The governments (trusted authorities) as a neutral third party may have a stronger position with a view to collaboration because of the authority of law which is the precondition to implement the AD-ecosystem.**

Interview No.	Job title	Revenue (2019)	Number of employees	Location of Headquarters	Location of globalizations	Potential system for AD vehicles	Reference customers
1	CEO	200 M €	950	Germany	USA and China	Smart suspension system with programming/software integration	Daimler; Apple
2	CMO	80 M €	500	China	Germany	Magnet	VW; Apple
3	CEO	500 M €	4200	China	USA and Germany	Smart suspension system with programming/software integration	FAW; NIO
4	CTO	357 M €	1900	China	Italy	Smart suspension system with programming/software integration	Geely; NIO

Table 1. Profile of the experts and the respective company

For the framework concerning "customer orientation," all of the four experts brought into play a more accurate "pattern": they stated that the mobility platform providers like Uber or DiDi should be the most important target customers for AD vehicles, especially in big cities with an established infrastructure. If the end users

assign responsibilities to the mobile platform providers, there is no need to consider costs such as parking, insurance, maintenance and repairs, nor other organizational activities.

All four experts have also emphasised that it is one of the most crucial success factors for an AD-ecosystem to set up a virtual platform with comfortable link and digital services embedded, whereas it is not essential when only building up a physical contact and face-to-face service.

Three participants stated that the IoTPPs did have a stronger position if the target customers are mobility platform providers because of the capacities and experience. In contrast, the OEMs are losing value since their core competitive factor is the physical sale system. One expert held a neutral point of view that if the number of target customers is limited, both OEMs and IoTPPs could have an equal chance and ability to build up their customer orientation quickly and properly.

Furthermore, two experts have argued in a more differentiated way concerning areas without a well-established customized infrastructure. The service density of mobile platform providers may be insufficient, to the extent that people have to wait a long time when necessary. In this case, to purchase a private vehicle is an alternative. Neither have confirmed whether the digital platform or physical distributions would be more important for those customers.

In addition, one interviewee affirmed that "premium vehicle culture" is very popular and stable in some developed countries, such as Germany. The customers have a remarkable loyalty to the premium car manufacturers such as Daimler, BMW, or Porsche to show their social image. For these premium auto market segments, the OEMs do have a stronger position than IoTPPs.

Therefore, the preliminary evaluation for the "customer orientation", also see as the hypotheses for further quantitative empirical studies should be defined, and should better differentiate between different market segments of the car industry, as:

- **The IoTPPs may have a stronger position with a view to customer orientation if the mobility platform providers are the main customers because of their digital capabilities as well as identical cultures.**
- **The OEMs may have a stronger position with a view to customer orientation for the premium car fans because of the remarkable loyalty.**
- **Neither IoTPPs nor OEMs may have a stronger position with a view to customer orientation for the customers who are private persons in the cities without an established infrastructure of the AD ecosystem. These customers will stay neutral.**

Regarding "technological know-how," all four experts have confirmed that the relevance of the software and the algorithms is higher than the hardware components since the former take command of the latter, who only operate the orders.

Therefore, three participants believed that the IoTPPs did have domination over the OEMs in technical core competence while the programming abilities are the core technical know-how with long-term experience and extensive expert resources. Nevertheless, it is time-consuming and labor-intensive to integrate the OEMs' technical competence to IoTPPs since OEMs contain complicated technologies such as development, massive lean production, assembly of a large number of products with a narrow quality tolerance, and excellent process stability. Instead, it may be easier for the OEMs to obtain the technical capacities of programming and algorithms, stated the other expert.

Thus, a cooperative approach with a focus on their respective strengths may be a solution. IoTPPs should take charge of the software and programming integrations, whereas OEMs could be responsible for hardware development and massive lean production.

Therefore, the preliminary evaluation for the "technological know-how", also see as the hypothesis for the further quantitative empirical studies should be defined as:

- **IoTPPs and OEMs should cooperate together to fulfil the technological know-how for the AD-ecosystem. IoTPPs may take the software parts and OEMs may take the hardware and production parts.**

With regard to "capital core competence," three experts are convinced that the reference IoTPPs such as Google and Apple have the advantage in both market capitalization and cashflow. The traditional OEMs are at this point far behind and are not comparable. Furthermore, one expert declared that the IoTPPs have less risk resilience because of their highly profitable future investments. The market caps and the general high evaluations of the IoTPPs may decline dramatically and bankrupt the IoTPPs under abnormal circumstances such as economic depression or war. In this case, OEMs would have dominance because of their greater risk resistance. Nevertheless, under normal circumstances, the IoTPPs are in the better position.

Therefore, the preliminary evaluation for the "capital core competence", also see as the hypothesis for the further quantitative empirical studies should be defined as:

- **IoTPPs may have a stronger position with a view to long-term investment motivation and capital resource capabilities because of the advantages in both market capitalization as well as cashflow based on other business units.**

Figure 2 presents the data structure and summarizes the matching between interview transcripts and theoretical patterns (generated hypotheses).

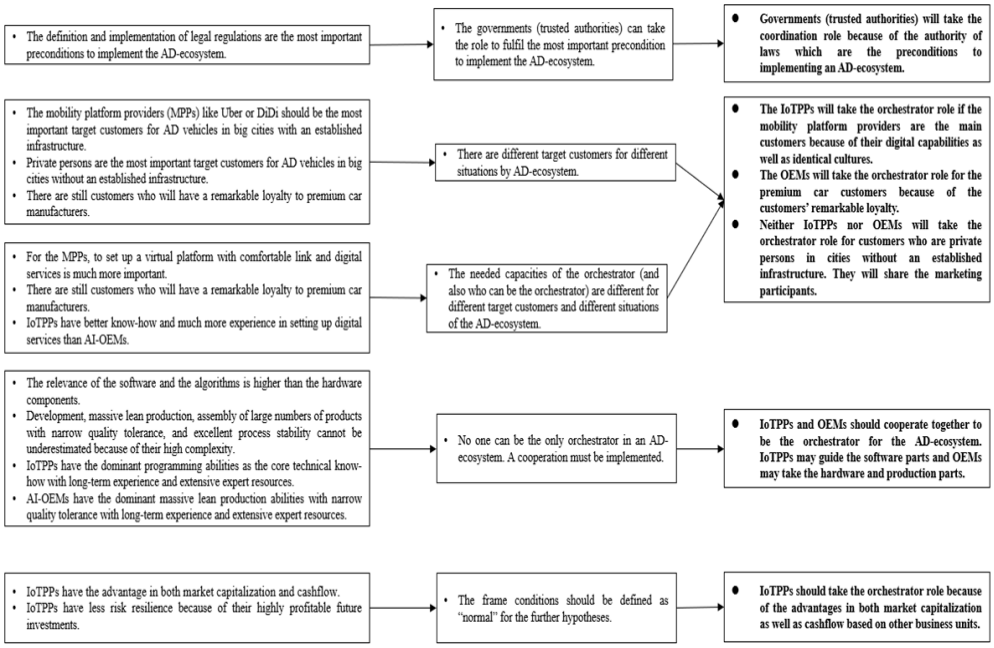

Fig. 2: Data structure (own presentation according to Gioia *et al.*, 2010; Corley and Gioia, 2004; Langley and Abdallah, 2015; Nag *et al.*, 2007)

6. Conclusion and outlook

The purpose of this study was to define a framework of an AD ecosystem, determine the needed capabilities for the orchestrator of AD ecosystem, implement four qualitative interviews to make a first preliminary evaluation for every capability the orchestrator needs, generate hypotheses as well as to develop a questionnaire as a preparation and pretest process for a large quantitative empirical study asking what challenges the IoTPPs and AI-OEMs face in taking on the dominating role compared to other referencing participants.

Five layers in AD ecosystem were defined and their responsibilities and roles in the AD ecosystem were descripted.

Four core competences (organizational, marketing, technical, and capital) were defined based on the theoretically needed capabilities in orchestration of the business ecosystem. The framework with four pairs of hypotheses based on the four core competences was defined.

By conducting a pretest by technical expert interviews, a preliminary evaluation for every core competence was discussed concerning the question who could be the orchestrator and why. Six generated hypotheses werde discussed (see 5.2) for a future large quantitative empirical study and a questionnaire was developed (see Table 2).

Table 2. Summary of the results of the interviews

Core competence as orchestrator	Preliminary qualitative evaluation and the generated hypotheses	Further research
Organizational core competence	The governments (trusted authorities) as a neutral third party may have a stronger position with a view to collaboration because of the authority of law which is the precondition to implement the AD-ecosystem.	● What exactly should the government do for the collaboration? ● Is there some difference between different countries?
Marketing core competence	The IoTPPs may have a stronger position with a view to customer orientation if the mobility platform providers are the main customers because of their digital capabilities as well as identical cultures. The OEMs may have a stronger position with a view to customer orientation for the premium car fans because of the remarkable loyalty. Neither IoTPPs nor OEMs may have a stronger position with a view to customer orientation for the customers who are private persons in the cities without established infrastructures of the AD ecosystem. These customers will stay neutral.	● What exactly should the IoTPPs and OEMs do to implement their stronger customer orientations for the customers they may have the stronger role. ● What exactly should the IoTPPs and OEMs do to reverse the customer orientations for the customers they may have the weaker role. ● What exactly should the IoTPPs and OEMs do to win the customer orientation by private persons in the cities without established infrastructures of the AD ecosystem.
Technical core competence	IoTPPs and OEMs should cooperate together to fulfil the technological know-how for the AD-ecosystem. IoTPPs may take the software parts and OEMs may take the hardware and production parts.	How should the close cooperation be implemented?
Capital core competence	IoTPPs may have a stronger position with a view to long-term investment motivation and capital resource capabilities because of the advantages in both market capitalization as well as cashflow based on other business units.	How can an anti-risk capacity and high resilience for the AD-ecosystem be built up?

Many more interviews and data, especially from the experts of all five layers, in particular from IoTPPs and OEMs, are needed for a clearer statement. Therefore,

next research steps should be a well-defined evaluation and the implementation of the interactions among all the five layers of AD ecosystem on a larger quantitative empirical scale. In addition, the role of the regulating authorities and the effects of different legal frameworks are of central interest in the further study. Moreover, based on strategic moves and whether the cooperation of AI-OEMs and IoTPPs is promising, e.g., by merging or by forming alliances which may allow them to develop a joint, industry-standard platform, is still under discussion.

The limitation of the approach is the neglect of non-hypotheses aspects even though new ideas generated from the interviewees were considered. In addition, our sample consisted of only four CXOs of the AD-ecosystem. The experts from other layers of the AD-ecosystem must be integrated for the large quantitative study; thus, the hypotheses and questionnaire may not integrate all the aspects and factors generally and representatively. Furthermore, multi-level sample sizes are required since variation in results may occur depending on different criteria or different groups such as gender, age, nationality, and ethnic group, etc.

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