



# The emergence of the electric vehicle industry in Chinese Shandong Province

## A research design for understanding business ecosystem capabilities

Business  
ecosystem  
capabilities

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### Abstract

**Purpose** – The purpose of this paper is to propose a research design that seeks to explore the evolutionary pathways of the emerging electric vehicle (EV) industry through employing the business ecosystem framework, which focuses on the interaction between firms, government officials, industrial associations and customers; and at the same time to identify the necessary strategic capabilities behind such emergence.

**Design/methodology/approach** – Qualitative research methodology will be employed such that multiple case studies will be carried out through the implementation of interviews with companies, industrial players and policy makers.

**Findings** – The research findings of this paper include a comprehensive depiction of the emerging business ecosystem structure of the EV industry, which contributed in building the main elements of the proposed conceptual research framework.

**Research limitations/implications** – The research findings of this paper are based on one province in China; also the business ecosystem of the emerging EV industry may differ in different regions across the country.

**Practical implications** – Practically, this research would be able to provide a tool for industrial players and policy makers through the formulation of a capability maturity model, which allows the evaluation of the capabilities of the corresponding ecosystem players, so as to permit the assessment of their positions with the provision of guidelines benefiting the advancement of emerging industries.

**Originality/value** – This paper offers original theoretical contributions through developing strategic capabilities of emerging business ecosystems and is the first to provide a comprehensive structure on the low-speed EV industry in China.

**Keywords** China, Business development, Innovation, Automotive industry, Ecosystems, Business ecosystem capabilities, Emerging industries, Electric vehicle industry, Capability maturity model

**Paper type** Research paper

### 1. Introduction

Over the past few decades, there has been a renewed interest concerning the development of electric vehicles (EV). The emergence of this industry is related to the recent sharp increase in oil price along with the environmental concerns over climate change. The aim of this paper is to propose a research design that seeks to explore this industrial emergence through employing the business ecosystem framework (which focuses on the interaction between firms, government officials, industrial associations



and customers) and at the same time identifies the necessary strategic capabilities behind such emergence. Accordingly, a set of research questions have been formulated through the identification of practical and theoretical research gaps. The following sections of exploratory findings on the EV industry and the review of literature concerning theories of business ecosystems provide the foundation of these research gaps. Finally, the concluding part of the paper specifies the work to be conducted in the next stages of the proposed research.

**2. Exploratory case studies and initial findings**

The EV industry in Shandong province has been thriving in its own unique way. With more than 110 companies along the EV supply chain of which five in electric motor, 13 in traction batteries, five in electric control system, 22 in final assembly with various design houses and component supplying firms, Shandong has developed its own business ecosystem that low-speed EVs are produced by these small indigenous firms working in collaboration within the ecosystem. In 2009, it was observed in Shandong province that more than a 100,000 EVs are running locally. These micro-EVs are typically cheaper at around £3,000 with lower maximum speed at approximately 70 km/h and shorter distance per charge of less than 200 km.

For the purpose of gaining greater insights of the business ecosystem of this emerging industry so as to identify the current industrial challenges and potential research areas, exploratory case studies are carried out through the implementation of semi-structured interviews with firms along the supply chain, policy makers and industrial players. This exploratory work consists of interviews with one original equipment manufacturers (OEM), one traction battery manufacturer, one electric motor firm, Shandong University and one government offices in Shandong province (Table I).

*2.1 Shandong Baoya New Energy Vehicle*

Baoya is a private OEM company situated in Jinan, the capital city of Shandong province. The firm was founded in the beginning of this century, originally supplying key components such as motor engines to the traditional automotive sector and started producing low-speed micro EV in 2008. The products of Baoya range from electric bicycles, electric motorcycle, electric sightseeing EV and electric golf carts to private EVs. At present, the production capacity is around 3,000 vehicles each year. As an OEM, Baoya is occupied in the final assembly of its product and the design of electric motors while outsourcing the production of traction batteries, motors and other components to suppliers. In fact, the firm is a keystone player in the low-speed micro EV business ecosystem, as a central player establishing the industrial alliance of the EV industry in Shandong, it collaborates closely with many other companies and organisations. For its electric control system, Baoya is working closely with Shandong

**Table I.**  
Overview of the preliminary case studies in Shandong province

| Geographical location | OEMs (final assembly)    | Traction batteries | Electric motor | Supporting institutions   |
|-----------------------|--------------------------|--------------------|----------------|---------------------------|
| Weishan<br>Jinan      | Baoya New Energy Vehicle | Realforce          | Huanguan       | Government Shandong Univ. |

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University, while at the same time launching a joint-venture with JiuZhao to work on the system of power management. Nonetheless, Baoya is facing serious setbacks due to the absence of license required by the government which means Baoya cannot sell its product domestically. Accordingly, Baoya is exploring the foreign market through acquiring the relevant certificate for exporting overseas to Europe, the South American region and the USA. There is a stable demand from the overseas market as communities from these countries accept well the concept of an environmental friendly second car for families. Rather than producing a prudent design, Baoya produce these low-speed micro EVs with a fashionable design and better technical performance. In fact, the firm exports 80 per cent of the total product overseas that only 20 per cent is sold domestically to the local government as police patrol vehicles where registration is not obligatory. However, Baoya recognises the huge market potential and opportunity domestically and is frustrated with the lack of permission to sell its product within China. In addition, Baoya admits the issue of its limited production abilities in meeting the huge domestic demand is a major barrier for the development of the firm.

### *2.2 Shandong Realforce*

Realforce is a firm producing lithium batteries within the EV industry established in 2008. Located in Weishan in Shandong, the company was ready for production within two years of the initial set up and began to produce Li-Mn, Li-Fe and Li-Co batteries in July 2010. These batteries can be consumed in electric bikes, electric motorbikes, EVs as well as power storage. Currently, Realforce is providing lithium batteries used in the hybrid EV Prius by Toyota. With more than 2,000 personnel, an investment of £700,000,000 worth was financed by the founder of company who originally was a coal electricity provider and later shifted the attention to the lithium battery sector. The key to the success of the company's transformation is the ability of the founder of Realforce to identify and recruit a number of highly talented and competent people into the firm. At present, the general condition concerning traction batteries within the EV industry also applies to Realforce, the firm admits that it is facing a number of challenges including the technological side and the issue of uncertainty regarding standardisation guidelines supposedly provided by the government. However, the company is supported strongly by the local government of Weishan such that their cost of the production site is partly subsidised.

### *2.3 Shandong Huanguan*

Founded in 2008, Huanguan is a research-based enterprise focusing on the development of electric motors for EVs as well as the relating control and battery management systems. Located in Jinan, the core products of the firm are the axial magnetic field disc motor and the energy regenerative braking power system. Being extremely research oriented, Huanguan devotes most of its attention to the designing and testing of its product outsourcing all manufacturing parts to other firms. The firm is a classic niche player within the EV business ecosystem. Interestingly, Huanguan is completely self-funded without government support such that a total of 120,000,000 RMB was invested into the company. It is established based on the accumulated life income of the founder who was a research engineer within this field. Nevertheless, Huanguan is closely working with the manufacturing firms of the local EV industry and its specialised ability in designing more efficient electric motors for the EV industry is a key to the development of this emerging business ecosystem.

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#### *2.4 Shandong University*

Situated in the capital city of Shandong province, the university was established more than a century ago in 1901. Regarding science and engineering associated departments, the university is dedicated and keen in developing its R&D abilities. Two laboratories from the university are currently involved in the development of EVs. The powertrain system laboratory of the department of engineering implements and enhances the performance of the EV powertrain system and is working closely with OEM firms from the EV industry in Shandong. Collaboration with Baoya is frequent such that the firm has requested assistances in the powertrain system of its EV products from the laboratory. Whereas for the battery material laboratory from the department of chemistry, the research centre focuses on the exploration of better anode material for traction batteries so as to ameliorate the current technological challenge of the issue of battery power density. The assisting character of the two research centres to the EV business ecosystem in Shandong is important in its development especially when the ecosystem is at the emerging stage.

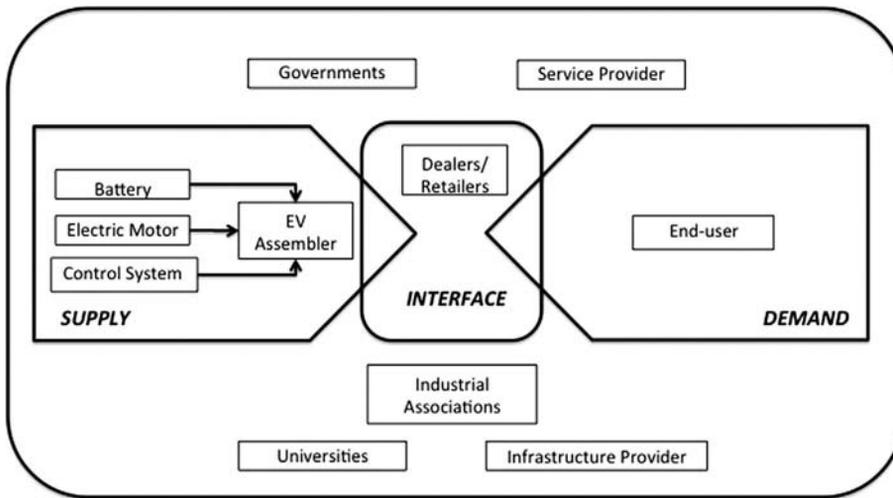
#### *2.5 Shandong local government office: EITC*

The Economic and Information Technology Committee (EITC) in Shandong is the local government office supporting the Ministry of Industry and Information Technology from the Central Government in China. This local committee works to stimulate the development of emerging sectors while at the same time providing guidelines and assistance to the firms within these industries. Recently, the local government has devoted more efforts to the progression of the EV industry, through setting relevant policies and subsidising firms that manufacture the key sections of EVs such as traction batteries and electric motors as well as OEM companies. Currently, there is a barrier for the local government to promote the low-speed EVs. Because the specification of the low-speed micro EVs produced locally in Shandong does not meet the official requirement which means they cannot obtain the license from the central government. As the central government is attempting to prevent the manufacturing of these EVs, the local government on the other hand is reluctant to restrict firms as they contribute sizable amount of tax. As a result, while the local government is issuing policies promoting the ordinary EV industry, the regulations concerning low-speed micro EV is ambiguous. This is a major obstacle especially for the development of the EV business ecosystem in Shandong as most of the firms involved in this industry are engaged in the manufacturing of low-speed EVs.

#### *2.6 Initial findings: current structure of the Shandong EV business ecosystem*

From exploring the low-speed micro EV industry in Shandong, the business ecosystem of this emerging sector is mapped out from the observed case studies shown in Figure 1.

The business ecosystem is divided into four main sections which are the supply, the demand, the interface and support. The supply side is concerned with the production of the EVs encompassing core components manufacturing firms such as Huanguan and Realforce, the final assemblers such as Baoya as well as the car body components makers. Meanwhile, EV users and the incentivising programme occupy the demand side. The interface consists primarily of dealers and retailers such that it provides the opportunity in which supply and demand are integrated. The supporting participants



**Figure 1.**  
Business ecosystem of the emerging EV industry

of the ecosystem include research centres from universities, electricity providers such as the state grid, industrial associations and the government.

### *2.7 Practical challenges to the Shandong EV business ecosystem*

Several issues obstructing the development of this emerging business ecosystem are identified from the preliminary findings of the cases studies implemented. First, firms along the supply chain are urgently demanding a guideline of industrial standardisation. This uncertainty together with the high cost of batteries constitutes major barriers for the commercialisation of EVs. Second, the current weak infrastructural support of the lack of charging stations and recharging points implies that there are substantial amount of work yet to be done from the perspectives of end-users. Further from the demand side, currently, for the low-speed EV industry, the market response is strong within the greater Shandong region due to the practical benefit and the pricing associated with the product. The challenges for industrial players in Shandong are therefore to find ways so as to meet such demand. Yet, the abilities of the core components firms, OEMs, research centres as well as the service and infrastructural providers are not sufficient to fulfil these demands. Mainly due to the lack of component suppliers and the technology challenges of batteries and motors. In fact, the limited capabilities of these industrial players restrict them from developing product with more advanced specification which means they cannot evolve to the higher end of the market of ordinary EVs even if the product allows them to capture more value. In addition, ambiguous regulating policies pose another impediment towards the successful nurturing of the EV business ecosystem as the capability of governments in making sound policies is a key issue for the advancement of the industry. Consequently, it is evident that the understanding of capabilities of business ecosystems is crucial in affecting its development and growth. Currently, these capabilities are unknown which poses great industrial challenges for the EV industry.

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### 3. Literature review

This section attempts to address the previous industrial challenges identified through reviewing the relevant literature on the theories of business ecosystems and capabilities. This section seeks to cover the definition and the evolutionary stages of business ecosystem while reviewing the literature on the strategies of the players within the ecosystem.

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#### 3.1 Business ecosystem theories

The concept of business ecosystem was proposed originally by Moore (1993) who defined the term as:

An economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world. This economic community produces good and services of value to customers, who are themselves members of the ecosystem. The member organizations also include suppliers, lead producers, competitors and other stakeholders. Over time, they co-evolve their capabilities and roles and tend to align themselves with the directions set by one or more central companies.

In Moore's view, the term business ecosystem not only encompasses the core supply chain and extended enterprises but also envelopes other stakeholders such as industrial associations and the government. More importantly, it is stressed by the founder of business ecosystem theory that the co-evolution and interaction among these different level of organisations including firms within the supply network, extended enterprises and policy makers are critical for their co-development. Following Moore's steps, various definitions have also been proposed by scholars researching on the topic. Surveying business ecosystem studies since Moore's work, our working definition of business ecosystem is said to be "a community consisting of different levels of interdependent organisations, who are loosely interconnected and generate co-evolution between partners and their business environment" (Manning and Thorne, 2002; Iansiti and Levien, 2004; Peltoniemi and Vuori, 2004; Quaadgras, 2005; Adner, 2006; Iansiti and Richards, 2006; Li, 2009; Rong, 2011).

There are four stages in the life cycle of a business ecosystem including the phases of birth, expansion, authorities and renewal (Moore, 1993). In the first stage of birth, firms work in collaboration to identify new value proposition surrounding a new invention. Once the business ecosystem reaches its second stage, the market expands with participants cooperating with each other to increase the level of production while at the same time trying to get hold of the key market segments in the fierce competition between suppliers. In the next stage of authorities, the business ecosystem is consolidated such that the leaders within the ecosystem decide the ways in which participants are incentivised to collaborate with one another. In the last stage of renewal, the already matured business ecosystem is vulnerable due to the innovative ideas arising from the emerging business ecosystem. At this point, the death of the mature ecosystem may occur if the leaders do not adapt and amalgamate the new invention into the established ecosystem. Adapting from Moore, Rong (2011) identified five phases of emerging, diversifying, converging, consolidating and renewing as the evolutionary pathway of the ecosystem using cases studies from the semi-conductor industry.

Based on Moore's ecosystem, Iansiti and Levien (2002) identified four categories of players which are the keystone player, the niche player, the dominator and the hub landlord who are participating within the ecosystem while at the same time the

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functions and strategies of these players are also recognised by the two scholars (Iansiti and Levien, 2002, 2004). Defining the business ecosystem as:

[...] formed by large loosely connected networks of entities; As with species in biological ecosystem, firms interact with each other in complex ways and the health and performance of each firm is dependent on the health and performance of the whole. Firms and species are therefore simultaneously influenced by their internal complex capabilities and by the complex interactions with the rest of the ecosystem.

Iansiti and Levien contend that the task for the keystone player is to provide a platform allowing other participants to work and collaborate with one another (Quaadgras, 2005). For niche players, they aim to progress their specialized capabilities in certain spheres so as to create more value for the business ecosystem. The dominators on the other hand manipulate the main segments of the network while enjoying the majority share of the value through vertical or horizontal integration. Concerning the hub landlords, they seek to obtain the greatest possible benefit they could acquire from the ecosystem while not managing the system in any straightforward manner.

In addition, three parameters are used in examining the fitness level, i.e. the health, of the business ecosystem, namely the levels of productivity, robustness and niche creation (Iansiti and Levien, 2004). The two scholars assert that productivity is “a network’s ability to consistently transform technology and other raw materials of innovation into lower costs and new products.” Robustness refers to the capability of a business ecosystem when they are “facing and surviving perturbations and disruptions”, which implies that it is testing whether or not the ecosystem is able to endure the dynamic shift of its surrounding environment. Regarding niche creation, it is questioning the level of variation of companies and products within the ecosystem so as to test its health. For assessing the level of productivity, measures of total factor productivity, productivity improvement over time and delivery of innovation are used while survival rates, persistence of ecosystem structure, predictability and limited obsolescence are prescribed as the examining factors for robustness. Last but not least, the aspects of variety and value creation are employed for determining the level of niche creation as a parameter in understanding the health of business ecosystems.

From reviewing the literature, a static picture of business ecosystem has been depicted along with the identification of the various roles of different players interacting within the business ecosystem. More importantly, traces of business ecosystem capability have been discovered from the discussion of business ecosystem health (Iansiti and Levien, 2004). It is argued by Iansiti and Levien that the dimensions of productivity, robustness and niche creation which implicitly are the capabilities of a business ecosystem should be used in assessing its fitness level. However, the measurement criteria for health concentrate solely from the firm’s perspective lacking the dimensions involving the broader scope such as policy making. This implies that the capabilities of business ecosystem require further exploration.

### *3.2 RBV, core competences, dynamic capabilities and network capabilities*

From reviewing the literature concerning business ecosystems, it is evident that scholars such as Iansiti and Levien have recognised business ecosystem capability exist and has used the concept to measure the health of the ecosystems through the robustness dimension. The following section reviews the past literature concerning the

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traditional views on capabilities which identified by the two researchers as important in determining the performance of firms within business ecosystems (Iansiti and Levien, 2002). On top of this, the concept of network capabilities which is relevant to the study of business ecosystem is also discussed.

Proponents of the resource-based view (RBV) of the firm contend that the possession of resources is critical in determining the competitive advantages of firms such that these competitive advantages could be obtained through embracing value creating strategies using the available resources (Barney, 1991; Nelson, 1991; Peteraf, 1993; Wernerfelt, 1984, 1995). Mills *et al.* (2002) proposed various categories for distinguishing different types of resources. The types of resources which could be classified include tangible resources, knowledge resources, skills and experience, system and procedural resources as well as cultural resources and values. These resources which are the key in maintaining the competitive advantages of firms can be physical, human or organisational assets, capabilities and organisational processes (Barney, 1991; Amit and Schoemaker, 1993; Mahoney and Pandian, 1992; Penrose, 1960; Wernerfelt, 1984). Hence, capability under the resource based view is regarded as a form of resource of firms (Daft, 1997).

Despite the fact that RBV has made substantial contribution to theory in considering firm as a bundle of various resources, it nevertheless neglects the origin of these resources without specifying the ways in which they could be obtained and managed, particularly when facing the circumstances of uncertain volatile environments. Accordingly, researchers devoted more efforts in gaining insights of the means in which firms could achieve the differentiated level of performances and began to focus on the concept of core competence. According to Prahalad and Hamel (1990), core competence is “the company’s collective knowledge about how to coordinate diverse production skills and technologies”. Using the case from NEC, Prahalad and Hamel demonstrated that the possession of core competencies of firms allows the subsequent advancement of core product which in turn could be employed in the creation of various other products for potential customers. The core competencies are nurtured from the ongoing progress of routines accumulated over time.

The concept of dynamic capabilities originally put forward by Teece *et al.* (1997):

[...] refers to the particular (non-imitable) capacity business enterprises possess to shape, reshape, configure and reconfigure assets so as to respond to changing technologies and markets an escape the zero profit condition (Augier and Teece, 2007).

That is to say, it is the ability of firms to detect, grasp and adjust to the fluctuating external environment through which the level of competitive advantage is maintained. One of the main characteristics of dynamic capabilities is that it administers the degree of variation of normal capabilities that are static (Collis and Montgomery, 1995; Winter, 2003). This implies that in the scenario of a firm owning only competences without dynamic capabilities, the firm would not be able to achieve sustained level of competitive advantage and the return, but instead gaining the competitive advantage only within a short period of time. In fact, the concept of dynamic capabilities have deep roots in RBV, as put by Teece *et al.* (1997):

If control over scarce resource is the source of economic profits, then it follows that such issues as skill acquisition and learning become fundamental strategic issues. It is in this second dimension, encompassing skill acquisition, learning and capability accumulation that we believe lays the greatest potential for the resource-based perspective to contribute

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to strategy. We will refer to this as the “dynamic capabilities approach”, recognizing of course that it is part of the overall resource-based perspective.

Thus, from studying the relevant literature, the review has provided various insights for the firms within a business ecosystem in which it is evident that the issue of capability is an essential aspect in the determination of firms’ performance and the sustainability of their competitive advantage over time.

According to Walter *et al.* (2005), network capabilities is conceptualised as the firm’s ability to advance and employ inter-organisational relationships such that it encompasses the four dimensions of coordination, relational skills, market knowledge and internal communication. Acknowledging the fact that network capability has deep roots within the RBV, these scholars considers network capabilities as a higher ranked resource in which case the level of this resource rises with the expansion of any of the four dimensions. Specifically, the coordination factor links firms together thereby result in reciprocal interactions; the relational skills dimension refer to the communicational ability of businesses whereas market knowledge and internal communication allow firms within the network to circulate the information of its partners and the market in order to prevent superfluous procedures and misjudgement. In comparison, the strategic capabilities developed from the configurations of the international manufacturing network are concerned with the capabilities of the network as a whole rather than assessing the concept from a firm’s perspective in achieving greater performance at the firm level (Shi and Gregory, 1998). The dimensions of the international manufacturing network capability involve the strategic resource accessibility, thriftiness ability, manufacturing mobility and learning ability. Due to the fact that various configurations are composed with diversified structures and dynamic operating mechanisms, accordingly, dissimilar capabilities are required so as to fulfil the requisite of each individual configuration.

As a consequence, it is evident that the issue of capability is an essential aspect in the determination of firms’ performance and the sustainability of their competitive advantages over time. At the firm level, theories of the RBV, core competence and dynamic capabilities have been discussed. At the network level, the dimensions put forward by Walter and his colleagues examines the concept of network capability, but solely from a firm’s perspective in gaining better performance at the firm level without a holistic view concerning the overall network. In comparison, the work implemented on international manufacturing network capabilities derives the dimensions from different network configurations. From studying the literature, it is recognised that while the work of network capabilities is relevant to business ecosystem research to the extent that it involves also the interaction between firms, it on the other hand only covered one layer of interaction within the business ecosystem. In other words, collaborating activities between other entities such as the government and trade associations are absent. In addition, existing theories have not yet explored the capabilities regarding the emerging industries. Therefore, it is in the interest of scholars to conduct future researches concerning these areas which would shed lights for the progression of industries as well as exerting benefit on the theoretical development.

### 3.3 Literature review summary

For the purpose of addressing practical challenges, this section has reviewed the associated academic literatures in searching for existing theories so as to offer solutions to the industry. Taking a multidisciplinary approach, two areas of business ecosystem and

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capabilities have been reviewed in detail that the relationships between these theories have become apparent. At the firm level, capability theories attempt to analyse the internal characteristics of firms to help them maintaining their competitive advantages, business ecosystem theories provide broad insights of their surrounding in assisting them making strategically sound decision while at the industrial level, capabilities theories aim to help firms within the industry in maintaining their competitive advantages with network capabilities from the firms' perspectives, business ecosystems theories on the other hand point out the importance of the supporting infrastructure for the development of the industry. At the business ecosystem level of analysis, it is clear that capabilities theories have not yet extended their theoretical boundaries to include the interaction between firms and industries with the supporting organisations such as the government, but it is evident that elements of their theories can be used in analysing business ecosystem. For instance, scholars such as Iansiti and Levien have recognised that business ecosystem capability exist and has used the concept to measure the health of the ecosystems through the dimensions of robustness, productivity and niche creation. As a consequence, following the evaluation of the current theoretical frameworks within these different disciplines, research gaps have been identified which the next section provides an in-depth discussion.

#### **4. Research proposal**

##### *4.1 Research gap*

From the preliminary case studies implemented, it is evident that one of the fundamental challenges faced by industrial players and governments in Shandong is their limited capabilities in technology, production and policy making to develop the industry. This has resulted in the situation where firms are trapped in the manufacturing of low-speed micro EVs only, without the ability to upgrade to markets with higher value while the government struggles to prescribe suitable policies in which the growth of firms and infrastructural support within the industry can be promoted. The importance of the capabilities of business ecosystems identified practically in turn lead to the interest in the current academic literatures concerning the relevant fields. As a consequence, the theories of business ecosystems and capabilities are reviewed. From reviewing the literature, it is apparent that despite the concept of business ecosystem has been researched for nearly two decades, the issue concerning the capabilities of business ecosystems are rarely touched upon. The closest to which is perhaps the robustness measurement of the health of business ecosystem by Iansiti and Levien that measures the capability of a business ecosystem when they are "facing and surviving perturbations and disruptions" (Iansiti and Levien, 2004). However, the detailed dimensions of capabilities and its maturity levels are not discussed. Furthermore, theories of capabilities such as the RBV, core components and dynamic capabilities all seek to understand the capabilities at the firm level whereas the issue of network capabilities which is associated with business ecosystem is underdeveloped. Therefore, the challenging issues faced by the industry cannot yet be solved using theories from the relevant academic disciplines due to the current research gap within the literature.

##### *4.2 Research questions*

Following the identification of research gaps based on the exploratory case studies and the literature review, the research question is formulated shown in Table II. The main research question is:

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*RQ1.* How to define and measure business ecosystem capabilities for the emerging EV industry?

The conceptual research framework shown in Figure 2 demonstrates the steps of this research toward answering the research questions. Based on the preliminary industrial findings, the core areas of a business ecosystem are mapped out. The capabilities of each of these core areas including supply, demand, interface and support are to be identified. Following the formulation of these dimensions, a capability maturity model measuring the maturity level of each stage of the business ecosystem life cycle is then developed. The stages of business ecosystem life cycle are based on Rong's (2011) classification including the phases of emerging, diversifying, converging, consolidating and renewing.

#### *4.3 Research process framework*

Before formulating the conceptual research framework and the research question, the process of this research is distinguished step by step. First of all, industrial review and exploratory case studies are conducted in order to identify the current industrial challenges. With these practical needs in mind, literature review is performed for the purpose of solving these problems through using current academic knowledge. However, as identified in the previous section, these industrial challenges cannot be addressed solely by reviewing the literature due to the current research gaps. Therefore, it is necessary to conduct research both to address the industrial need and at the same time enrich the theoretical foundations on the matter. Subsequently, the third stage of the research process is to develop the research design while formulating the research question where a conceptual research framework is also presented. The next stages are then to collect the appropriate data according to the decision on research methodology, implement detailed analysis and finally drawing conclusions from the research findings (Figure 3).

#### *4.4 Research methods*

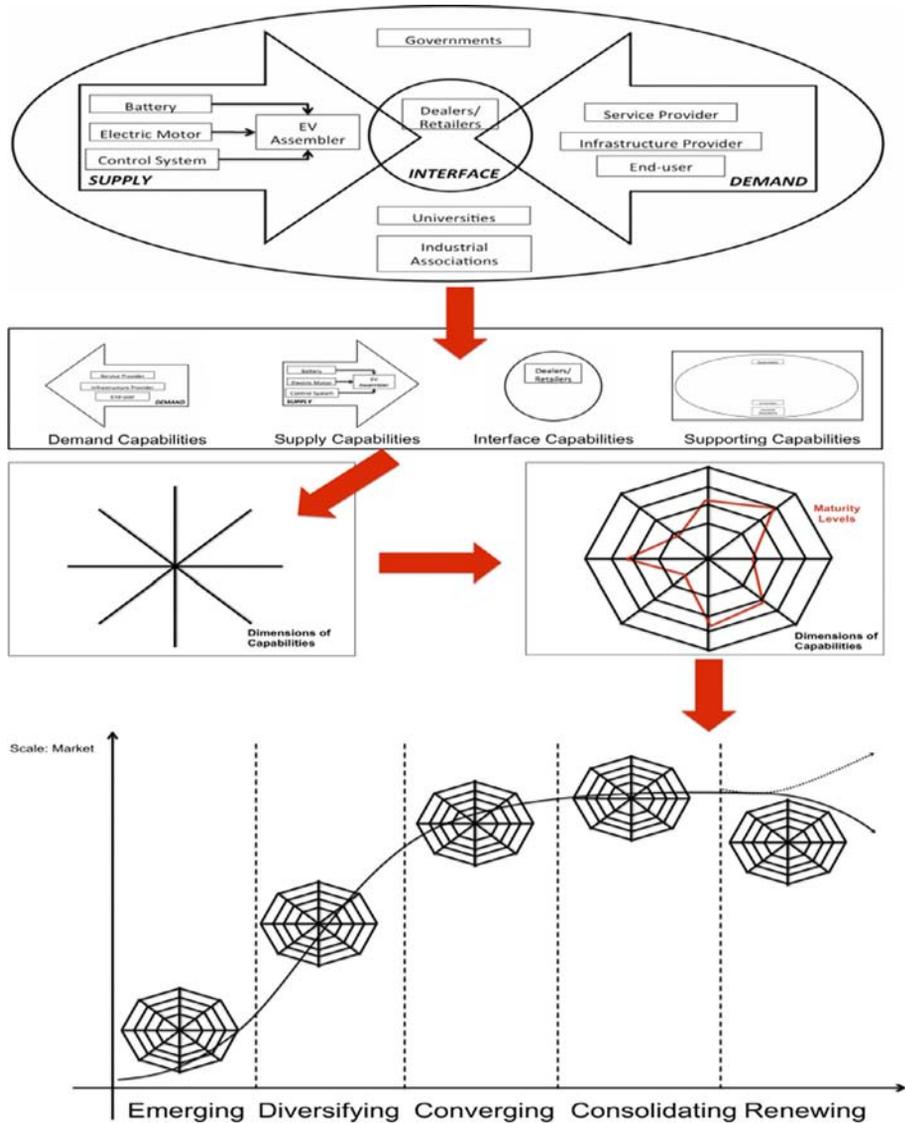
The exploratory and theory building characters of the proposed research point toward the method of case study (Yin, 2009). In fact, the justification in selecting case study is related to the complex and embedded nature of the research topic that a holistic and comprehensive examination is required (Eisenhardt and Marin, 2000). In order to understand and define business ecosystem capabilities, it is unavoidable to identify not only the capabilities at the firm level, but more importantly at the network level. For the research regarding network capabilities, insights could only be obtained through the deep understanding of interactions between case companies. Furthermore, the method of multiple case studies is chosen rather than single case studies due to the higher level of robustness along with its ability of generalisation (Herriott and Firestone, 1983; Yin, 2009).

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|               |   |
|---------------|---|
| Question      | How to define and measure business ecosystem capabilities for the emerging EV industry?   |
| Sub-questions | <ol style="list-style-type: none"> <li>1. What are the dimensions of capabilities in the four-core sections (supply, demand, interface and support) of the business ecosystem?</li> <li>2. How to define the dimensions of capabilities from each structural part along the business ecosystem life cycle?</li> <li>3. How to assess the maturity levels of the capabilities identified?</li> </ol> |

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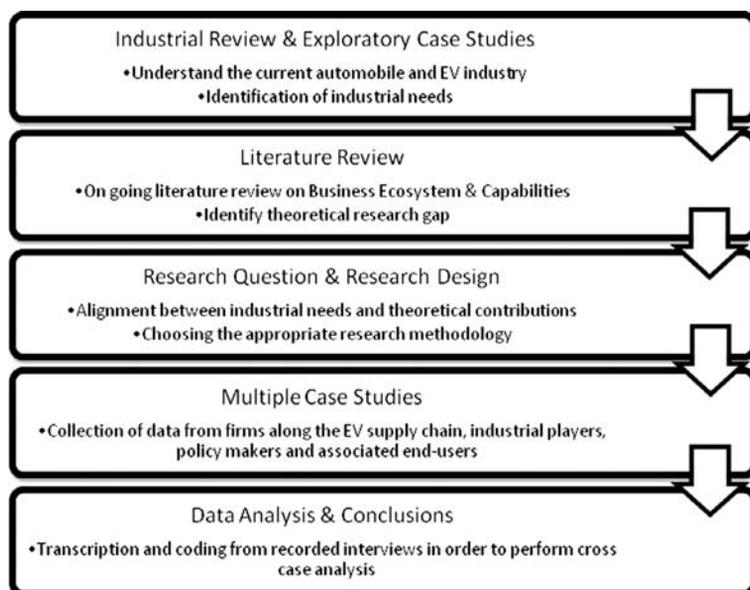
**Table II.**  
Research questions



**Figure 2.**  
Conceptual research  
framework

### 5. The next step

This research seeks to contribute to the theoretical development of business ecosystems in the emerging industry context while at the same time addressing the practical challenges faced by the policy makers and industrial players. Using exploratory case studies from the EV industry, the key issue of capabilities in affecting the advancement of this emerging business ecosystem is identified. Based on both the preliminary practical findings and the literature review, a conceptual research framework has been put forward with the objective of answering the proposed research questions.



**Figure 3.**  
General research  
process framework

Subsequently, the next step of this research is the data collection stage that multiple case studies are to be conducted with firms along the supply chain, service providers, dealers/retailers, research centres, industrial associations, governments and infrastructural providers within the emerging EV industry. The findings of this research proposal could theoretically enrich existing business ecosystem theories through the identification of detailed structures of the ecosystem as well as the capability dimensions at each stage. Practically, this research would be able to provide a tool for industrial players and policy makers through the formulation of a capability maturity model which allows the evaluation of the capabilities of the corresponding ecosystem players so as to permit the assessment of their positions with the provision of guidelines benefiting the advancement of emerging industries.

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#### **Further reading**

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