Digital Transformation and New Business Models in Urban Mobility: The Case of Carsharing in Brazil

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***Abstract*—Digitalization has brought new business opportunities, leading to profound changes in how organizations create, deliver and capture value in their respective markets. Carsharing is no different. Having first appeared as grassroots initiatives in small European communities, operations in carsharing were analogic, from vehicle access to control and management of the fleet. With digitalization, the activity has gained momentum, and new business models have emerged, including those which do not require and own car fleet. In Brazil, carsharing businesses have developed in the past decade. However, there is a lot to overcome, with just a handful of carsharing operators (CSOs), a list of as many closed companies, and lacking adequate regulation and supporting public policies. In this paper, we discuss the primary resources and competencies that have been mobilized by Brazilian CSOs operating under distinctive business models. Based on in-depth multiple case studies, we analyzed four Brazilian CSOs, according to the main elements defined in the Business Model literature (Chesbrough, 2007; Teece, 2010). Findings reveal a general reliance on cloud computing, smartphone applications, and competencies related to software development and data analytics. Nonetheless, the importance of resources such as owned car fleets, onboard hardware, and parking spaces differ between operators.**

I. Introduction

Understood as a process in which organizations use technology to radically improve their performance or reach [1], Digital Transformation (DT) has gained prominence among scholars and practitioners in recent years. Different from digitization which started with the first mainframes in the 1960s [2], DT brought profound implications to how businesses create, deliver and capture value, tensioning established architectures and forcing business model experimentation [1], [3]–[6]. For example, Apple, IBM, and General Electric are mobilizing technologies like cloud computing, the Internet of Things, artificial intelligence, and machine learning to design new services that could better address customers' needs and allow new revenue streams [7]–[10].

Scholars have explored the DT phenomenon throughout many sectors, such as banking [11], health services [12], manufactured goods [13]–[15], media and publishing industries [15]–[17], commerce [18], and transportation [19], [20]. In the latter, new business models (BMs) under DT are gaining room among other modes of transportation. Ride-hailing services (*e.g.,* Uber, Cabify, and Lyft), bike sharing (*e.g.,* Grin, Nice Ride, and Yellow), and carsharing (*e.g.,* ShareNow, Zipcar, and Turo) are often viewed by policy-makers as a complement to traditional urban transport systems with the potential to reduce car emissions and congestions inside urban areas [21]–[23].

Automakers such as Mercedes-Benz, Ford, Hyundai, General Motors, and BMW are already present as carsharing operators (CSOs), offering on-demand mobility through a shared car fleet for customers interested in covering last-mile travels inside the urban perimeter. Startups like Turo and Getaround also entered the market offering peer-to-peer carsharing, a leaner approach to service provision in which CSOs intermediate carsharing transactions between users [24]. Different from what previous CSOs had mobilized since the late 1940s [25], the newly formed operators are extensively using smartphone applications alongside digital platforms to deliver value to customers and improve value propositions from booking, tracking to payment, and remote access.

In Brazil, carsharing appeared around 2010 with a small business named Zazcar [26]. Since then, many other small operators have started in the country. To name a few, Fleety, Joycar, Olacarro, Urbano, and Parpe. However, there is a lot to overcome, with just a handful of CSOs, a list of as many closed companies, and lacking adequate regulation and supporting public policies. In this paper, we address the following research question: "What are the main resources and competencies being mobilized by Brazilian CSOs for distinctive business models?". To answer it, we present the theoretical background used to lay our analysis in section II, followed by a definition for carsharing and its past and recent developments worldwide and in Brazil in section III. The method applied to conduct the study is presented in section IV. Results and an in-depth discussion are present in sections V and VI. Finally, we synthesize our main findings in section VII.

II. Theoretical Background

A. The Business Model concept

Practitioners and scholars have discussed the Business Model (BM) concept since the late 1990s during the emerging digital era [27]–[30]. Despite its already longstanding debate, there is no single definition of BM [31]. Some authors define it as being "logic" [32], "description" [33], "history" [27], "system" [34], and even an "architecture" [29], [35]–[37] of how an enterprise competes in a given market. The same can be said regarding BM's building blocks. According to their research objectives, different authors bring different components under BM's umbrella [31].

For instance, [33] considers that a Business Model "depicts the content, structure, and governance of transactions designed

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to create value through the exploitation of business opportunities." (p. 511). Content refers to what the firm mobilizes resources and competencies to operationalize a given activity. Structure regards to which stakeholders are related to the business. Finally, governance is derived from what type of hierarchy the previously elements are submitted.

Later, the same authors in reference [34] build upon their previous discussions suggesting another definition: "we conceptualize a firm's business model as a system of interdependent activities that transcends the focal firm and spans its boundaries" (p. 216). The activity system perspective considers that a given firm conducts a particular set of activities derived from existing resources and competencies under a specific structure and governance. Activities are linked in each structure with precise order and distribution among agents. Meanwhile, activities are governed through contracts, the market, or the firm itself.

References [32] and [38], on the other hand, describe BM as the underlying logic of how a given firm creates, delivers, and captures value. Reference [32] suggests that BM and strategy are connected, with the former being a partial materialization of the latter.

As a practitioner's publication, [27] provides a definition more abstract but not less important. For her, "(…) [Business models] are, at heart, stories – stories that explain how enterprises work." (p. 4). So, an efficient BM comprehends elements that compose a "coherent story" in the big picture and must make sense in their interrelations with each other, yielding profit to the firm.

Reference [27] also explores the differences between BM and strategy. While the BM is a story that explains how the firm operates in a given market, it does not consider the competition. In this sense, the BM is a static understanding of how the firm plays the game. On the other hand, strategy is a dynamic consideration of how a firm operates when it runs into competitors.

Notwithstanding the authors' contributions to BM literature, we need to cement our analysis on a single definition. In this matter, [39] presents a co-citation analysis involving the BM literature. This analysis presumes that as two works are cited together, the greater are the chances of both being correlated in content [40]. Thus, being able to build clusters from bibliographic data with co-cited papers, the authors in [39] use mapping and cluster analysis to determine the most influential publications. They find that both works of [35] and [29] are linked to a considerable number of clusters. In other words, even though different approaches and perspectives are being developed regarding BMs, both articles play an essential role in the literature, providing a theoretical basis to their discussions.

In [35], the authors revisit the Xerox case and its technological spin-offs. Being an innovative company in the past, Xerox managed to sustain a consistent portfolio of technological innovations, many of which were not adequately exploited by the firm. Xerox brought an innovative business model in the past that guaranteed its profits for a long time. The success, however, defined a dominant logic on how to do business that was not necessarily adequate to sell its new technological innovations. Discontent with how the company was handling its creations, some technical staff dropped the company to open businesses independently. The new businesses formed relied extensively on Xerox's "underexploited" technologies. While some spin-offs designed very distinct BMs to operate on the market, others stick to Xerox's logic.

Under this technological point-of-view, [35] defines BM as a "revenue architecture" that dictates how a firm exploits the latent value of a given technology. Therefore, a BMs is how a firm will capture the value created by technological innovation [41].

Teece [29] uses the same term "architecture" to describe a BM, but the author goes further than [35]. Teece revisits Netflix's example. The company thrived upon its main competitor, Blockbuster, through a combination of technological innovation and business model innovation. Avoiding the usual home video rental BM, Netflix reached a leaner cost structure and better customer value propositions. First, Netflix structured its BM to provide home video rental by mailing. So, it did not rely upon physical stores to reach its target. Customers ordered online and paid monthly to receive a fixed number of DVDs directly in their homes. The value proposition that emerged from this service configuration offered customers the possibility to avoid driving to physical stores and waiting in line to rent a single DVD.

Of course, technological novelty laid the ground for this new level of convenience [29]. To allow service offerings via its website, the company had developed a new technology that allowed customers to list their orders online. The new technology served as a basis to Netflix employ its BM, but it would mean nothing alone. It added other BM's elements, such as the subscription model and the online customer channel, to compose competitive value propositions [29]. Thus, Teece defines BM as being the "… architecture of the value creation, delivery and capture mechanisms employed [by the firm]." (p. 191).

Likewise, reference [35], the understanding of BM as an "architecture" evokes Magretta's definition of BM as a "story." It implies that both interrelations among elements and their final disposition matters to the big picture. At the same time, in considering it as being an "architecture of the value creation, delivery and capture" and not as a "revenue architecture", the author also implies that the BM can be the source of value itself [41]. Therefore, this definition gives room to the widely discussed technological innovation and business model innovation.

III. Carsharing: Past and Recent Developments

Carsharing can be understood as a service that "… provides customers with short-term access to a fleet of shared vehicles, thereby offering the benefits of private vehicle use while avoiding the burdens of vehicle ownership" [42]. During the late 1940s, grassroots initiatives in Switzerland were the first to introduce this concept to mitigate the economic hardships of post-war Europe [25]. Nowadays, however, carsharing is

notably different. Incumbents from traditional industries entered the market offering on-demand urban mobility services, employing large car fleets in multiple countries at once [43]. On the other hand, startups also joined as carsharing operators under traditional BMs – mobilizing a private car fleet –, and as digital platforms, intermediating transactions between car owners and mobility consumers [44]–[46]. Carsharing was transformed from small and localized initiatives that served restricted communities into a multinational venture addressing wider user groups [43], [47].

The underlying reasons for carsharing expansion can be traced to technological, economic, and institutional shifts that nurtured new BMs in urban mobility.

First, the adoption of digital technologies by CSOs allowed better value propositions. Since its inception, operators have maintained analogic interactions with their users. Vehicle access, for example, was made through manual key handover [25]. With the digitization of carsharing in the 1990s, operators offered instantaneous access through smart cards, smart locks, and later, smartphones. The latter even allowed customers to book and find near vehicles available using GPS [47], [48]. For CSOs, the new digital technologies also gave them tools to mitigate theft and vehicle damage, verify users' profiles, and analyze usage patterns to improve their services and better address different customer segments. A critical output derived from digitalization is the formation of the first digital platforms dedicated to carsharing in 2010 [45]. CSOs could assume an intermediary role in carsharing services through these digital communities without owning a single car for value creation and delivery [45], [48]. Instead, the business creates value through users interactions, leading to value cocreation [49].

Howbeit, technological shifts are not the only game-changer. To CSOs adequately capture value from carsharing, customers need to perceive the service as a valid alternative to their mobility needs [50]. Since the 2008's financial crisis, consumption has changed significantly. The new economic landscape made customers prefer access over ownership [46], [51], [52]. Today is not uncommon to "share" media, tools, rooms, and assets with strangers [44], [51]. Asset owners can capture value from an asset's idle capacity while consumers pay for a fraction of asset face value [51]–[53].

Carsharing was no different. Under the car culture, individuals perceive cars as extensions of their own identity [54], [55], and it is often related to freedom, independence, belonging, and danger [54]–[56]. Cars are perceived as a way to experience these feelings, even sustaining conspicuous consumption. Therefore, one may not understand car consumption by considering merely absolute and relative prices.

Mobility consumption changed under the new economic landscape and growing environmental awareness [57]–[59]. Instead of transacting property rights, consumers are choosing to pay for short-term access to experience the same sensations as before without the burdens of ownership [52]. Some operators incorporate this on their respective value propositions, offering a new way to experiment with different vehicles at any time [43].

At last, there are institutional changes that are promoting carsharing as a sustainable alternative to urban mobility, fostering its diffusion to other markets [59], [60]. Governments worldwide are changing how they design regulations and policies, considering the environment. The establishment of the Intergovernmental Panel on Climate Change in 1988 is an example of the growing environmental concerns among national governments. As a multisided effort under United Nations, IPCC offers Assessment Reports (ARs) regarding climate change to policy-making. From the Kyoto Protocol in 1997 to the Paris Agreement in 2015, IPCC's reports have subsidized countries' decision-making in mutual agreements to reduce local emissions [61], [62]. Other instances can also be observed in Europe with the European Green Deal and the USA with the Intermodal Surface Transportation Efficiency Act of 1991, which promotes and regulates the adoption of new modes of transportations in these regions respectively [63]–[65].

In 2010, Parisian city hall opened public bidding to establish carsharing services inside the capital's urban perimeter [22], [66]. Aiming to mitigate local greenhouse gas emissions, the public administration set a carsharing program with the Bolloré group named Autolib'. In its all-electric fleet composed solely by Bluecars, Autolib reached up to 4,000 shared vehicles and covered not only Paris but other cities around it as well. Although defunct in 2018, Autolib' is not the only recent example of carsharing integrated into public policy. In the USA, the San Francisco Municipal Transportation Agency provides exclusive parking spaces to CSOs in public streets [21]. Cities like Zurich and Basel in Switzerland, on the other hand, are following domestic policies in promoting sustainable cities, reducing energy consumption and waste [67]. Local policy-makers account for carsharing programs when designing urban policies to address future mobility demands.

Greenhouse gas emissions are not the only dimension policy-makers consider when promoting carsharing. According to the UN's report on world urbanization prospects [68], the world population living in urban areas corresponds to 55.30%, with estimates to reach 60% by 2050. Urbanization prospects are not limited to the already existing cities with over 10 million inhabitants (megacities) like New York, Sao Paulo, and Shanghai. It also comprehends the emergence of new megacities, mainly in Asia and Africa. Under the growing population, policy-makers foresee the need for alternatives to efficient urban transportation [21], [69]. New urban policies are adopting shared mobility – *e.g.,* carpooling, ride-hailing, bike-sharing, and carsharing – combined with traditional mass transportation services so to mitigate congestions and emissions [21], [70]–[72]. For carsharing, municipalities allow exclusive bus lanes and parking spaces, alongside full ticket integration to other modes of urban mass transportation such as trains and buses. All these changes in urban policy directly affect the value proposition in carsharing, transforming it into a more flexible and convenient service to users.

Despite the accumulated technological, economic, and institutional changes, carsharing is not mainstream yet. Ford experimented with its version of "Go Drive" in London during 2015 [73], [74]. However, the company called off its service in

the same year. Share Now, a joint venture between Daimler-Benz and BMW, was called off too from various cities across North America and Europe at the beginning of 2020, even before the Coronavirus pandemic [75], [76]. Operators could not reach a financially sustainable business due to high operation costs and competition with other already established shared mobility services (*e.g.,* Uber, Cabify, and Lyft). This landscape is also observable in Brazil. Since 2009, multiple CSOs – mainly startups – fluctuated in the activity. Some CEOs stated the same difficulties as their international counterparts. At the same time, they also pointed out other barriers, such as lack of interested investors, absence of proper regulation and support from the public sector, and weak demand.

A. Carsharing business models

Operators provide carsharing services through various BMs [45], [47], [48], [72]. Reference [45] suggest that carsharing BMs can be divided into (a) non-profit/cooperatives, (b) business-to-consumer roundtrip, (c) business-to-consumer point-to-point, and (d) peer-to-peer.

The first archetype refers to organizations cooperatively held by a group of individuals that maintain a car fleet for shared use. Being the first instances in carsharing, cooperatives were organized to address small communities' economic restraints and environmental concerns [45], [47]. Before carsharing digitization, customers accessed vehicles through manual key handover, and the CSOs managed their car fleets using reservation and roundtrip rentals. Users were required to book a vehicle for some time, use it, and return it to the same parking space they first initiated the service to end. Later, during the 1990s, cooperatives also adopted the new digital technologies in their offerings, allowing instantaneous access to their shared vehicles keeping their roundtrip nature withal.

Business-to-consumer (B-2-C) roundtrip emerged alongside with the digitization of carsharing [25], [45], [47]. This category refers to for-profit organizations mobilizing a private car fleet that offer services to final consumers. Operators require users to return the vehicles to the same starting position, likewise cooperatives. Scholars also suggested that B-2-C roundtrip operators have been using exclusive parking spaces both in public and private spaces [45], [47], [72].

In 2008, Daimler-Benz launched its carsharing service in Germany named "Car2Go" [43], [45], [77]. Different from what has been offered by previous operators until then, Car2Go did not offer roundtrip carsharing. Daimler's value proposition deepened carsharing service flexibility in offering "point-to-point" services (also known as one-way carsharing). Customers could use vehicles available in point "A" and park them on a different location in point "B", which allowed customers to pay only for their effective use of the car. At the same time, Car2go was the first CSO to use smartphone applications to deliver its service, allowing tracking shared cars via GPS and remote access to the fleet under a flexible reservation system.

Finally, the first peer-to-peer (P-2-P) carsharing appeared around 2010 [45]. Under this BM, operators assume an intermediary role between car owners and mobility consumers instead of mobilizing a car fleet. Through digital communities, P-2-P operators offer guarantees to both parties to engage in economic transactions with minimal asymmetric information [45], [51], [78]. Reference [45] pointed out that P2P carsharing was effectively roundtrip and required manual key handover between users.

Another paper that explores carsharing BMs is [48]. Building upon the erstwhile archetypes, the authors gathered data from 94 CSOs in Europe, America, Asia, and Oceania. They identified subtle differences among operators within the same archetype, which allowed them to design a taxonomy that could better illustrate the reality of carsharing operations.

Some CSOs under B-2-C roundtrip, for example, were mobilizing a heterogeneous fleet with multiple vehicle types, while others had a single-vehicle type. Operators under B-2-C one-way BMs could often designate specific locations to their shared cars (stations) or even allow customers to pick up and return the vehicles anywhere near their destinations (free-floating) since they respected local transit law. Among P-2-P operators, the authors identified two main variations. One that offered manual access to vehicles, as described by [45], involves key handovers between users. The other already automatizes vehicle access with the help of onboard hardware installed directly on users' cars to allow others to access it through a smartphone application remotely. Therefore, [48] proposed another categorization to carsharing BMs (Fig.1.).

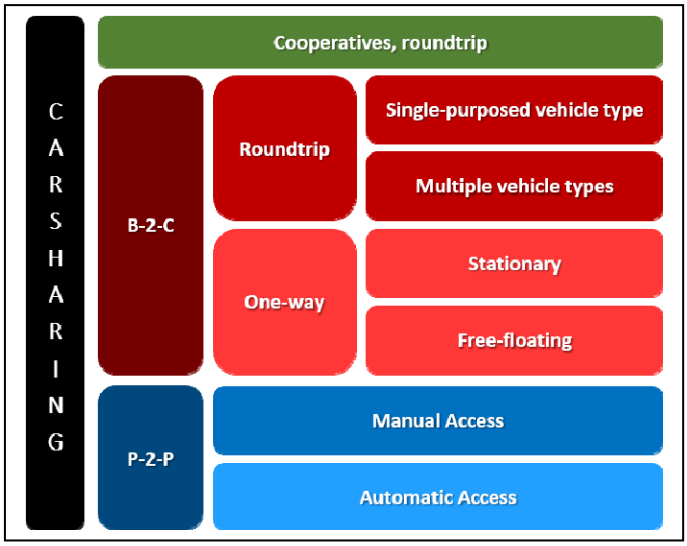

Fig. 1 Carsharing business models and their subtypes.

B. Brazilian carsharing in perspective

As aforementioned, carsharing emerged through cooperatives in Europe in small communities during the post-war period. In North America, dedicated operators started in the 1980s when university experiments and small enterprises initiated carsharing programs [25]. Two examples from this period are Mobility Enterprise, operated by Purdue University between 1983 and 1986, and Short-Term Auto Rental (STAR), a private company in San Francisco. In Brazil, however, carsharing only appeared in 2010 with Zazcar, a B-2-C roundtrip CSO which operated in Sao Paulo through 12 combustion vehicles [26]. Since then, many other operators

have appeared in the local market under B-2-C and P-2-P business models while no cooperative was held in the country [26], [79].

According to [79], in 2006, the total number of registered users worldwide accounted for 346,610 users, with Europe (61.19%) and North America (33.95%) being the most representative regions. Two years later, the total number of users almost doubled worldwide, and North America gained prominence, reaching 47.53%. Europe remained the leader withal with 49.82% of registered users. For 2010, North America slightly surpassed Europe with 48.26% against 44.18%. This year, Brazil started experiencing its first carsharing operations serving 110 users (0.009%) – all registered users in South America – while Asia already accounted for 81,812 registered users (6.54%).

The size of shared cars by cooperatives and B-2-C operators also presented a growing trend for this period. At the beginning of this time series, there were 11,501 shared vehicles worldwide, with Europe and North America leading with 7,491 and 3,337 cars, respectively. On the other hand, Asia held 608 vehicles (5.29%). Unlike registered users, Europe maintained the leadership until 2010, reaching 16,779 vehicles, North America (10,118) and Asia (4,315). Brazil held only 13 shared vehicles (0.04%).

The analysis conducted by [79] is limited, however. For Europe, the authors did not account for the UK, France, and Germany. The latter is one of the biggest carsharing markets in the world [47], [80]. In reference [47], the authors offer an in-depth analysis of German carsharing that highlights the importance of that market. According to the authors, 101 CSOs are operating in the country, with a significant number of cooperatives (51) and B-2-C roundtrip operators (43), with scarce instances of B-2-C one-way and P-2-P operators (see Table I).

TABLE I. CHARACTERISTICS OF CARSHARING BUSINESS MODELS IN GERMANY.

Business models	**Cooperatives**	**B-2-C roundtrip**	**B-2-C one-way**	**P-2-P**
Number of CSOs	51	43	4	3
Average car fleet size	11	200	1,642	5,006
Average number of cities served	1.2	7.2	3.5	National level
Fleet ownership	Fleet owned by the CSO			Cars owned privately
Fleet composition	100% varying cars	91% varying cars	25% varying cars	100% varying cars
Membership span	100% one city	77% one city 14% national 9% international	50% one city 50% international	100% international
Key partnerships	12% public transit 24% city-related partners	42% public transit 40% city-related partners 19% car-related partners	100% public transit 50% city-related partners 50% car-related partners	33.33% city-related partner
Operator background	100% non-incumbent	88% non-incumbent 12% incumbent	25% non-incumbent 75% incumbent	100% non-incumbent

The average car fleet size held by German cooperatives was 11 vehicles and served one city at a time through a heterogenous car fleet. B-2-C operators mobilized sizeable owned car fleets compared to cooperatives and served more cities simultaneously. Between B-2-C roundtrip and one-way operators, car fleet composition differs significantly. The former tended to hold more heterogeneous car fleets than the latter. P-2-P operators covered all of Germany with an average of registered vehicles around 5,000 from various models. Except for P-2-P operators, all CSOs analyzed by the authors owned the vehicles employed in their fleets.

In terms of partnerships, 12% of German cooperatives mobilized partners within public transit (*i.e.,* trains and bus transportation companies), and 24% interacted with city-related partners (*e.g.,* municipalities, local utilities, and building associations). B-2-C operators maintained higher levels of engagement with public transit and city-related partners, while only one P-2-P operator was partnering with city-related organizations.

Reference [81] updated the information regarding the number of registered users and the size of the shared vehicle fleet of B-2-C carsharing in America. Brazil counted for 12,926 registered users in 2018 (0.61%), while the US and Canada held 1,439,399 (67.67%) and 642,472 (30.21%) users, respectively. Other Latin American countries like Mexico, Chile, and Colombia were also timid, corresponding to 1.33%, 0.16%, and 0.03%. The total number of registered users in the continent surpassed 2 million in 2018. In 2010, the total number was roughly half a million registered users (516,198). Chile and Colombia started to present B-2-C operators only in 2016.

In terms of the size of shared car fleets, the total number of shared vehicles in the American continent was 23,739. The US and Canada were again the leading countries. Both held 15,224 (64.13%) and 8,052 (33.92%) of shared vehicles in 2018. Brazil and Mexico – the two leading Latin American countries – counted only 0.99% and 0.42%. Between 2010 and 2018, the total number of shared vehicles more than doubled, although in the last two years of the time series, the US showed a significant contraction from 19,555 in 2016 to 15,224 in 2018 for shared vehicles.

IV. METHODS

This paper relied upon an exploratory, qualitative, and empirical investigation based on multiple case studies related to active CSOs in the Brazilian market. Reference [82] states that case studies are ideal for complex and recent phenomena that the researcher does not control. At the same time, they are an ideal tool in investigating research questions based on *what* and *how*. Thus, the research question that guided this paper was: *What are the main resources and competencies being mobilized by Brazilian CSOs for distinctive business models?* The central construct utilized to determine the main resources and competencies was the Business Model concept, while the distinctions between carsharing BMs were extracted from reference [48] synthesized in Fig. 1.

For case selection, we considered the following criteria: (a) the organization should be directly involved in offering

carsharing services through a dedicated digital platform or managing a shared car fleet; (b) the organization should be operational at least until 31 December 2019; (c) the organization should maintain an updated website.

Possible candidates for case studies were first obtained from Crunchbase, an online database that gathers information from research institutions, public agencies, investors, and media companies regarding companies around the world. The user can search for a specific company and activity and filter by location and size of the organization. In this sense, we searched for carsharing and filtered by country (Brazil), which yielded 14 results. Each of them was checked using the criteria resulting in 9 exclusions (three enterprises did not maintain a website, three did not present their direct involvement in carsharing operations, and three were defunct by 2019).

The second source for our case selection was journalistic documentation from local lay media. Searches were conducted between June 2019 and January 2020 and considered publications from January 2009 to December 2019. The same results were obtained from Crunchbase with the addition of two other organizations which started operations in the first half of 2019. No exclusions were necessary. In total, 7 CSOs were found in Brazil for the reference year. All of which were for-profit organizations and were considered to compose this study. Nevertheless, three refused or could not answer our invitation in time for data analysis. The remaining 4 CSOs, named Alfa, Beta, Gama, and Delta, were operating under different BMs and were successfully incorporated in this study.

Research protocols were defined under semi-structured interviews with CEOs, CTOs, and other managers and team leaders from the carsharing operators. The content of the interviews was based upon [29] definition for BM that is an "(…) architecture of the value creation, delivery, and capture …" (p. 172). Therefore, questions were formulated to determine how the selected CSOs created, delivered, and captured value in the Brazilian market.

Access to the 4 CSOs were limited. Each enterprise allowed only one interviewee to participate in presential and remote interactions. We used secondary data gathered from the journalistic material accumulated during the case selection phase and information presented in CSOs' websites to guarantee data triangulation.

Data analysis was conducted utilizing the Content Analysis technique presented by [83]. This method allows the researcher to organize non-structured data into constructs conceived specially for data analysis. Following the analysis made by Remane and colleagues, we were able to define some constructs that could portrait the different BM pillars mentioned by Teece's definition. We considered value proposition and market segment as proper constructs for value creation. Value delivery is directly related to which resources, competencies, and suppliers are mobilized to sustain the firm's value proposition and reach its target market. Finally, value capture was represented by the enterprise's revenue streams when offering carsharing services. The results obtained from data analysis were iteratively compared with existing academic literature regarding carsharing BMs. Our study reached closure under theoretical saturation evidenced in section VI.

V. Results

During case selection, we identified 7 CSOs in operation in Brazil. Four of them accepted our invitations to participate in this study (see Table I). We did not identify cooperatives in Brazil. Beta was the only CSO operating under a BM that Remane and colleagues had not discussed. Instead, it focuses on corporative carsharing (business-to-business or B-2-B). An in-depth exposition for each case is presented next.

TABLE II. Enterprises considered for the study

CSO	Location	Business Model
Alfa	Sao Paulo, SP Brazil	P-2-P Manual Access
Beta	Sao Paulo, SP Brazil	Corporative carsharing or Business-to-Business (B-2-B)
Gama	Recife, PE Brazil	B-2-C One-way Stationary
Delta	Sao Paulo, SP Brazil	B-2-C Roundtrip Multiple Vehicle Types

A. *Alfa*

Alfa is a startup located in Sao Paulo dedicated to P-2-P manual access carsharing. Since 2017, Alfa has intermediates transactions between mobility consumers and car owners through its digital platform that can be accessed via a smartphone application. In the first two years, the organization was limited to Sao Paulo's state but rapidly expanded to the national level in 2019.

In terms of value creation, Alfa relies on the twofold value proposition. On the one hand, it offers "facilitated car rental services" to mobility consumers. User certification, vehicle booking, payment, transaction validation, vehicle documentation, and insurance services are all conducted via Alfa's platform, with only key handover requiring users to meet physically. On the other hand, Alfa appeals to car owners in offering "means to generate additional revenue via idle assets". That is, it guarantees secure transactions to car owners during carsharing.

Since Alfa's business process still requires vehicle booking and a certain level of premeditation to demand the service, its value propositions target users interested in carsharing for more extended periods than on-demand mobility services. The interviewee declared that most vehicle bookings occurred for holidays and weekends. At the same time, Alfa's tariff model also is projected to sustain this segment since it is based on daily rates rather than hourly or by-the-minute rates as in ride-hailing and in some B-2-C operators [48], [80]. Alfa frequently offered holiday and weekend bundles to foster transactions in its platform.

In sum, the primary resource for Alfa is its digital platform. Unlike the other cases presented, Alfa is entirely dependent on its virtual community to create, deliver and capture value. Thus, competencies related to software development (backend, frontend, and user experience) are essential to the business.

Although its leaner approach to carsharing, Alfa faces different challenges, which do not involve investment and

maintenance of an owned car fleet and dedicated parking spaces. First, the firm must guarantee secure transactions between users. The firm validates mobility consumers for car owners, checking whether they have a driver's license and criminal record. Nonetheless, car owners must present documents certifying their ownership over the vehicle and whether they maintain insurance services themselves. Although Alfa already offers insurance coverage to all vehicles registered in its platform, the required individual insurance certifies that the vehicle fulfills the minimum-security requirements for sharing. Hence, Alfa retains organizational structures specialized in anti-fraud techniques to inhibit misappropriation and free-rider behavior.

Another challenge Alfa faces is a significant imbalance between car owners and mobility consumers. At the moment of the interview, the organization held around 200,000 users, with only 800 car owners. Such disproportion directly hinders Alfa's virtual community expansion due to the lack of a consistent supply of registered cars available on its platform. The interviewee revealed that the enterprise has been trying to tackle the issue using data analytics to improve the value proposition to car owners, creating a dedicated team to analyze and consolidate insights from user behavior and consumption patterns, a section of which he was responsible.

All efforts to counter the imbalance between user groups utilize data stored in cloud services. Alfa contracted a cloud computing service provider as a small enterprise with a minimal budget and requiring a well-structured database. At the same time, Alfa sought partnerships with insurance companies to cover shared vehicles registered in its platform. A key partner to sustain an attractive value proposition to all users.

TABLE III. CONSTRUCT DESCRIPTIONS FOR ALFA CASE STUDY

Business Model Pillars	Constructs	Alfa
Value Creation	Value propositions	**For car owners:** "A secure way to generate additional revenue from idle vehicles"; **For mobility consumers:** "Facilitated car rental service";
	Market segments	**Mobility consumers** interested in car renting for more extended periods (leisure); **Car owners** interested in renting their idle vehicles;
Value Delivery	Key resources	- Virtual community; - Smartphone application;
	Key competencies	- Software development; - Antifraud competencies; - Data analysis;
	Key partnerships and suppliers	- Partnership with insurance companies; - Cloud computing services;
Value Capture	Tariff model	Commissions over shared vehicles paid by mobility consumers

B. Beta

Beta is also a startup located in Sao Paulo that initiated operations in 2017. However, unlike Alfa, Beta started as a B-2-C one-way stationary operator held by a luxury car rental company. Between 2017 and 2019, Beta owned 60 vehicles – 14 electric vehicles (EVs) and 45 combustion vehicles – all compact sizes models. Beta held no private parking spaces; instead, it allocated its vehicles near parks and pub houses in public parking spaces. Customers were required to download Beta's smartphone application to access its vehicles remotely. The software was developed by a third party and used by Beta.

This BM design was financially unsustainable, in any case. Many vehicles were lost to theft, vandalism, floods, and other damages with no specific parking spaces and proper monitoring mechanisms. At the end of 2019, the parent organization sold Beta to another society that rapidly redesigns its BM to accommodate corporative carsharing. The new management sought partnerships with small car rental companies and dealership stores to compose Beta's car fleet, granting them an additional revenue stream as compensation. The decision was made to free resources from erstwhile immobilized assets and allow the organization to focus and invest in other vital activities such as software development and fleet management.

At the interview, Beta was finalizing its BM reconfiguration and still had a small group of 12 employees. New hires were planned for the forthcoming months.

Beta is oriented to offer "customizable carsharing services for companies" for value creation. The targeted segment comprehends companies heavily dependent on car fleets to move employees in work-related appointments or as transportation to cover last-mile routes between airports, train, and bus stations. Customers can choose between different cars – e.g., EVs, sedans, and vans – and their allocation inside company premises. At the same time, they also can customize the fleet management software accompanied by the service, choosing between different functionalities related to fleet access and control, booking, and carpooling mechanisms. The current customers were from the banking and financial services sector.

Value delivery relies on crucial resources such as the smartphone application, fleet management software, and onboard hardware directly installed in each vehicle. The smartphone application is developed in-house and allows a customer's employee to book and remotely access a shared vehicle. In contrast, fleet management software allows the company to monitor and control car usage. Finally, the onboard hardware is an electronic circuit with a Bluetooth device that communicates with the employee's smartphone and the rest of the car systems like the door locking systems and alarms.

Accordingly, Beta essential activity revolves around in-house software development for smartphone applications and fleet management software. The firm also makes cleaning, recharging, refueling, vehicle allocation, and maintenance, requiring planning and organization to maintain the shared car fleet fully operational. Additionally, customers have access to reports with insights and information related to their shared

fleet usage, which requires data analysis to properly process the amount of data captured by the fleet management software.

Beta counts on small car rental companies, dealership stores for vehicle fleet, and cloud computing services for data storage and analysis. The latter is a key supplier since data captured from customers' employees are stored in cloud services. Reports are directly designed upon such data available online.

Beta charges customers for vehicle setup to cover costs related to car wrapping with identification and hardware installation onboard. Notwithstanding, a steady revenue stream is obtained through monthly payments per vehicle rented that will be available on the customer's premises.

TABLE IV. CONSTRUCT DESCRIPTIONS FOR BETA CASE STUDY

Business Model Pillars	Constructs	Beta
Value Creation	Value propositions	"Customizable carsharing services for companies"
	Market segments	Medium and big size companies that are dependent on car fleets to cover employee's mobility needs
Value Delivery	Key resources	- Smartphone application; - Fleet management software - Onboard hardware;
	Key competencies	- Software development; - Fleet management competencies; - Data analysis;
	Key partnerships and suppliers	- Partnership with small dealership stores and car rental companies for fleet composition; - Cloud computing services;
Value Capture	Tariff model	- Monthly payment per vehicle rented to customers; - Face value paid at the start to set up the vehicles contracted for carsharing;

C. Gama

Gama is an enterprise founded in 1988 in Recife in Pernambuco's state. Gama was dedicated to maintenance provision for telecommunication systems of public companies. Until the early 1990s, the company was distant from the mobility sector. Nevertheless, Brazil initiated an extensive privatization movement, which forced Gama to change its core business. Since then, the company started in three different segments: Maintenance of traffic light systems, public parking lots, and shared mobility. In the latter, Gama is an operator of bike-sharing and carsharing services. In total, Gama has over 500 employees distributed between the three segments.

In carsharing, Gama has been a B-2-C one-way stationary CSO since 2016, in which it serves the city of Fortaleza in Ceara's state. The company's fleet comprises 20 EVs – fifteen compact cars and five vans – distributed in 18 dedicated stations throughout the city. Any resident can access Gama's vehicles once registration is made via a smartphone application.

Fortaleza's city hall launched public bidding, establishing the city requirements for a regulated carsharing service integrated with existing public transport systems. Gama met the requirements and won, initiating operations in the next year. The company was the only operator found that enjoyed a formal relationship with a public administration.

In these terms, Gama's value proposition follows the intended city hall's demands in promoting a "sustainable urban mobility service". Therefore, Gama is oriented to cover last-mile transportation needs for residents. Its integration with other modes of transportation is observed by arranging dedicated carsharing stations near transport hubs and touristic attractions.

Gama's key resources are its smartphone application, onboard hardware, and its owned car fleet. The smartphone application utilized by Gama is not developed in-house. Instead, the company relies on a partnership with Gama-2, a startup where Gama holds ownership with a business partner. Gama-2 is responsible for developing software solutions to Gama not only to the company's carsharing operations but also to the other branches. Like Beta and Delta, Gama depends on onboard hardware installed directly on its vehicles to turn them into sharable assets. Under this BM configuration, Gama is dedicated to competencies related to fleet management. A critical activity that extends from maintenance planning, vehicle allocation in the different stations, charging and cleaning services. Gama's key partnerships are the municipal administration materialized under a concession for its operations in the city and the local utility company responsible for managing recharging stations.

Gama's tariff model is based on time (by the minute fees). It requires customers to pay online *ex-ante* vehicle booking and offers discounts for customers using bus tickets. Additionally, the company receives sponsorship from a Health service company.

TABLE V. CONSTRUCT DESCRIPTIONS FOR GAMA CASE STUDY

Business Model Pillars	Constructs	Gama
Value Creation	Value propositions	"Sustainable urban mobility services"
	Market segments	Residents of Ceara's capital that are interested in covering last-mile travels between modes of transportation and touristic attractions
Value Delivery	Key resources	- Smartphone application; - Onboard hardware; - Car fleet;
	Key competencies	- Fleet management competencies;
	Key partnerships and suppliers	- Partnership with Gama-2 for software development; - Partnership with utility companies for recharge stations; - Sponsorship from health service companies; - Municipal concession;
Value Capture	Tariff model	By-the-minute tariffs

D. Delta

Delta is one of the first Brazilian operators. Initiating around 2010 in Sao Paulo, the firm was first structured as a B-2-C roundtrip multiple vehicle types CSO. It required final consumers to return the vehicles to the same starting position while relying on a heterogeneous car fleet to provide mobility to users. Until 2015, the operator held an owned fleet that reached 80 vehicles parked in private parking lots dispersed throughout the city. Carsharing was provided through a website interface, a datacenter, and onboard hardware onboard vehicles. These technologies, however, were imported and already outdated for 2010. Customers could only book Delta's shared fleet through its website. Remote vehicle access was made using SMS technology, and payment systems were limited, which frequently yielded misappropriations, fraud, and customer default.

From 2015 to 2019, the CSO changed its BM. First, Delta's car fleet and its data center were sold to leverage its working capital, allowing investment in other areas like software development and anti-fraud activities. In contrast, the enterprise firmed contracts with traditional car rental companies to sublet vehicle fleets and contracted cloud computing services for data storage. After one year, the firm obtained a functional solution composed of onboard hardware based on a Bluetooth system and user interface designed for smartphone applications. Under this new configuration, Delta improved its anti-fraud, booking, and fee collection systems and scaled up its operations up to 200 shared vehicles. During this period, Delta employed over 30 people.

Delta's value creation was based on "facilitated car rental services" to users interested in covering long distances, especially for leisure. The interviewee revealed that most of Delta's customers, likewise Alfa, preferred to demand services for holidays and weekends.

For value delivery, this CSO relied on a smartphone application and onboard hardware alongside their respective competencies for development in-house. Furthermore, since its beginning, Delta has conserved fleet management-related competencies, such as vehicle allocations, repairs, and refueling. Another aspect not mentioned previously is that Delta also improved its data analysis competencies during BM reconfiguration. A new team specialized in analyzing usage and consumption patterns was formed. According to the interviewee, insights obtained from this team were responsible for helping management focus on specific market segments and evade competition with ride-hailing services.

Delta started to offer holiday and weekend bundles that fostered leisure travels in this regard. The tariff model considered the time spent with the shared vehicle (by the minute) and miles driven by the customer. A customer would pay for each minute spent plus miles driven during standard service provision. However, when contracting weekend or holiday bundles, the same customer would pay a fixed fee for the duration of contracted service with a lower additional fee for each mile driven.

TABLE VI. CONSTRUCT DESCRIPTIONS FOR DELTA CASE STUDY

Business Model Pillars	Constructs	Delta
Value Creation	Value propositions	"Facilitated car rental services."
	Market segments	Users interested in covering long distances for leisure purposes
Value Delivery	Key resources	- Smartphone application; - Onboard hardware;
	Key competencies	- Antifraud competencies; - Software development; - Fleet management competencies; - Data analysis;
	Key partnerships and suppliers	- Sublet relations with traditional car rental companies; - Partnerships with private parking lots; - Cloud computing services;
Value Capture	Tariff model	By-the-minute and miles driven tariffs

VI. DISCUSSION

Returning to the research question: What are the main resources and competencies mobilized by Brazilian CSOs in distinctive business models? A set of key resources and competencies is required for each case study to create, deliver, and capture value properly. Alfa, for example, relied on a virtual community, focusing on facilitating transactions between different user groups. Alfa's key competencies were

related to platform improvement, implementation of anti-fraud techniques, and data analysis. Authors dedicated to explore the digital economy [15], [44], [49], [51], [84], [85] emphasize the importance of trust inside digital platforms. Companies like Amazon and eBay, which intermediate transactions between users, adopted rating mechanisms and feedback sections to reduce asymmetric information and foster transactions. Alfa applied such technologies and verified and certified new users in terms of credit, authorization to drive, their criminal record, and vehicle documentation for car owners.

Beta, Gama, and Delta depended on a car fleet and fleet management competencies to operate. Beta and Delta, both small enterprises, choose to free their resources and mobilize partnerships with car rental companies and dealerships stores to scale operations. As a B-2-C roundtrip operator, Delta did not own a car fleet like German operators. On the other hand, Gama was the only operator owning a car fleet and doing business under a public concession. A condition that allowed the company to enjoy dedicated public parking spaces and a certain level of integration with other modes of transportation. Gama's value proposition was different from its counterparts since it addressed customers interested in covering last-mile travels and not necessarily leisure-related travels as Alfa and Delta.

Beta, Gama, and Delta held fleet management competencies in their core business since they embraced maintenance and fleet allocation activities. Nevertheless, Gama handed over software development activities to a key partner, unlike the other operators. At the same time, no evidence for the importance of data analysis was found to Gama in the process of refining its value proposition and delivery.

Some resources and competencies were common among the majority of CSOs. Alfa, Beta, and Delta were using cloud computing services and data analysis competencies to improve their value propositions and value delivery. Alfa employed data analysis in data stored in the cloud to face the imbalance between car owners and mobility consumers in its platform. At the interview, Alfa counted for 800 registered vehicles, a small fraction of the average held by German P-2-P operators (5,006 registered vehicles). Delta could generate insights to further explore its market segment with customers interested in carsharing for leisure. Beta captured car usage data from customers' employees and offered reports containing various data related to fuel and charge consumption, time spent, miles driven, passengers, and destinations.

Brazilian operators did not follow their German counterparts in terms of key partnerships. As presented by [47], German operators under distinct BMs mobilized at different levels of city-related partnerships. Except for Gama, all Brazilian CSOs could not align themselves with public administrations, utility companies, and building associations. During interviews, the oldest CSO from the case studies – Delta – demonstrated interest in participating in public biddings. However, according to the interviewee, participating conditions were not feasible for a small business-like Delta.

Concerning Beta's BM, despite Remane and colleagues' not mentioning it, corporative carsharing is not limited to Brazil. Some authors have already pointed out the lack of recognition of B-2-B carsharing among scholars interested in the issue. References [86] and [87] explored B-2-B carsharing in Europe, and both studies suggest that corporative carsharing is not well documented since it is often underestimated. It was not uncommon to observe final consumers using carsharing services during work-related tasks [87]. During the interviews, the respondent from Delta mentioned that sometimes, workers from offices near Delta's shared cars used the fleet to move between work-related meetings and appointments.

VII. Final Considerations

This paper explored the main resources and competencies mobilized by Brazilian CSOs in distinct business models. The study was developed from multiple case studies methodology and considered all 7 CSOs present in the region, but only four accepted to participate. We identify four business models in Brazil. Two were dedicated to final consumers (B-2-C one-way stationery and B-2-C roundtrip multiple vehicle types), one intermediated carsharing transactions between peers with manual key handover (P-2-P manual access), and one was dedicated to corporative carsharing (B-2-B).

The majority (75%) of case studies relied on resources related to smartphone applications and competencies related to software development and data analysis. Key suppliers were cloud computing service providers which stored captured data for CSOs to analyze and refine value creation and delivery. Only one operator relied on a key partnership to conduct software development. It was also the only operator to do business under public concession mobilizing a unique set of city-related partnerships (*e.g.,* utility companies, municipalities) and sponsors.

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