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# Competing and Co-existing Business Models for EV: Lessons from International Case Studies

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This paper presents four innovative business models that are being developed in three countries to support the commercialisation of electric vehicles (EV). Using an original business model framework and interviews with EV company founders and directors, we analyse the coexistence of competing business models (China) and partnership strategies along the EV value chain (US and France). Findings emphasise the importance of designing flexible business models and leveraging resources and inter-industry partnerships in the emerging EV ecosystem. The results provide practical recommendations for industrial players and insights for policy-makers.

## Introduction

In the last few years, climate change and energy security concerns have strengthened policy support for the electric vehicle (EV) industry as one pathway to reducing greenhouse gas emissions (GHG). However, many barriers to adoption still challenge the growth of the sector despite ambitious government targets: 5 million PEVs in China by 2020, 1 million in the US by 2015, and 2 million in France by 2020 (IEA 2012). Firms entering the EV industry have yet to define profitable business models that address these barriers while securing sustainable growth (Kley et al. 2011; Bohnsack et al. 2013).

Business models define how firms create and capture value from their product or service offerings, with particular attention to how they configure their activities with partners and suppliers and deliver value to a customer segment (Osterwalder et al. 2005; Chesbrough & Rosenbloom 2002). In the emerging EV industry, a number of these elements of the business model are still unclear – the value proposition, the target customer segment, and the relationships and roles within the value network.

Business model innovation has attracted attention in recent years as a source of competitive advantage in early-stage technological industries. Indeed, research has shown that business model innovation, i.e. the design of innovative business models (or change to existing ones), can often make the difference between innovations that are successfully commercialised, vs. those that stay on the shelf (Chesbrough & Rosenbloom 2002; Teece 2010). The importance of the business model is such that two different business models to commercialise the same technology can yield different outcomes (Chesbrough 2010). Ultimately, a good business model may be just as valuable as a good new technology, and “a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model” (Chesbrough 2010).

Given the challenges to reaching targets for EV penetration in global markets, this paper examines how business model innovation is helping companies overcome barriers to adoption

and enable value creation and capture in the sector. At this early stage of market and technology, a diversity of new business models is being implemented and experimented with. As (McGrath 2010) and others highlight, the early experimental stage holds important insights and sometimes critical lessons for firm success (Sosna et al. 2010; Chesbrough 2010).

In this paper, four cases of innovative business models around EVs are compared on the basis of an original framework developed from the academic literature and from original case study data. The four business models analysed in this article are EV sales with fast-charging (case 1: "BYD"), EV sales or leasing with battery-swapping (case 2: "Wanxiang"), high-end EV sales with fast-charging (case 3: "Tesla"), and electric mobility services (case 4: "Autolib") (Table 3). The focal company in each of these cases manufactures and/or supplies electric vehicles to consumers. The business models are discussed in terms of outcomes for consumers, the configuration of activities to realise the value proposition, and the relationships between the organisations involved in the value chain.

Our analysis shows a tendency towards new configurations of service delivery for EV with, for example, the bundling of vehicle sale and energy supply. In each of these cases, the focal original equipment manufacturer (OEM) started incorporating new services downstream from its original core business, either through a partnership/joint venture or through vertical integration of new capabilities. Partnership strategies along the value chain appear essential to solve the EV industry's problems. In the short term, as the industry searches for a "dominant design" (Suarez & Utterback 1995) in the charging services and vehicle technology, competing business models can co-exist.

## Literature Review

This paper draws on the strategic management literature on business models. The business model was proposed as a novel unit of analysis in strategy that spanned beyond the boundaries of a specific firm to define "a system of interdependent activities that transcends the focal firm and that enables the firm, in concert with its partners, to create value and to appropriate a share of that value" (Zott & Amit 2010). Though consensus has yet to be reached in the management literature on a common definition of a business model (Zott et al. 2011), a number of definitions converge in key areas: the existence of a value proposition, a customer segment, cost and revenue streams and a value network of partners around the focal firm (Bohnsack et al. 2013; Zott et al. 2011). One largely influential ontological framework is Osterwalder et al.'s (2005) decomposition of the business model into nine constitutive elements. Most of these are also found in the other dominant theory in (Chesbrough & Rosenbloom 2002) who highlight the following functionalities of business models:

- the value proposition;
- the customer market segment;
- the value chain;
- the cost and profit structure;
- the strategic position of the firm in a value network;
- the formulation of the competitive strategy.

The literature on EV strategy has also shown that the business model itself can be the subject of innovation (Zott et al. 2011), then called "business model innovation". Business model innovation can be essential to overcome the barriers to adoption of the technology (Bohnsack et al. 2013; Kley et al. 2011). Moreover, scholars contend that the ambidexterity approach of

achieving both continuous improvement of traditional business models and innovative business models is important for the development of the EV industry and learning capabilities are essential for the incumbent automotive firms concerning the discontinuous innovation from traditional vehicles to EVs (Fojcik 2013; Aggeri et al. 2009).

The challenges companies face in innovating and implementing new business models have been the subject of recent research (Chesbrough 2010; McNamara et al. 2011; Sosna et al. 2010). The EV sector is at an early stage of evolution where firms are designing and experimenting with diverse business models for commercialisation.

The EV sector is emerging with very diverse business models designed by companies to respond to the major barriers to EV adoption: limited driving range, limited availability of charging infrastructure, long recharging times, and high costs. New strategies for value creation and capture are also being implemented, for example by integrating EVs in mobility service business models or valuing them as resources for electricity markets (Kley et al. 2011; Sioshansi & Denholm 2010). However, at this early stage, viable business models for EVs have yet to be determined (Bohnsack et al. 2013).

This research expands the literature on business model design in an emerging industry by considering two central aspects of the commercialisation of a technological innovation: reducing the barriers to adoption and enabling value creation and capture. Within these broad functionality groups, we derive dimensions along which business models can be evaluated in the EV industry.

## **Framework**

Existing frameworks in the literature (Osterwalder et al. 2005; Kley et al. 2011; Zott & Amit 2010) provide conceptual representations which guide companies in thinking about the issues of business models. However, these frameworks are limited in terms of evaluating companies' strength or performance in the component areas and thus in providing grounds for comparison between various business models.

This paper uses previous literature on electric vehicles and business models to develop a systematic framework of barriers to adoption and enablers of value creation and capture. The objective of the framework is to help evaluate and compare the advantages of various business model configurations which are presented from our case studies. The framework is useful to make sense of the diversity of co-existing – sometimes competing – business models and to explore what “kind of business model configurations are possible within an industry”(McNamara et al. 2011). Similarly as in (Amit & Zott 2012), the framework is designed as an inquiry, through a number of questions to be asked by companies innovating their business model in the EV sector.

The framework allows each EV business model to be ranked according to 11 criteria that are compiled from the academic literature on technology adoption, innovation, energy policy, as well as industry and consulting reports. The five first dimensions have to do with how the business model addresses the barriers to EV adoption from the consumer perspective (Table 1). The next six dimensions relate to value creation and capture from the supply side (Table 2). The dimensions are presented in four quadrants that reflect the type of competitive advantage: business-oriented vs. customer-oriented and financial vs. strategic advantages. The research

framework is presented in detail in Tables 1-2 including a short description, main implications, and scoring scales of each dimension. Scores are attributed on a scale of 0 to 5 that represents the strength of the business model in each dimension of advantage. The scale distinguishes null, low, neutral, high and maximal (0-5) performance in each criterion. The dimensions and analysis method for the ranking is described in detail below.

The first six dimensions relate to consumer barriers to adoption (Table 1). Out of these, the first three dimensions evaluate how the business model addresses financial considerations for customers. The three major direct cost sources for EV customers are the battery, the vehicle (without the battery), and the price of electricity as a fuel (Andersen et al. 2009). As for customer exposure to electricity prices, a business model obtains a high score if the customer is protected from variable market prices. The scoring for this dimension was chosen for the cost advantage provided to customers in the short term. In the longer term, cost-based electricity pricing ensures an advantage for customers because a competitive efficient market for retail electricity services can only develop – for maximum social benefit – in the context of market-determined prices, i.e. if EV charging is done at market rather than at regulated prices. The fourth dimension of EV business models is that of risks for ecosystem actors, including consumers. Higher scores indicate that a firm takes on or reduces risk for other stakeholders in the ecosystem. The highest score is given to firms which distribute risks evenly in the ecosystem between the firm itself, its ecosystem members, and consumers. The nature of risks in the EV sector is multiple. The uncertainty of battery technology costs, lifetime, and development schedule are examples of technical risks. The failure of the EV market to take off is a market risk, as is the concurrent development of alternative transportation markets (e.g. fuel cells, liquefied natural gas, and hybrid vehicles). Systemic changes, such as macro-economic, environmental, and energy policy environments, may change the investment priorities at a global level and affect the EV ecosystem as a consequence. The fifth and sixth dimensions focus on two major barriers to customer adoption that are commonly cited by industry experts: EV limitation for long-distance travel and underlying change required in customer behaviour (Turrentine et al. 2007). Business models which offer solutions for long-distance trips as part of their value proposition receive high scores. The next dimension is a scale of change and adaptation required in consumer behaviour, similarly as in Kley et al. (2011), Business models that stimulate and support a shift in attitudes and behaviour score highest, while those that fit within customers' existing habits, i.e. business-as-usual, score lower.

The following five dimensions relate to value creation and capture for the supply side (Table 2). The three business-oriented, strategic dimensions of the framework are the ability to shape an innovative/competitive technological ecosystem (Adner & Kapoor 2010; Adner 2006; Geroski 1990), the explicit or implicit formulation of business model innovation (McNamara et al. 2011; Chesbrough 2010), and the openness of innovation in the business model (Chesbrough 2007; Christensen et al. 2005).

**Table 1. Business model innovation around barriers to consumer adoption**

Scale	Explanation/Criteria	Implications	Low score (0)	High score (5)
<b>Reduces battery ownership costs</b> (Andersen et al., 2009)	Who owns the battery?	- Technological risk associated with battery degradation and improvements - Capital costs	Customer fully owns the battery	Company fully owns the battery
<b>Reduces vehicle ownership costs</b> (Andersen et al., 2009)	Who owns the vehicle in the BM?	- Vehicle cost risk - Market risk associated with industry evolution	Customer fully owns the vehicle (- battery). Business-as-usual	Company fully owns the vehicle
<b>Reduces customer exposure to electricity prices</b> (San Roman et al., 2011)	Does the BM include the price of recharging, or do customers pay a fixed rate, or market prices?	- Fuel price risk - Elasticity of demand for electricity - Incentives for “smart” charging choices - Pay-back time of initial costs	Customers pay for electricity at market prices. Highest elasticity of demand and price risk.	The cost of electric recharge is fully included/covered by the supplier.
<b>Spreads risk across ecosystem</b> (Visnjic & Neely, 2011)	Who bears the risks in this BM – technical, market, financial, infrastructural?	The distribution of risks influences EV adoption and entry strategies	All risks of adoption accrue to consumers. Business-as-usual	Risks are distributed over different agents
<b>Advantage for long distances</b> (Andersen et al., 2009)	Does this BM resolve the issue of range limitation?	- Solution to a major barrier to EV adoption	The BM does not address the problem	The BM explicitly offers a solution for long-distance recharging
<b>Encourages change in consumer behaviour</b> (Turrentine et al., 2007)	Does the BM change the way people drive and attitudes?	- Market research and modelling; cannot treat driving behaviour as exogenous	No changes in consumer behaviour	Full range of changes: driving habits, attitudes towards personal vehicles and mobility

**Table 2. Business model innovation to create and capture value**

Scale	Explanation/Criteria	Implications	Low score (0)	High score (5)
<b>Enables technological innovation</b> (Adner & Kapoor, 2010)	Does the BM allow for innovations in vehicle design, in battery technology, in charging networks?	Technology-based competition drives industry growth	The BM does not require or facilitate technological change	The BM requires significant technological change
<b>Clear formulation of business model strategy</b> (Chesbrough & Rosenbloom, 2002)	Does the company explicitly define its strategy as BM innovation?	Emphasis of entry strategy on technical vs marketing aspects may be a determinant of success	The BM and its innovative component are not addressed explicitly.	Explicit focus of the company on BMI
<b>Enables business model experimentation</b> (Chesbrough, 2010)	Is the BM flexible? Can it be adapted to new technological and market conditions?	BM flexibility improves firm resilience in a changing market	The BM requires irreversible actions	The BM can be implemented gradually and adapt to market needs
<b>Uses intelligent charging infrastructure</b> (Andersen et al., 2009)	Does the BM require smart charging and grid communication technologies to be implemented?	Arguably, ICT allows the full value creation and capture from innovations in the EV sector	The BM uses a “dumb” charging infrastructure	The BM requires smart controls for charging
<b>Servitized business model</b> (Tukker, 2004)	Does the BM create and capture value from services, e.g. mobility services?	Changes the value proposition and the revenue model	Vehicles sold as a product. Business-as-usual	Mobility as a service with maximum efficiency and optimisation

The role of information and communications technology (ICT) in new value creation and capture is considered in the next dimension. The co-integration of smart communications in the vehicle and in electric charging infrastructure is a source of complex value creation. ICT can be used to optimise vehicle charging (Madina et al. 2012) and to improve customer experience – which obtains a medium score on this ranking. Intelligent vehicle charging technology also has the potential to generate additional external value through the renewable energy storage and secondary energy market services. Business models that use ICT to pioneer this type of new value-creation opportunities with EVs obtain maximum scores on this dimension. Finally, financial value for the focal companies may be amplified as a result of implementing service-oriented business models (Tukker 2004; Visnjic & Looy 2013). Fully servitized business models score highest on this scale as they improve the creation of value for the customer and capture of recurring revenues for the firm.

It uses the business model as unit of analysis rather than focus on a single company and takes into account the ecosystem of companies involved in the realisation of a particular business model. It is therefore useful in this study where the aim is to investigate and compare “business models” rather than specific companies. The case studies presented in the following section will be analysed in light of the variables of the framework.

### **Case Study Selection**

The complex and exploratory nature of the research topic and the early stage of the EV industry justify the use of the case study method (Eisenhardt & Graebner 2007). Case study research is well adapted in exploratory research where theory is inductively constructed (Yin 1994). The international cases in this article have been identified through a review of the academic literature, published case studies, and specialised industry news sources.

Globally, countries that are leading the market, as evidenced by car sales but also by their emerging business ecosystems that display a diversity of entrants and of business model innovation, include the US, the Netherlands, Japan, China, France, and Norway.

Out of the business ecosystems in these countries, the case studies analysed in this article were chosen on the basis of three criteria based in theory on multiple case study research design and on business models. The first criterion is having a strongly innovative and contrasting business model as defined in the literature, i.e. diverse value propositions, customer segments, partners and value networks, and revenue and cost streams. Second, the cases were designed to be comparable in pairs, the first two illustrating examples of competing business models for charging, while the last two are extremes on the product/service business model continuum: high-end EV sales vs. integrated mobility-as-a-service. Third, the cases were selected for the range of strategies they represent in terms of firm mobility along the value chain: companies forming partnerships or vertically integrating certain functions (charging, customer relations).

The four business models analysed in this article are EV sales with fast-charging (case 1), EV sales or leasing with battery-swapping (case 2), high-end EV sales with fast-charging (case 3), and electric mobility services (Table 3). Each one of these cases is centred on a focal company that manufactures and supplies electric vehicles to consumers. In the first three cases, the focal company is an OEM with own production capabilities while in case #4 the focal company, Bolloré, manufactures EVs through a joint venture. However, these focal companies all have in common that they started incorporating new services downstream from their original core

business, either through a partnership/joint venture or through vertical integration of new capabilities. In the first three cases, the OEM has started providing charging services to their customers, by installing stations, designing and selling connector equipment, and offering contracts for electricity. The fourth case is an example of a firm that integrates the value chain even further downstream with mobility services.

**Table 3. EV business model case studies**

Case No.	Business model	Focal Company	Core Ecosystem Function	Partnership	Secondary Ecosystem Function	Market Presence
1	EV sales + fast-charging	BYD	OEM	Partnership with electricity supply company China Southern Power Grid	Fast-Charging	Shenzhen, China (Metropolitan area)
2	EV leasing and sales + battery-swapping	Wanxiang	OEM	Joint venture with electricity supply company State Grid of China	Battery-swapping	Hangzhou, China (Metropolitan area)
3	High-end EV sales + fast-charging	Tesla	OEM	NA	(Renewable) Energy supply; Fast-charging	California, USA (Regional)
4	EV car-sharing	Autolib' (Bolloré)	Mobility-as-a-service (Battery OEM)	NA	All from vehicle provision to customer relations (Vertically integrated)	Paris, France (Metropolitan area)

## Case Studies

This section provides the background and description of the case studies followed by the analysis using the framework. The level of government involvement in the business model differs in each case, but all 3 States (China, US, France) strongly support their automotive sector and EVs as a strategic industry to achieve sustainable economic growth.

## Context

China initiated research and development concerning the EV industry at the beginning of this century. Following the implementation of the "EV Key Project" and the "Key project of Energy-



saving and New Energy Vehicles” from the National 863 Program, the Ministry of Science and Technology invested around RMB 2 billion (€230M, \$320M) in the course of the tenth five-year plan and the eleventh five-year plan. In 2009, the Chinese government carried out the “Thousands of Vehicles, Tens of Cities” program. This is an EV demonstration project where subsidies are given to the 25 pilot cities to use EVs in the public transportation system (buses, taxis, government vehicles, cleaning vehicles and postal vehicles). Among the 25 demonstration cities, 6 cities were chosen as the pilot cities for private usage of EVs. Both Shenzhen and Hangzhou were chosen to conduct demonstrations programmes for both public transportation and individual EV purchases. The business models of their major local EV OEMs are discussed and analysed below.

The EV market in California has been through multiple phases of boom and bust before becoming the world’s most innovative EV ecosystem. In 2013, California alone accounted for 40% of all plug-in electric vehicles sold in the US, which represented nearly half of the global EV market. The EV market went through a first surge of interest in the 1990s, when the state passed the Zero-Emissions Vehicle Mandate (1990) which required the seven major automobile suppliers in the United States to derive at least 2% of their sales revenue from cars producing no emissions, i.e. electric vehicles, by 2003 to be authorised to continue selling gasoline powered vehicles in California<sup>1</sup>. Electric car models released at the time included the GM EV1, the Toyota RAV-4, the Ford Ranger Pickup, and the Chrysler Chevy S10. Despite strongly positive reviews, many of these EVs were recalled and destroyed, and California abandoned the zero-emissions vehicle (ZEV) mandate in 2003 following pressure from the Bush government. As of 2007, a new “boom” in the electric vehicle industry in California is occurring, with the formation of new entrants such as Tesla, Fisker (OEMs), Charge Point, 350 Green, and Clipper Creek (charging). Between 2007 and 2013, the government has been supportive in funding the EV industry in many ways, including loans such as the \$25 billion Advanced Technology Vehicles Manufacturing Loan Program for cleaner vehicles, the \$7,500 federal tax rebate on purchases of zero-emissions vehicles, California’s additional \$1,500 state tax rebate, as well as grants for infrastructure development. Additionally, California benefits from a consumer market that is highly receptive to new technologies, to environmentally and sustainably responsible consumption, and that tends to be “early adopters” (Rogers 2003). Both incumbent firms and start-ups encourages innovation as a major contributor to economic growth. Financial resources from investment funds and wealthy individuals in the Silicon Valley also help fuel the entrepreneurial culture and the development of new businesses that attract and retain highly skilled technical talent.

The electric car-sharing service Autolib’ was launched with the support of local municipalities in the Paris greater area to help reduce local pollution and traffic congestion by reducing car ownership. Autolib’ is Bolloré’s marketing message to the public that the transition to EVs is occurring, aiming to stimulate commercial demand for EVs. While Autolib’ directly results from local public policy, it was started in the context of French policies to support innovation and technological leadership from its automobile manufacturing sector, the second largest in Europe. The automobile industry in France represents 17% of total R&D spending (€5 billion) and more than 12% of France’s exports<sup>2</sup>. French automobile manufacturer Renault, one of the forerunners of the EV market, launched four EV models in 2011: the Fluence ZE (185 km range),

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<sup>1</sup> [http://www.huffingtonpost.com/jonathan-kim/let-california-lead-the-g\\_b\\_477691.html](http://www.huffingtonpost.com/jonathan-kim/let-california-lead-the-g_b_477691.html)

<sup>2</sup> <http://www.finpro.fi/documents/10304/799ceeb6-77e8-483f-8c65-4d388cefbccf>

the Kangoo ZE, the Twizy, and the Zoe (100-150 km range). In 2013, electric vehicle sales in France were the second highest in Europe after the Netherlands, with 14,905 units sold<sup>1</sup>. Various policies are in place to promote the emergence of the electric vehicle market, including a rebate of up to €5,000 on EV retail prices and an average emissions limit of 130 g CO<sub>2</sub>/km for new vehicles sold by 2015<sup>2</sup>. The electricity mix is also favourable to the diffusion of EVs in France, as 75-80% of electricity generated is from nuclear power. In 2011, the carbon intensity of electricity production was less than 100 g CO<sub>2</sub>/kWh, much lower than its European neighbours that average 443 gCO<sub>2</sub>/kWh. France is also a net exporter of electricity.

In the rest of the section we describe the four cases (Table 3) individually and rank and analyse them using the framework (Table 1-2).

## Description

**Case #1** (China, Shenzhen) Build Your Dreams (BYD) is a global player in the IT, energy and automobile sectors founded in 1995. The firm is a publicly listed company on the Hong Kong Stock Exchange with over 200,000 staff across 11 different sites in China. The firm has experienced doubled growth rate in 5 consecutive years and it was highly publicised when the subsidiary of well-known American investor Warren Buffet's Berkshire Hathaway Inc. purchased a 10% share of BYD in 2008. BYD specialised in mobile phone batteries in the early days, and the company has become the world largest rechargeable battery manufacturer in less than 10 years. The firm stepped into the automobile industry by creating a wholly owned subsidiary, "BYD auto" in 2003 after acquiring the Tsinchuan Automobile Company. By combining the battery technology it possessed and the production capability of automobile, BYD became a key player in the China EV industry. Since 2005, BYD has released 3 EV models, the K9, the F3DM and the E6. The K9 is a 12-meter pure electric bus with a range of 250 km per charge. The F3DM is a plug-in hybrid EV. In this case, we discuss how BYD entered a joint venture agreement with the China Southern Power Grid as part of a pilot project for fast-charging infrastructure and services in the city of Shenzhen in 2012. In fact, charging poles are constructed near the user's home once the EV is bought and this is implemented through the collaboration between BYD and the China Southern Power Grid. Furthermore, the joint-venture company between BYD and the China Southern Power Grid operates the electric taxis in Shenzhen.

**Case #2** (China, Hangzhou) Headquartered in Hangzhou Zhejiang, Wanxiang group is a multinational company supplying automotive components such as universal joints and bearings to over 40 countries around the globe. The group was the first Chinese private enterprise exporting automotive parts to the United States since 1984. Currently, Wanxiang's automotive product has a local market share of about 70% in China while cooperating with global leading carmakers such as GM, Ford and Volkswagen. As an automobile component supplier, Wanxiang started the research and development (R&D) on pure EV in 1999 by modifying traditional cars, and the company has successfully manufactured the first self-designed pure EV in 2003. Wanxiang Group has been concentrating on the development of EVs with a customized development roadmap of "battery-motor-controller-EV" such that the company has been devoting major resources on the research of the core key components regarding EV. Wanxiang is one of the main OEMs participating in the EV demonstration program in the city of

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<sup>1</sup> [ev-sales.blogspot.co.uk](http://ev-sales.blogspot.co.uk)

<sup>2</sup> EC 443/2009

Hangzhou. There are two types of EVs supplied by Wanxiang: electric buses and private EVs<sup>1</sup>. The electric buses were served as public transportations inside the exhibition areas during the Shanghai Expo. The private EV model HAIMA has a range per charge of 150 km with a charging time of 3 hours and a maximum speed of 110 km/h.

**Case #3** (US) Tesla is a start-up EV manufacturer founded around the launch of AC Propulsion's prototype sports electric car, the T-Zero, by successful entrepreneurs and investors in the Silicon Valley in the early 2000s. The four founders grew the company out of their personal investments and private equity and venture capital funding rounds between 2003 and 2008. Tesla produces two battery EV models, the Roadster (since 2008) and the Model S (since 2012) using laptop lithium ion batteries. The Roadster is a luxury sports with 350 km range car targeted at a high-end customer segment with high-performance vehicles, while the Model S is a sedan with up to 426km range. Tesla is therefore progressively entering the mass automobile market with the perspective to establish itself as one of the major OEMs. Furthermore, Tesla has expanded its value proposition by offering super-quick charging solutions (stations and connectors) to charge its vehicles at 120 kW (compared with 50 kW for usual "fast-charging"), i.e. the equivalent of 320km of range in 30 min. The company started building a network of these stations across North America and Europe, intending to enable their EV owners to travel uninterrupted for long journeys. Tesla has also built solar-powered fast-charging stations which provide energy to its customers in its sales area for free. Their strategy is discussed with a particular focus on their entry in the renewable energy supply function of the value chain.

**Case #4** (France) Autolib' is the case of a project commissioned by the Paris municipality to introduce car-sharing with EVs as a public transportation service in the city of Paris and over 40 municipalities in its suburbs. Within the public-private partnership, Autolib' provides all competencies in-house through subsidiaries of its parent company, Bolloré, from battery technology to maintenance and end-user services. The fully vertically integrated structure of the value chain is discussed in the analysis.

In both cases 1 and 2, an OEM has developed a joint venture or cooperation with a major electricity supplier to develop its vision. Cases 3 and 4 represent two ends of the spectrum for the provision of EVs to the consumer market: direct vehicle sales focused on high-performance technology and mobility-as-a-service, focused on customer outcomes and value-in-use of the vehicle. The evolution of these competing and complementary business models is discussed.

## Analysis

### BYD's business model (Fast charging) - Shenzhen

BYD is participating in Shenzhen's demonstration project for both public transportation and private purchases. BYD formed a joint-venture company with China Southern Power Grid to operate Shenzhen's public demonstration project that uses the BYD E6, five-door hatchback EVs, as taxis. The joint-venture company has also built a centralised charging station for the taxis. Concerning private purchases, BYD offers both F3DM and E6 for sale. Moreover, BYD builds two charging posts for free at the location of consumers' preference. The free establishment of charging infrastructure is a result of the collaboration between BYD and the

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<sup>1</sup> Wanxiang's passenger EVs are not used in the Hangzhou taxi fleet as opposed to the case of BYD. The EVs produced by Wanxiang are part of the demonstration programme for private purchases, while the participating OEM supplying electric taxis for the Hangzhou demonstration programme is Zhongtai.

electricity providers in Shenzhen. The business model of BYD does not directly reduce the cost of the battery (0/5) or address the upfront cost of the vehicle. However, subsidies for vehicle purchase have been granted from both the central and local governments who partner with BYD in the demonstration programme – this indirect solution to high vehicle costs, is attributed a score of 2/5. The cost of electricity for EV users is already very cheap (approximately 10 pence per kWh) and subsidised in Shenzhen – a score of 2/5 (low – neutral) is given on the dimension of customer exposure to electricity prices. BYD is collaborating with infrastructure and electricity providers, but the traditional nature of its business model of selling EVs as a product does not distribute risks across ecosystem players. Concerning the dimension for long distance travel, BYD receives 4/5 due to the development of its F3DM model, which enables long distance travel through the hybrid system. However, both products (E6 and F3DM) do not encourage fundamental changes in consumer behaviour (2/5). Its approach to EV commercialisation has triggered some degree of technological innovation for other EV industrial players through its collaborations within the EV ecosystem in the region. The charging technology is compatible with alternative charging infrastructure and other vehicle models. However, BYD follows a closed innovation approach for its battery technology, which limits complementary and upstream innovation. The business model therefore receives a neutral to high score (3/5) for the dimension of “enabling technological innovation”. BYD has a clear formulation of its business model strategy which scores 4/5. Through its recent deals to sell EVs for commercial fleets to international markets, BYD demonstrates the flexibility of its business model (4/5). BYD is developing software to improve its vehicles, such as an eye movement detector to prevent tired driving, but is not using smarter ICT as an enabler of new opportunities in the vehicle – grid integration – it receives a score of 3/5 on this dimension. On the dimension of servitization the business model is entirely product-based (0/5).

### **Wanxiang’s business model (Battery swapping) - Hangzhou**

The business model of Wanxiang focuses on battery swapping and offers a battery rental model. The HAIMA EV manufactured by Wanxiang Group can be rented from retailers at a monthly cost (without the battery) while the battery can be rented from the State Grid on a monthly basis (costing around £200 or €330 per month). However, during the first 3 years or 60,000 km following the EV purchase, customers enjoy free battery usage and swapping services through a government subsidy. As a result, the upfront cost and the usage cost of the EVs have been significantly reduced. In addition, Wanxiang is cooperating with the State Grid on developing a standardised EV battery pack that enables a quick system for battery exchange in the station operated by State Grid in Hangzhou. Wanxiang’s business model effectively incentivises consumers to adapt their behaviour and thus receives 5/5 on this dimension while reducing the costs of battery (5/5) and vehicle ownership (5/5). At the same time, customer exposure to electricity prices is also reduced through the swapping services subsidy (4/5). It scores 3/5 on spreading uncertainties across its EV ecosystem because while the risks of EV users have been reduced and the company is actively collaborating with the state grid, Wanxiang is still bearing a substantial amount of risk due to the high investment nature of this emerging technology. In the nascent EV market, as there are not yet enough battery swapping stations outside of the city, the battery swapping model means that EV users are restricted to operating within a certain range from the swapping station zone in Hangzhou, therefore the dimension concerning advantage for long distance travel receives 1/5. Wanxiang has formulated its business strategy clearly through working in collaboration with the State Grid, receiving 4/5. Due to the sunk costs in the co-development with other ecosystem players of the battery swapping standardisation and infrastructure, Wanxiang’s business model has the

disadvantage of restricting alternative business model experimentation (0/5). The business model uses intelligent charging infrastructure to schedule charging in order to efficiently supply the swapped batteries and therefore scores 4/5 on this dimension. The business model is different from a business-as-usual model of EV product sales through a change of value proposition to swapping and leasing and thus scores 4/5 on the service business model dimension (Figure 2).

### **Tesla's high-performance EV manufacturing- California**

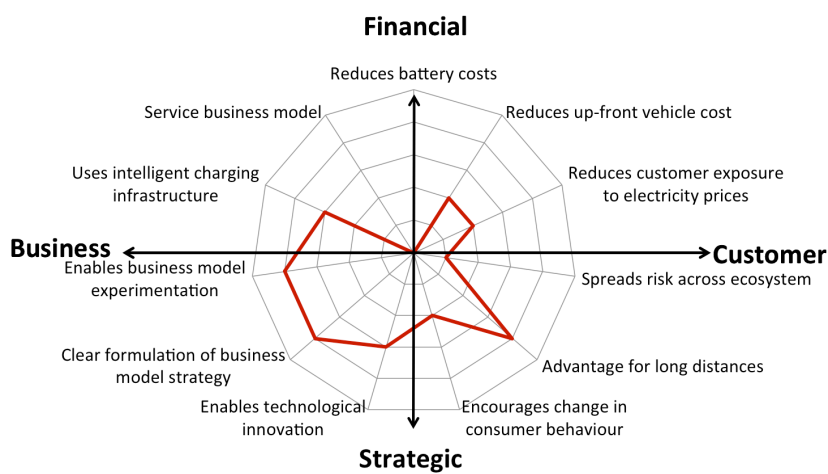
Tesla's business model does not address battery and vehicle costs and therefore receives 0/5 on these dimensions. However, their research and development (R&D) in battery technology indirectly contributes to overall reductions in battery costs. Tesla's entry into electricity provision with free solar-powered fast-charging contributes to reducing electricity prices to customers, but only for a small proportion of their charging needs at the Tesla stations. It does not otherwise deal with the costs of charging for consumers – it receives a neutral score (3/5). The business model focuses on high-end vehicle manufacturing and sales and does not have any particular focus on decreasing technology or financial risks for customers. Tesla's business model has changed consumer attitudes towards electric or private transportation without aiming to lead any behavioural or societal changes in the way people drive or perceive private car ownership – it therefore receives a neutral score (2/5) on the dimension of customer change. By providing the highest range EVs in the market and fast-chargers, Tesla's value proposition serves long distance travel well and scores 5/5 on this dimension. The business model enables technological innovation in the rest of the ecosystem, complements, components and alternatives, by focusing on a particular part of the value chain independently of others, receiving 4/5. The business model strategy is clear on all aspects (cf definition) as can be expected from its experienced entrepreneurial founder and receives 5/5. Though Tesla has focused on a specific niche, the business model is flexible enough to be adapted to changing market conditions (4/5). The EVs are compatible with intelligent charging infrastructure though it is not intrinsic to the business model, thus receiving a neutral score on the use of ICT (3/5). The value proposition contains a service offering with the fast-charging system, however the main focus is on the EV product rather than a service business model, leading to a low-neutral score of 2/5 on this last dimension.

### **Autolib's E-mobility service - Paris**

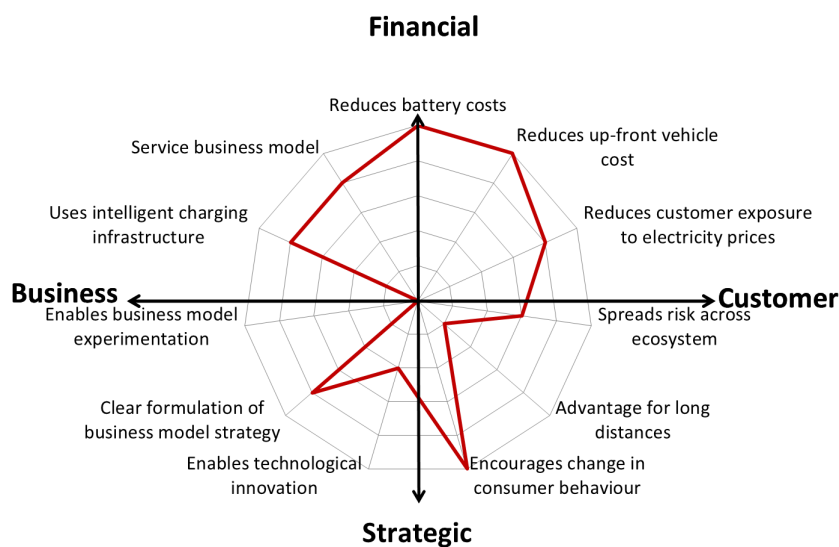
The electric mobility service company Autolib' in France obtains the highest possible scores (5/5) in terms of customer financial dimensions: with the all-inclusive service package, customers pay a tariff in two components, a membership fee and a time-of-use rate. The business model therefore removes the cost burden of vehicle purchase, battery costs, and electricity prices from the customer onto Autolib'. The service is vertically integrated, i.e. all elements from vehicle concept and design, to call centers and electricity charging and billing services, are provided by Autolib' and its subsidiaries. Part of the financial investment cost falls onto the participating municipalities. Therefore, a large share of the risks associated with EV technology, market evolution and infrastructure fall onto Autolib' alone. Though the business model prevents all of these risks from falling onto the customer, it scores neutrally (3/5) for not distributing the risks amongst many ecosystem players. The service is limited to urban areas and does not allow long distance travel (despite the high range of the battery of 250 km) and thus scores 0/5 on the associated dimension. This mobility-as-a-service with electric cars requires significant change in consumer behaviour. However, the goal of Autolib' is not to cause this change but rather to take advantage of an observed trend towards services in

private transport, therefore it scores a 4/5. The closed business model as is does not encourage external or internal technological innovation. However, if the management decided in favour, it could change some elements of the business model, such as letting other OEMs to supply vehicles to their platform, thus a score of 1/5 is attributed. Autolib' have been experimenting with some aspects of the business model such as opening the charging platform to private EVs. However, the score for business model experimentation is a low-neutral 2/5 due to the inflexibility of the Autolib' car-sharing system itself. The business model strategy is mostly explicitly formulated though the profitability and revenue streams which are important components of business models, do not seem to be a priority (3/5). The system does not currently use "smart charging". It is a 100% service business model and obtains 5/5 on the associated dimension.

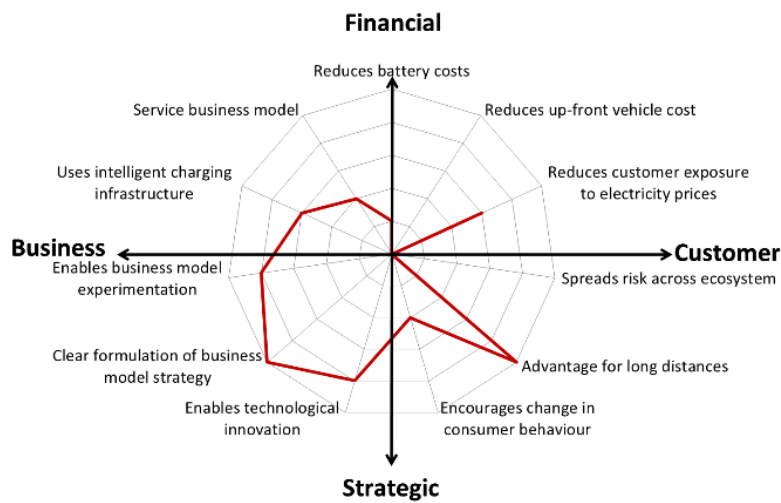
**Figure 1. Framework analysis of BYD's business model (fast-charging)**



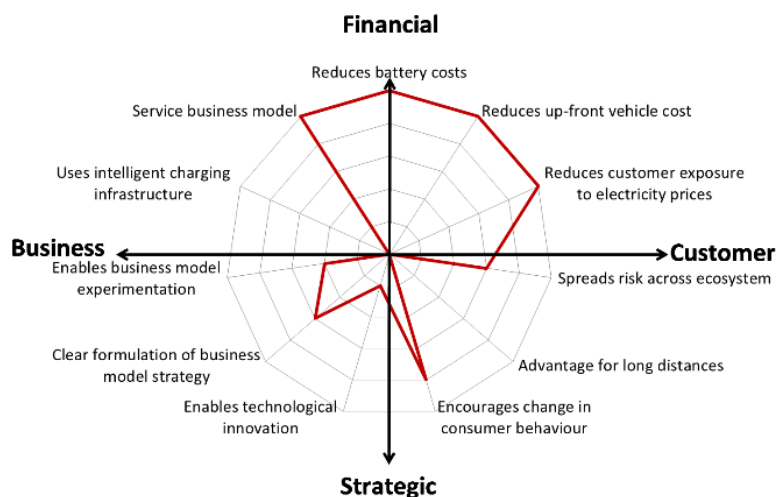
**Figure 2. Framework analysis of Wanxiang's business model (e-mobility services through battery swapping)**



**Figure 3. Framework analysis of Tesla's business model (high-performance EVs and free fast-charging)**



**Figure 4. Framework analysis of Autolib's business model (E-mobility services in urban metropolis)**



### Cross-case analysis

Four radically different business models (BYD, Wanxiang, Tesla, and Autolib') have been analysed using the framework tool. The benefits of the battery-swapping (Wanxiang) and mobility service (Autolib') business models seem to be weighted towards solving financial issues and customer barriers to adoption, and monetising value through service revenue for the company. In contrast, BYD's and Tesla's strengths lie in the business-strategic quadrant, due to their expert understanding of entrepreneurship and of the importance of high-performance innovation in establishing competitive leadership. Both start-up EV OEMs are moving into providing fast-charging infrastructure services to support their products.

These cases in emerging EV ecosystems show examples of companies that are succeeding at providing EVs and/or EV-related services while the rest of the market is still very immature. In

practice, Autolib' which started in 2011 already achieved 30,000 premium subscriptions by April 2013 of the 80,000 it planned to reach by 2018 -- nearly 40% of the way in 25% of the time it set itself to reach its financial objectives. Tesla, founded in 2003, just announced its first annual profit in 2013 and continues expansion plans, including the release of a new model in 2015, the Model X, a cross-over utility vehicle targeted at a mainstream market. Concerning the two Chinese EV OEMs, BYD, recently has secured a number of international contracts to supply electric vehicles (for cities such as London, Los Angeles and Bangalore) and Wanxiang has successfully acquired the battery company A123 and an EV OEM Fisker from the US. Both companies and ecosystems are growing and proving to be successful in the short term. In the case of Autolib', business model innovation in the car-sharing system has clearly contributed to the growth of the EV ecosystem in France.

The differences in institutional environments are striking and the role of local, regional and/or national public authorities differs across these cases. Autolib' benefits from the financial support of local municipal authorities (Autolib' 2013). Tesla benefits from federal and state support in the form of financial subsidies and R&D grants as well as favourable policy. Tesla additionally benefits from a financially active technology innovation cluster in the Silicon Valley and. BYD and Wanxiang's EV projects have been encouraged by the local and central government through financial subsidies and supported by the collaborations between the demonstration program office and their electricity infrastructural providers locally. In all cases, end-users tend to be progressive early adopters and environmentally aware.

In conclusion, the cocktail for success in each of these cases with contrasting approaches, was the following:

- Specialised "capabilities": focus on strengths in a particular area, either focus on the end-user experience or on the competitive strategy; each business model occupies the same total area on the figures, but in different quadrants of the framework
- A favourable context for innovation, either supported by the State (France) or by the entrepreneurial culture and community (Silicon Valley)
- A market of customers relatively receptive to innovations, particularly environmental ones.

The framework was designed to represent all the potential strengths of business models in the EV ecosystem. However, the cases have shown that strengthening one's position in a few specific areas is enough to have a viable business model. We suggest that the four companies could improve their business models by considering other aspects of the framework that they didn't previously focus on. Tesla, for example, has started thinking of consumer experience and barriers to adoption by offering fast-charging services; they could progressively increase their value proposition by offering innovative solutions around battery costs and smarter energy management. Autolib' could also increase their use of ICT and smart charging systems in their service though some dimensions, such as the range of travel for users, have limited opportunities for improvement.

## Discussion

From the cross-case analysis, the business models of BYD, Wanxiang, Tesla and Autolib' have been analysed through the framework put forward by this paper. It is evident that BYD and



Tesla performed better in the business-strategic quadrant while Wanxiang and Autolib have more strength in solving the adoption barriers in terms of the up-front financial concerns for EV purchase. This section of the paper discusses the implications of the analysis concerning the four contrasting business models.

### **Competing vs. co-existing business models**

From the case studies of BYD and Wanxiang, we have observed competing business models for charging systems, fast-charging and battery-swapping, operating in two cities in the context of Chinese government demonstration programmes. While BYD (working in collaboration with the Southern Grid) are developing a fast-charging business model in the city of Shenzhen, Wanxiang (working with the State Grid) on the other hand are seeking to implement the battery-swapping model in the city of Hangzhou. Compared with BYD, the battery-rental model of Wanxiang has certainly shown strength in reducing the financial barriers of the high upfront cost for potential EV users. However, it is unclear at this stage whether this business model would be sustainable in the long term without the government subsidy for the cost of batteries and the battery-swapping stations operation. Through this country-wide demonstration programme, the government is able to encourage different types of business models to compete and evaluate against the advantages and disadvantages of each, so as to deploy a wider infrastructure project for EV emergence for the next stage of its industrial development.

### **Partnership strategies along the value chain**

Tesla focused on producing highest quality EVs in the sports car market at first and then expand their target with a mass-market EV. Tesla started investing in solar-powered fast-charging stations, a move downstream into providing electric charging services, perhaps in reaction to insufficient dynamic competition in the charging infrastructure sector. This case shows that it is possible to remain an aggressive competitor with a very targeted strategy – become the leading entrant in EV manufacturing – while leaving opportunities open for other ecosystem competitors around it to develop, whether in the vehicle sector or in downstream charging and mobility services. In comparison, Better Place<sup>1</sup>'s strategy implied asphyxiating any other competing business model at the level of charging services.

In contrast, while Autolib', Wanxiang and BYD's vertically integrated organisational structure may have been effective at launching the service quickly, it prevents competitive ecosystem for similar or other types of EV services from developing. The "in-house" strategy is advantageous in the medium term but once the market evolves with new demands and innovative alternative services, the business model will be threatened.

### **Recommendations**

Our two main recommendations based on this research and the "cocktail for success" for entrants in the EV industry at any level of the value chain, are the following:

1. Leverage ecosystem resources
2. Capitalise on your specific competencies, then expand your value proposition.

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<sup>1</sup> Better Place is a battery-swapping company founded in California that pursued an aggressive fundraising strategy that filed for bankruptcy protection in May 2012.

- **Leverage ecosystem resources**

Companies that will succeed in the EV ecosystem will be the ones that are able to envision a shared future for the ecosystem as a whole and build strong partnerships and alliances with both complementor and competing firms. In defining a strategic positioning and value proposition for EVs, whether it is in selling EVs and providing charging services, or selling electricity and providing additional services such as smart home energy management systems, companies must fully map out the resources and capabilities of the network of firms around them. Designing a business model that is compatible with other players in the ecosystem and that makes best use of their capabilities is essential.

Autolib' in France, for example, leveraged its internal knowledge of lithium metal polymer battery technology (Autolib' 2013) as well as its capabilities from its parent company (Bolloré)'s subsidiaries: IT services, infrastructure and logistics, while building partnerships to integrate external competencies in vehicle design and manufacturing. BYD and Wanxiang, as OEMs who realised the necessity of building a charging network to support their EV sales, entered partnerships with utility companies to leverage their competencies in energy infrastructure and services. They both also leveraged the support from local and central government. Tesla started its operations in California, where the favourable investment environment due to a successful entrepreneurial culture supports competitive and dynamic innovation in the area. Mobility service company Move About, for example, developed its corporate EV sharing service in Norway, where tax and others benefits for EVs have favourable impacts on their market success either indirectly or through direct financial impacts (Move About 2012). These examples highlight that understanding the socio-political context for EVs is a key part of an ecosystem strategy.

- **Excel in specialised competencies, then expand the value proposition**

All cases start out in niche markets and have different expansion strategies and potential. Autolib' will use its battery technology in markets for energy storage and services (Autolib' 2013), while its mobility service know-how will help it replicate its business model in other cities and countries, either through the provision of consulting services or through direct involvement. Wanxiang is aiming to consolidate its EV supply chain through increasing its control of the core component manufacturers through acquisitions of lithium ions batteries companies (e.g. A123 in the US). Tesla is exporting its mid-range Model S worldwide and can expand its manufacturing base to meet increasing demand. As mentioned previously, Wanxiang, Tesla and Autolib' succeeded in establishing an EV business by focusing strongly on a specific area of strength: customer-centric Wanxiang and Autolib' address customer financial barriers to adoption of EVs, while entrepreneurial Tesla and BYD built an effective business strategy.

The third recommendation is therefore to incorporate new competencies identified from the framework into the business model. For example, a company that has been particularly good at designing the customer experience should think of focusing on business strategy and financial advantage dimensions, e.g. by developing optimisation systems with intelligent charging networks, or transitioning into service revenue models.

## Generalisability of findings

While each of the company strategies was embedded within a specific socio-economic, political and environmental context, which allowed for very different business models for EVs to emerge, the main recommendations above are applicable to all settings of EV ecosystem emergence. The framework offers a comprehensive way of thinking about business models in the EV ecosystem: from the consumer and the business perspective, and including strategic and financial value. It integrates views on barriers to adoption and enablers of value creation and capture. While the business models in the cases would not work directly (as they are) in other countries or cities, companies in other locations can assess their strengths and strategic objectives in comparison with them. In addition, demonstration programmes using competing business models are recommended in the early stages of industrial development to develop co-opetition in the EV ecosystem. A common result in all of these cases is that customers use EVs and have their charging requirements covered. This is the result of business model innovation and the reconfiguration of actors and their roles in the value chain that enable this joint value proposition to be delivered to the user.

## Conclusion

In summary, this paper has explored a spectrum of business models operating in the current EV sector. Employing an original business model framework developed through literature, four case studies of BYD, Wanxiang, Tesla and Autolib' (from China, the US and France respectively) have been analysed. From the cross-case analysis, we have gained insights on the competing business models of fast-charging and battery-swapping between BYD and Wanxiang and their co-existence in the context of the Chinese government demonstration programmes. Moreover, the partnership strategies within the EV ecosystem of Tesla and Autolib' has provided learning points regarding the ways in which organisations configure their position and relationships in seeking to lead EV ecosystem emergence. Concerning the business model framework, both Autolib' and Wanxiang have demonstrated strength in the Financial and Customer dimensions through the benefits of mobility-as-a-service and battery-swapping. In contrast, BYD and Tesla obtained higher scores in the business-strategic areas because of their entrepreneurship driven ethics and their goals in achieving high-performance innovations. Through these analysis, we provided two recommendations for industrial players who are seeking to operate in the EV ecosystem: 1) Leverage the ecosystem resources and 2) Capitalise on your specific competencies and then expand your value proposition. As a result, the paper has offered practical contribution concerning the development of a multi-dimensional framework as a tool to help firms in the EV ecosystem systematically evaluate their business model propositions.

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