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Casual Carpooling: A Strategy to Support Implementation of Mobility-as-a-Service in a Developing Country

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Abstract: Mobility-as-a-Service (MaaS) offers tailored-made, on-demand mobility solutions to users by integrating on a single service subscription, public and private transport modes. However, the concept is still uncertain, and its current development and applicability is centered on developed countries. On the other hand, we advocate that MaaS is modular, adaptable, and applicable to several realities. In developing countries where public transport is mostly inefficient and insufficient, MaaS could help to "balance the scale" with private transport offerings, such as ridesharing. Casual carpooling could be an affordable alternative. Not only for being a low-tech transport mode but also for optimizing vehicle usage of idle seats. In that optics, we have identified drivers who would facilitate integrating casual practices into a MaaS. To identify the motivating factors behind casual carpooling and propose a strategy to implement it in a MaaS scheme, a quantitative survey was applied to 307 university students in the city Lavras, Brazil. Data were analyzed using descriptive statistical techniques. We assumed that casual carpooling is sustained by solidarity, simplicity, and agility; no costs to passengers; and institutionalized pickup points. Then, we identify principal strategic components to implement such an initiative. We concluded that casual carpooling as a low-tech transport mode could enhance local strategy for implementing an eco-innovative MaaS in places with inefficient public transport offerings.

Keywords: mobility-as-a-service; casual carpooling; eco-innovation; urban mobility planning; consumer behavior; smart mobility; sustainable transports

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1. Introduction

Smart mobility is being in the right place at the right time. It is no longer about getting from point A to point B as quickly as possible. Travel time is no longer lost time at the expense of work, leisure, and social relations. It is a way to access more locations, an opportunity to facilitate access to experiences, activities, and people you want to meet.

This smart mobility is characterized by the desire to inject more flexibility into travel, to discover new modes of transportation [1] and sharing experiences. It offers the opportunity to eliminate entry barriers into the mobility market, whether economic (a one-way ticket) or technological variables (for example, smartphone use). It is the desire to propose sustainable mobility [2] in the sense of submitting eco-innovations that reduce environmental impacts (less pollution, and zero tickets) or social consequences (disabled access) and that promote equality of territories (inclusiveness). We adopt the consensual definition of eco-innovation proposed initially by Kemp and Pearson (2007): "Eco- innovation is the production, application or exploitation of a good, service, production process, organizational

structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives."

In this respect, inter-modality (which refers to the successive use of several modes of transportation to travel. Theoretically, it covers all modes, but in practice, intermodal policies have focused mainly on public transport and private cars) represents the most advanced tool for making smart city efficient, allowing the distances to be covered and the time available to users to be adjusted according to their current needs. MaaS, "Mobility as a Service", is an illustration of this inter-modality promoting smart mobility. Mobility-as-a-Service (MaaS) aims to offer tailored-made, on-demand mobility solutions to users by integrating on a single service interface, public and private transport modes [3].

Benefits for the stakeholders of this system are numerous. For local authorities, MaaS facilitates the modal shift from autosolism to collective schemes, improves access to the various mobility services promoting social inclusion, and collects data to adapt mobility practices. For transportation operators, the idea is to offer new products and modes of service distribution, build users' loyalty and increase services and profitability. As for users, the aim is to provide access to more services under more comfortable conditions and better fares.

Corroborating with this, [4] states that MaaS is a viable answer in most places because the modal split can be adaptable. For this, in places where PT is inefficient and mostly insufficient (e.g., developing countries), MaaS could help to "balance the scales" with private transportation offerings, for instance, by increasing private car efficiency with casual carpooling. [5] also stated that the use of carpooling in Slovenia, can increase savings "because of the reduction in total distance and time travelled by personal vehicles as well as parking demand reduction in cities."

However, the concept is still surrounded by uncertainties, and its current development and deployments are mainly centered in developed countries [6,7]. In addition, as Public Transport (PT) entails the backbone of successful MaaS schemes [8–10], it is understood that to properly implement efficient MaaS services, capable offerings of PT are pivotal.

Casual carpooling is an informal, ad-hoc, user-run type of ridesharing that provides a high-occupancy rate on private vehicles [11]. In this type of "free trip", the passenger occupies an idle seat that the driver would not use on his/her daily routine from point A to B anyway [12,13]. In this sense, by occupying the idle capacity, casual carpooling is aligned with the concepts of the sharing economy [14,15] and for its the simplicity, it can be considered as a low-tech transport modal.

The sharing economy provides positive environmental effects [16,17]. Thus, having casual carpooling as a transport mode inserted in a MaaS scheme could help in the construction of service in favor of eco-innovation, in the sense that such access-based business models are pivotal to foster innovation in developing countries and frontier markets [18]. Ref. [19] state that sustainability should not be an intrinsic characteristic of MaaS. According to the authors, a MaaS should only be characterized as an eco-innovation if car owners would either replace their vehicles for other transport modes or make more efficient use of their vehicles, that is, by reducing the idle capacity—such as offering casual carpooling.

However, several factors can influence casual carpooling, due to its consonant aspects to the sharing economy, such as trust and reputation [20,21] governance in collaborative consumption [22], and generational cohorts influence [23,24].

The present paper sought to focus on such issues in the context of a small city (Lavras) in a developing country (Brazil), since this city holds several universities and therefore many students, who—on their daily commute—routinely practice casual carpooling (whether as passengers or as drivers).

Our research problem can be summarized in the following guiding questions: Which are the motivating factors behind casual carpooling? Moreover, how can casual carpooling be implemented in a MaaS scheme? Thereby, our general objective was to identify the

motivating factors behind casual carpooling and propose a strategy to implement it in a MaaS scheme.

This paper addresses three main contributions. First, we identified the main drivers for actors to practice casual carpooling that could be integrated in a MaaS [15]. Second, by understanding MaaS as adaptative and modular, its business model could be conceived without having public transport as a backbone. In this sense, solutions aimed at reducing car-occupancy inefficiency while also complementing PT would be a feasible MaaS alternative in developing countries that struggle with public transport offerings. Finally, our contribution sought to analyze a strategy to implement casual carpooling in MaaS. An approach that to the best of our knowledge has not yet been taken into account, either in the academia or in real-world deployments.

2. Literature Review

2.1. Mobility-as-a-Service: An Overview

The first comprehensive definition of MaaS emerged in 2014 in Finland, where [25] described MaaS as a mobility solution offered by a single interface of a service provider that combines different transport modes to offer tailored mobility packages.

It is noteworthy that given its promising prospects, there is still a high degree of ambiguity surrounding the concept, with multiple sources vying to offer definitions of MaaS [6]. According to [26], the main idea of MaaS is to offer a unique and seamless interface to its users, aggregating heterogeneous transport options offered by different mobility providers handling the whole experience of traveling, from providing information to travel planning and payments.

According to [6,27], we propose the characterization of a MaaS according to the following elements:

Multi stakeholders platform: Several mobility service providers' offerings are aggregated by a sole mobility provider (the MaaS provider) and supplied to users through a single digital platform. This integrator could be the public transport authority, any transport operator, a cutting-edge MaaS company, or companies from the banking, telecommunications, or other sectors.

- User-centered innovation. MaaS is a personal mobility option that puts the customer experience first, increasing convenience, effectiveness, and satisfaction by enabling sharing and personalization through real-time connectivity [28] the traveler has some specific expectations when he's planning for MaaS: simplicity (with an easy, user-friendly, and convenient service in order to alleviate the decision-making process), flexibility (as the service must be able to adapt to changing traveler's needs being it public transport, taxi or car rental, or even ride-, car-, or bike-sharing; and it should be personalized in order to take into account personal preferences), safety (offer reliable transport services [29], and low-threshold accessibility.
- Subscription service: a single MaaS account provides freedom of choice regarding the user's mobility needs, for either an agreed period or via pay-as-you-go subscription. MaaS offers a wide range of integrated services. Ref. [9] thus proposes different levels of service integration ranging from integrated information solutions without payment to the integration of societal objectives (as value created for the territory in terms of well-being, for example).
- Potential to create new markets: for transport providers, MaaS can offer new sales channels, access to untapped customer demand, simplified user account, and payment management, as well as richer data on travel demand patterns and dynamics. For instance, [30] states that shared mobility has to have the potential to grow beyond niches.

It is therefore relevant to address the conditions of implementation of such a system, which plans to combine multiples products and services (integrating transportation modes) in a unique platform customized for passengers to fulfill their needs.

2.2. Conditions for the Implementation of a MaaS

The various experiments already carried out worldwide allow us to identify a certain number of factors that will condition the implementation of MaaS, even if we retain the diversity of patterns.

2.2.1. Technical Facilitators and their Possible Lock-in

Beyond the regulatory framework, we note that the quality of open data (whether it be the quality of real-time information [31] or problems of confidentiality and security [26], the existence of interoperable programing interfaces, or platform architectures [32] are a necessary condition for the development of MaaS. Furthermore, it must be based on an existing high-performance mobility system with facilitated physical intermodality. Finally, reliable internet access is essential to ensure real-time data transfers. Thus, the transition to a MaaS imposes a new pathway to an integrated system of networks, telecommunications, data, and services [33]. These technical dependencies and sometimes their lock-in will limit the diffusion of MaaS in certain territories, notably in developing countries.

2.2.2. Integrated and Global Governance

The implementation of MaaS reflects regulatory choices in a given territory, taking into account existing transportation infrastructures, organization, and planning of transportation services, and understanding of user needs. Such a performance intermodal offer is based on spatial, temporal, and institutional coordination. Thus, MaaS requires physical and organizational arrangements to integrate all modes of transport, including soft modes (walking and bicycles), and to combine public and private, collective, and individual vehicles. It also requires institutional regulation [34]. Public transportation is often presented as the backbone of MaaS (UITP, 2019) because it naturally develops and manages physical infrastructures. Thus, MaaS is based on innovative public-private collaboration that plans, operates, and manages transportation networks with limited synchronization conditions (e.g., public transport/bike sharing) and different cultures and socioeconomic objectives. [35,36] characterize the governance of these new stakeholder networks to create an increasingly integrated and adaptive value chain [37]. In developing countries, the limitations related to these variables make a need for new models to build public-private innovation partnerships that facilitate the implementation of MaaS [38].

2.2.3. Profitability and New Market Opportunity

The new mobility system display exciting dynamics, but its profitability remains problematic, and its financing is often secured d by public subsidies [39–41]. The added value of MaaS lies in its integration of all modes of transport and its real-time information functions, which enable better services. Thus, MaaS brings value to users (for example, increased efficiency in terms of time, profitability, or convenience), to mobility service providers (public and private), and to MaaS operators and MaaS integrators (if external actors take on these roles). It also creates value for the territories by providing better services and reducing environmental impacts without weighing on public spending. To avoid MaaS becoming a new cost center for the collectivity, it must simplify service distribution channels and generate additional revenue. Thus, the economic success of MaaS depends largely on transforming structures and practices that maintain personal mobility services and private car traffic (see [42]). These systems are all supported by complex networks of institutional co-operation and user acceptability. If public transport networks in developing countries will not be a driving force for the development of MaaS, perhaps users will create new dynamics to change mobility practices.

2.2.4. Users Acceptability

We analyze the users' acceptability towards the integration of public transport and shared private cars in terms of three factors:

- The sensitivity of travelers to use different modes of transport in their travel habits and their sensitivity to innovation in mobility: walking, cycling, individual, electric, shared, and connected vehicles, etc.
- Attitude towards public transport. A positive attitude towards public transport is useful to accept a MaaS system with public transport at its core, as it is already focused on sharing and with similar common objectives: reducing costs and environmental impact. In developing countries, we will particularly test this sensitivity.
- Attitude towards private cars. From a practical point of view, MaaS can offer a good alternative to the use of a private vehicle. However, car use's symbolic and emotional motives have been found to be more important than practical ones [43].
- Mobile applications. Since individuals interact with MaaS services via an application interface, it is necessary to study their willingness and ability to adopt the application.

Thus, MaaS has to be analyzed as a business model modular, adaptable, and applicable to several realities [19]. Distinct contexts will have different transportation models (low- and high-tech ones). In a developing country, it is not easy to meet these overly formal conditions. However, in real life, we see informal practices close to a collective, flexible system that shares mobility, as proposed by casual carpooling. Following the analytical framework proposed by [44] on urban mobility planning, we will focus on the drivers that could facilitate MaaS implementation (SUMP principles).

2.3. Casual Carpooling: A Low-Tech Innovation towards MaaS Implementation

The private-owned vehicle is still holding its dominant position [30]. Its use contributes to our transport system's significant issues, being responsible for various adverse environmental impacts globally and locally [45,46].

Thus, an eco-innovative MaaS needs to consider reducing car ownership or using it more efficiently by commuters and "not-sharing" peer-to-peer (P2P) commuters [19]. In this sense, using a car more efficiently, such as casual carpooling, can be a solution. This innovation is part of the available services of a MaaS because it respects the main characteristics mentioned above. In addition, this low-tech transportation model does not need infrastructure investments, making it feasible for introduction in developing countries.

Casual carpooling, also known as "slugging," consists of informal carpools for purposes of commuting and can be understood as a variation of hitchhiking for urban areas [11,15,47].

The concept was born in communities north and east of San Francisco (USA) and spread to other states in America [15]. The essential idea is to provide a free ride for a passenger to complete idles seats in a car. By doing this, the driver gets access to benefits offered for high-occupancy vehicles (HOV), such as access to dedicated lanes and discounts in tolls.

According to [11], for casual carpooling to be successful—in the context of the USA—it should present the following features: (1) time savings incentive for drivers; (2) monetary savings for passengers; (3) pick-up locations near freeways, residences, parking, or public transit stops; (4) a common drop-off location; (5) convenient public transit for the evening commute; and (6) a high occupancy vehicle requirement of three or more persons to ease personal safety concerns [13,48].

Casual carpooling can also occur by solidarity (benevolence), that is, without time and costs benefits to the driver, it can simply occur by the act of sharing. [49] states that it is necessary to move from the old wisdom mindset of "you are what you own" towards "you are what you can access."

This mindset evolution finds its justification in the diffusion of economy of sharing [16,50]. According to [49] (p. 126), "sharing is the act and process of distributing what is ours to others for their use as well as the act and process of receiving something from others for our use." Historically, the concept of sharing was restricted to people from the same social circle, making it a tendency not to share with strangers [12]. However, the emergence

of peer-to-peer digital platforms has facilitated the exchange of underutilized assets by strangers [51] to facilitate building trust [17,52].

According to [53], sharing may have interesting social and theoretical implications when analyzed outside of the immediate family circle. Thereby, the author brings the definitions of "sharing in" and "sharing out". The former expands the sphere of the extended-self and the domain of common property. It is closer to the archetype of sharing within the family because it involves ownership as standard so that others are included in the extended self. The latter, however, deals with dividing a resource between different interests. It preserves the self/other boundary and does not involve expanding the extended self's aggregate sphere by expanding the common property domain. It involves giving others outside the boundaries that separate self and the other and is closer to the gift and commodity exchange.

In this way, sharing a car with family, friends, or acquaintances would be closer to the concept of "sharing in", while extensive P2P sharing services may be more related to "sharing out". However, other means of sharing (such as casual carpooling) could be inserted in between these two. Given these characteristics, it is important to understand the motivations of users to engage in casual carpooling. This understanding will allow us to identify the drivers that will allow carpooling to contribute to the MaaS implementation.

3. Research Design

This study is characterized as quantitative of exploratory and descriptive nature with a survey was applied to 307 university students in Lavras, Brazil, enrolled from the second academic semester of 2018. The research design is depicted in Figure 1.

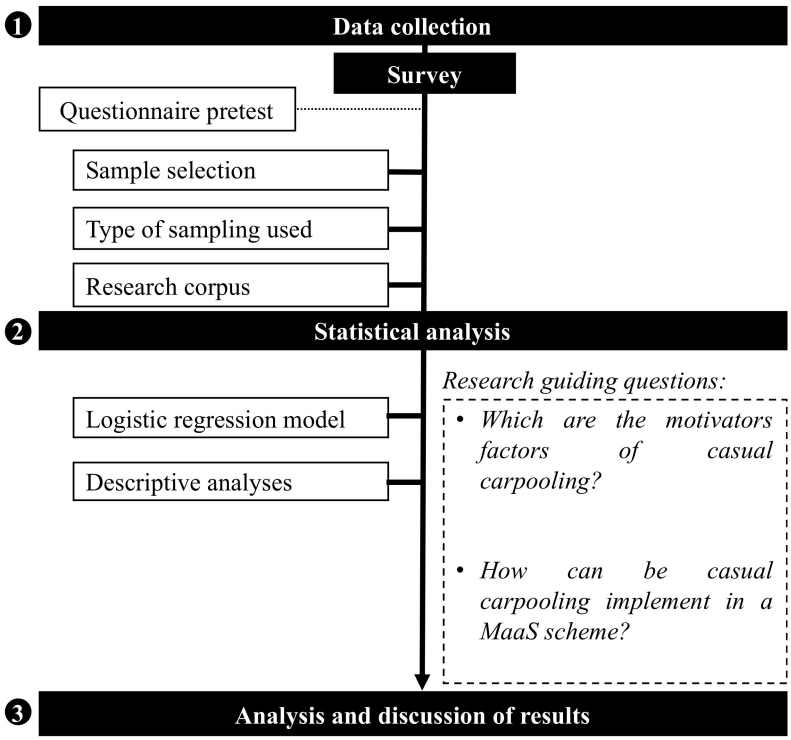

Figure 1. Research design.

Step 1 referred to data collection. Data collection was carried out by a cross-sectional study (survey) with 307 students of the four Higher Education Institutions (HEI) of the city. The sample was selected through non-probabilistic sampling [54–56]. All students belonging to the target population were invited to participate in the research. They were informed about the objectives of the study and the volunteers (participants) completed an

online questionnaire on mobility. The collected data were pre-processed and prepared for statistical analysis.

Step 2 consisted of statistical analyses. Our paper aimed to answer two main research problems. To answer such research problems (Which are the motivating factors of casual carpooling; and How can casual carpooling be implemented in a MaaS?) survey data were analyzed using logistic regression models fitted via software R. Furthermore, descriptive statistical techniques to understanding the socioeconomic factors associated with the habit of offering and picking up rides (casual carpooling) were used.

After data pre-processing, logistic models were fitted separately for the groups of drivers (n_c = 78) and non-drivers (n_{nc} = 204), considering as response variable the habit of offering or taking a ride (Y = 1, for the answers "yes" or "occasionally", and Y = 0 for the answer "no"). At first, full models were fitted considering the predictors' age, sex, income, marital status, type of institution (public or private), day/night shift, and distance to the institution. The best models were then selected stepwise based on Akaike Information Criterion (AIC values). The final models are presented for each of the groups and interpreted in terms of odds ratios.

In all inferential procedures, we set the level of significance at 5% at last, step 3 consisted of the analysis and discussion of results.

4. Research Context

The city of Lavras-MG, with around 100,000 inhabitants, is located in the south of Minas Gerais, 425 km from Rio de Janeiro, 380 km from São Paulo, and 240 km from Belo Horizonte. The city holds four higher education institutions, one public (Universidade Federal de Lavras—UFLA) and three privates (Unilavras, Fagammon, and Fadminas).

UFLA currently holds 31 undergraduate and 33 postgraduate programs, totaling more than 16,000 people among students, faculty, and staff. Due to its extension and peripheral location regarding Lavras' city, the campus counts with five pick up points for casual carpooling, which all have different destinations in the city. Today, the practice of casual carpooling is already institutionalized in the local culture. The university also provides a free internal articulated shuttle that is intermittent at peak times and periodic during weekdays.

As for the private institutions, although significantly smaller than UFLA, they also represent a significant portion of the academic population of Lavras. Together, they hold ten postgraduate programs and 17 undergraduate courses. However, unlike UFLA, they do not have physical stops for casual carpool (mainly because they are located within the city and not in the vicinities as UFLA).

5. Analysis and Results

Results are displayed in 2 steps. Initially, we present the socio-demographic structure of our sample (Table 1). Then, results from the logistic models are presented, followed by a descriptive analysis.

Table 1. Socio-demographic structure.

Variables	Category	Private	Public1	All Participants
Age	17–25	89 (72.95%)	143 (89.38%)	232 (82.27%)
	26–30	15 (12.30%)	16 (10.00%)	31 (10.99%)
	31–40	14 (11.48%)	1 (0.63%)	15 (5.32%)
	Higher than 40	4 (3.28%)	0 (0.00%)	4 (1.42%)
Gender	Female	83 (68.03%)	69 (43.13%)	152 (53.90%)
	Male	39 (31.97%)	91 (56.88%)	130 (46.10%)

Table 1. *Cont.*

Variables	Category	Private	Public1	All Participants
Income (R$)	≤954	13 (10.66%)	12 (7.50%)	25 (8.87%)
	955–1908	40 (32.79%)	25 (15.63%)	65 (23.05%)
	1909–4770	50 (40.98%)	74 (46.25%)	124 (43.97%)
	4771–9540	12 (9.84%)	27 (16.88%)	39 (13.83%)
	9541–19,080	7 (5.74%)	16 (10.00%)	23 (8.16%)
	≥19,081	0 (0.00%)	6 (3.75%)	6 (2.13%)
Marital Status	Single	102 (83.61%)	157 (98.13%)	259 (91.84%)
	Divorced	2 (1.64%)	0 (0.00%)	2 (0.71%)
	Married	18 (14.75%)	3 (1.88%)	21 (7.45%)

5.1. Logistic Regression Model

To understand the habit of casual carpooling among the participants of this study, the first analysis we carried out was the logistic regression model (Table 2).

Table 2. Estimates and Wald tests for the effects in logistic regressions, odds ratios estimates and confidence intervals.

Group	Effect	Estimate	s.e.	*p*-Value [1]	$\widehat{\text{OR}}$	$\text{IC}_{95\%}(\text{OR})$
Drivers	Intercept	−1.192	1.451	0.411	-	-
	Age	0.071	0.056	0.203	1.074	(0.977; 1.221)
	Institution=Public	1.501	0.609	0.014	4.486	(1.427; 16.129)
Non-Drivers	Intercept	0.688	0.457	0.132	-	-
	Institution=Public	0.601	0.334	0.072	1.824	(0.944; 3.513)
	Distance = 50 0m and 1 km	0.125	0.551	0.820	1.134	(0.376; 3.339)
	Distance = 1 km and 2 km	−0.201	0.540	0.709	0.818	(0.276; 2.334)
	Distance = 2 km and 3 km	−0.751	0.549	0.172	0.472	(0.156; 1.364)
	Distance = 3 km and 4 km	−1.756	0.685	0.010	0.173	(0.042; 0.631)
	Distance = 4 km	−1.320	0.549	0.016	0.267	(0.087; 0.763)

[1] Results of the Wald test for fixed effects in logistic regression models. *p*-values less than 0.05 indicate statistical significance for the variable or effect under test.

For drivers, a significant effect was found regarding the type of institution they belong to. When belonging to a public institution, the estimated chances of him/her offering a ride are approximately five times higher than those of students from private institutions ($\hat{OR} = 4.486$). This result was already expected due to the structured and robust sharing culture in the public university studied.

For non-drivers, we observed that the type of institution is also an essential variable in the model, but not significant at a 5% significance level. For this group, we noticed a significant effect of the distance that the student lives from the institution. If this distance is greater than 3 km, the odds of the student to seek for a ride are reduced ($\hat{OR} = 0.173$ and $\hat{OR} = 0.267$) compared to students who live within a walking distance of (up to 500 m) from the institution.

5.2. Descriptive Analyses

Based on the logistic regression model, the only predictor variable that affected the question "do you offer a ride?" was a type of institution (public or private). In this way, stratified analyses were performed concerning the institution's nature (public and private). Analyses were done separately for drivers and passengers.

Table 3 presents the predisposition and offer of casual carpooling, stratified by type of institution. In general, we observed a greater predisposition by drivers to offer casual carpooling in the public institution over private ones (62.3% and 26.7%, respectively). The number of drivers who offers rides to strangers is also much higher in the public institution (45.9%). On the other hand, in private institutions, the most extensive offer leans towards family, friends, and acquaintances (62.1%).

Table 3. Predisposition for casual carpooling by institution type.

Do You Offer a Ride?	Higher Education Institutions	
	Public	**Private**
Yes	62.3%	26.7%
No	11.6%	35.6%
Occasionally	26.1%	37.8%
Usually, for Who do You Offer a Ride?		
Family	3.3%	24.1%
Family or friends	16.4%	3.4%
Family, friends, or acquaintances	34.4%	62.1%
Anyone	45.9%	10.3%

Those drivers who do not offer rides were asked why they opt to not do so, and what could make them change their minds (Table 4). While the most significant concern among respondents from the public institution was the loss of freedom (50%), the fear of robbery was the most prominent cause (43.8%) in private institutions. We observed that 48.8% of drivers would offer a ride to anyone if they were paid financially, but in the private institution, for most respondents, no sort of reward would make them change their minds (54.8%).

Table 4. Reasons to not offer rides and possible incentives.

Why do You not Offer a Ride?	Higher Education Institutions	
	Public	**Private**
Losing my freedom	50.0%	12.5%
Fear of theft	25.0%	43.8%
Routes without riders	0.0%	37.5%
Other	25.0%	6.3%
What Type of Reward Would Make you Offer Rides to Strangers?		
Tax exemption	2.4%	4.8%
Crypto-coins	7.3%	2.4%
Rewards program	4.9%	4.8%
Paid rides	48.8%	26.2%
Nothing	34.1%	54.8%
Would offer without reward	2.4%	7.1%

Given that the celebration of casual carpooling should be mutual and have acceptance of both drivers and passengers, we also sought to understand casual carpooling habits among non-drivers (Table 5). It was noticed that the acceptance was more significant in the public institution in which 62.6% of the respondents say they are carpooling fans, while in privates, the number was 44.4%.

Still distinguishing between UFLA and private institutions, when comparing the proportion of respondents who are willing to take rides with strangers, we also found a greater predisposition among UFLA's students (81.2%) while for the private universities, this number drops to only 12.5%.

The analyses were also made under the MaaS perspective (Table 6). Considering that MaaS is a relatively recent concept [25], most respondents might not have been familiar with it. Thus, to analyze the results, we presented a compilation of MaaS central features as a single statement to the respondents.

Table 5. Casual carpooling habits among non-drivers.

Do You Get a Ride?	Higher Education Institutions	
	Public	**Private**
Yes	62.6%	44.4%
No	37.4%	55.6%
Usually, from Who do you Get a Ride?		
Family	2.6%	15.3%
Family or friends	2.6%	26.8%
Family, friends, or acquaintances	13.7%	44.6%
Anyone	81.2%	12.5%

Table 6. Willingness to offer rides within a MaaS context.

Adept at MaaS	Do You Offer a Ride?								
	All Participants			Public			Private		
	Yes	**No**	**Occasionally**	**Yes**	**No**	**Occasionally**	**Yes**	**No**	**Occasionally**
Yes	29.1%	16.5%	53.2%	27.3%	6.8%	65.9%	32.4%	29.4%	38.2%
No	20.0%	28.6%	51.4%	24.0%	20.0%	56.0%	10.0%	50.0%	40.0%

Overall, 53.2% of those who answered "yes" to the question regarding MaaS have already offer carpool rides. This number rises to 65.9% from UFLA's respondents' standpoint and drops to 38.2% among the private schools' respondents.

6. Discussion

6.1. Motivating Factors of Casual Carpooling Practices

The logistic regression model showed that the type of institution (public or private) was the only influential variable in offering casual carpooling. It is worth mentioning that other variables such as sex, age, and income were not representative to explain differences in the habit of offering rides.

We observe that this happens due to a long standing culture established in the city, especially by UFLA, which encourages this benevolent form of casual carpooling. In this sense, the institutional theory's lessons can be used, mainly regarding the role of normative isomorphism [57]. Ref. [58] pointed out that normative isomorphism occurs when there is a demarcation of conditions, methods, and practices common to activity, defined by shared norms and knowledge with other individuals, generating a similarity among them.

We verified that UFLA had institutionalized the practice of casual carpooling by installing physical pick-up points in avenues within the campus (Figure 2). The pick-up points indicate the region where the riders in the queue wish as a final destination.

Although there are no explicit signboards outside UFLA's campus indicating pick-up points, there are "informal" sites scattered throughout the city that lead to UFLA. These sites are generally close to public transportation bus-stops (Figure 3), similar to those observed in metropolitan areas in the USA [15].

In the USA, there are policies put in place to stimulate the practice of casual carpooling. Several incentives are offered to drivers, such as access to dedicated lanes and discounts in tolls [15]. However, contrary to one of the factors of success of the casual North American carpooling, "time-saving incentives for drivers" [11], there is no municipal or institutional incentive for drivers to offer these rides in Lavras. In addition, rides have no cost to passengers as well. In this way, 91.1% of the drivers do it out of benevolence and solidarity.

One of the factors that encourage this solidarity is the simplicity and agility in offering rides in Lavras. Passengers make a self-organized queue without any outside intervention. Whenever a car stops, visual communication or few words are enough to consummate the ride's act in this queue. The driver indicates how many passengers can enter the car,

while the queue order is generally respected. It is worth noting that eventually, whenever a driver sees someone, he/she knows in the queue, he/she stop a little ahead of the pickup point, and that given person in the queue (regardless of their position) goes to the car.

Figure 2. Casual Carpooling Pickup point at Federal University of Lavras.

Figure 3. Informal Casual Carpool Pickup point in the city of Lavras, near to a bus stop.

On the other hand, in the city's private universities, there are no physical carpooling pickup points on their campuses (as shown of Figure 2) nor in the city (as shown on Figure 3 for riders willing to go to UFLA). Such a fact may explain the discrepancy between

the percentage of rides to strangers offered by drivers from UFLA compared to drivers from private institutions (45.9% and 10.3%). Such a lack of "physical infrastructure" can act as a motivator to not offer a ride.

In this regard, the importance of trust in the carpooling act is more pronounced among the riders/drivers from UFLA than in the private schools (e.g., the driver's fear of being robbed/mugged is lower for UFLA's respondents than those from the private institutions 25% and 43.8%, respectively). In addition, in private institutions, 37.5% of drivers claimed that they do not offer rides because they usually do not encounter riders on their way to university, which may be explained due to the lack of "carpool pickup points" towards those institutions on the streets of the city.

Based on those findings, we advocate that the act of casual carpooling in Lavras is based on:

- Solidarity: drivers offer rides out of benevolence. They do not gain financial rewards or municipal incentives to do so.
- Simplicity and agility: for both drivers and riders coming and going to UFLA, casual carpooling is an intuitive and straightforward act, with the pickup points at normally placed on strategic points for most drivers, offering these rides does not affect their time-schedule.
- No costs to passengers: due to the institutionalized benevolent carpooling culture in the city, an unspoken sense of mutual trust is naturally installed. Thereby riders have no costs and are willing to accept and trust to carpool with unknown drivers and other unknown passengers.
- Institutionalized pickup points: lead legitimacy and practicality to casual carpooling' act.

One important peculiarity of those mentioned above casual carpooling practices is the role of solidarity (benevolence). They are far from the profitability concerns mentioned in the analysis of the characteristics of a MaaS. By being a long, well-established practice among UFLA's community, and we observed that these benevolent rides are inherent to the institution's culture, and it can be justified by normative isomorphism since the university counts with several formal and informal pickup points, but also by being a common-place practice shared by its members. This cultural practice allows users to have confidence in these sharing services [59]. However, trustworthiness relates to safety issues and not to the characteristics identified for the MaaS in terms of guaranteeing correct real-time information, a high level of quality, or offering reliable transport services.

Thus, we consider this institutionalized UFLA's casual carpooling practice as being aligned with [53] (p. 721) concept of sharing (see Figure 4 for further details).

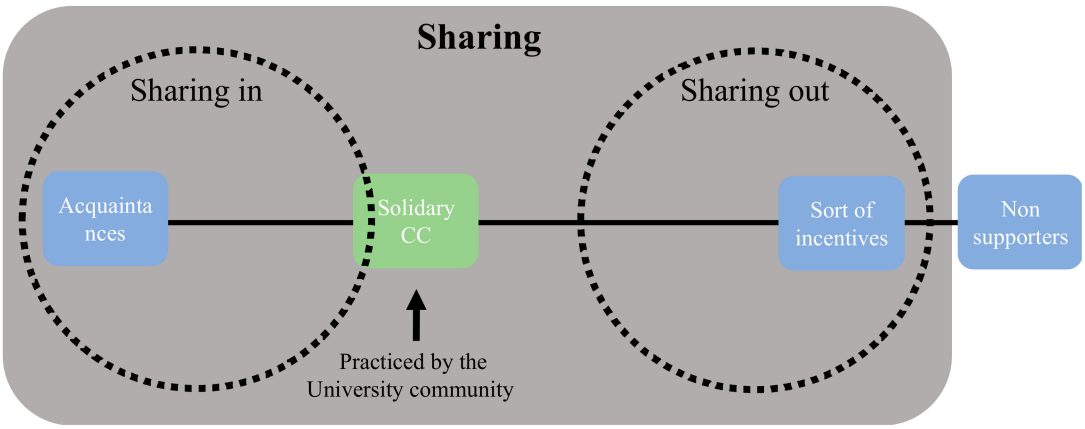

Figure 4. Conceptual framework for casual carpooling supporters under [53] sharing archetypes.

So, the act of providing shared rides is not suited for everyone. Thereby, it is essential to outline the user groups identified in our sample:

- Supporters of casual carpooling for acquaintances;
- Supporters of solidary casual carpooling for anyone;
- Supporters of casual carpooling for anyone given some incentives provided;
- Non-supporters of casual carpooling—drivers and riders that do not engage in casual carpooling activities.

By being a relation that mitigates interpersonal boundaries posed by materialism and possession (by private car-sharing); we believe that within the "sharing in–sharing out" spectrum proposed by [53], the practice of group 2 (supporters of solidary casual carpooling for anyone) is closer to the concept of "sharing in". Figure 4 demonstrates the identified groups plotted in [53] spectrum of sharing in–out.

By analyzing Figure 4, we advocate that group 1 should be placed on the left-end of the spectrum, within the sharing in concept propose by [53]. Group 2 suggests a level of openness that enables the self-extension [53]. In contrast, group 3 is placed on the opposite right-end of the spectrum.

Carpooling enabled by incentives resembles the rental of a vehicle by a car-sharing company, as suggested by [53]. It meets general MaaS characteristics: high level of service quality (as to reliability, strong reputation, and safety), simplicity (user-friendly, and convenient service), neutrality (presents available mobility options in a transparent way), flexibility because adaptable to changing customer needs. The distinction is that, in the carpool case, the activity is not configured as a business.

The presence of group 2 in the spectrum is only possible due to the analyzed context's peculiar institutional environment. However, this does not mean that such a group cannot exist in other contexts or even be stimulated. In addition, as we advocate towards a context-adaptive MaaS, this group can and should be used as a carpool catalyst to insert a MaaS business model.

The group of non-supporters of casual carpooling (4) is outside of the sharing spectrum. For this group motivating rewards would hardly be accepted. Further, due to their resistance to sharing, this group would have a particular aversion to MaaS. According to [4], MaaS is not meant to serve all; there will always be a demand that will not be fulfilled. However, stimuli can make drivers ride to other passengers besides acquaintances for the other groups (1, 2, and 3).

6.2. Urban Planning Strategies to Implement Casual Carpooling in a MaaS Scheme

Although we consider public transports to be a key actor for MaaS schemes, it cannot be generalized as a MaaS backbone. That being true, MaaS could not be adaptable to places where public transport is inefficient (and desperately needs mobility solutions). Based on our observations, we propose that casual carpooling practices might be a viable alternative for the implementation of MaaS. Indeed, we conclude that in UFLA Campus, drivers predisposed to use MaaS offer rides in most cases (82.3%). This number rises to 93.2% when stratified for the public institution. However, we need to structure this modal transport initiative so that casual carpooling becomes an efficient possible choice of services integrated into a MaaS.

Our first thought is that casual carpooling should not be made available to all MaaS users [4]. This strategy is based on the customization option offered by the service provider. In a MaaS scheme, transport options are offered to the users based on their personal preferences. For instance, a user who is not open to physical exercise may not have bike-sharing among his/her transportation options. Likewise, MaaS users should only have the option of accessing casual carpooling as a mode of transport if they are part of a specific interest groups (e.g., universities or enterprises).

The MaaS platform's customization could provide casual carpooling as a transport mode for the same company or university users. For instance, users (e.g., a student, professor, administrative staff, and so on) from the same institution would have access to casual carpooling among their MaaS transport modes, whereas this option would not be available to other users who are not part of this given university.

Moreover, based on logistic features, universities and big companies have common drop-off locations [11]. The institution as a unit can also encourage the act of sharing due to the safety and possible inherent social links established among its members [53].

Although the solidarity profile exists, we observed that some reward would motivate a more outstanding commitment to casual carpooling for anyone (48.8%). However, casual carpooling is a user-organized system [15]. In this way, establishing prices per ride/trip to be practiced among passengers and drivers would be quite complicated due to a lack of governance structures and mechanisms. In addition, stipulating prices per ride/trip could cause rebound effects [60] and transform casual carpooling into a business, such as Uber.

In this way, we propose that the financial rewards should be converted into credits into the drivers' MaaS accounts. A similar proposal to obtain credit is pointed out by [61]. Thus, the driver (consumer) becomes the service provider and user of the MaaS platform (prosumer). For instance, the consumer can offer, as a driver, casual carpooling (service provider); however, eventually, they can choose to use public transport, a bike-sharing service, or even casual carpooling itself, but as a passenger (user).

Further, we suggest that casual carpooling in a MaaS scheme should also be offered for free to passengers. That strategy is justified because this modal does not need governance; on the contrary, it must remain user-run (self-governed), and act only as support for MaaS implementation (Figure 5).

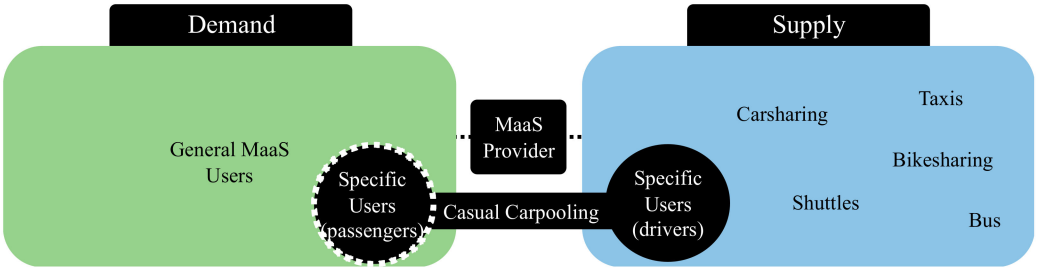

Figure 5. Theoretical model of casual carpooling in a MaaS.

Furthermore, the destinations served by casual carpooling are specific to certain regions. We observed that casual carpooling is better suited to fulfill the first or last-mile issue, given that the passengers who live near the final destinations are more willing to get a ride (see Table 2). For this, casual carpooling users are most likely to need transport connections to complement their transportation needs to commute to other locations.

Thus, an urban planning strategy for implementing casual carpooling in a MaaS scheme is based on four pillars:

- Unified drop-off points: with universities or enterprises as compelling alternatives due to their large number of commuters. Further, such commuters are likely to present similar social circles, which may contribute to the act of sharing.
- Modal customization: casual carpooling will not be for every MaaS user. This modal will only be available for users inserted in specific environments (e.g., unified drop-off points) that allow the creation of supply and demand.
- Credit rewards in MaaS: it would feedback the system, making providers of casual carpooling to be included in MaaS as users as well.
- No additional costs for passengers.

The strategy of implementing casual carpooling expands the possibilities for MaaS users who are part of specific institutions. Thus, casual carpooling is a positive strategy for the urban mobility scenario, as the incentives offered to drivers are expected to expand the offer of drivers willing to offer a ride while still meeting demand (the maintenance of this free mode). Thereby, casual carpooling as a transport mode within MaaS will remain simple, free of charge for passengers, encouraging drivers with incentives and rewards and targeting specific audiences.

7. Conclusions

Most studies on MaaS are being carried out in developed countries with efficient public transportation systems. This study aimed to contribute to initial discussions about MaaS in developing countries through more efficient usage of private vehicles' in favor of sustainable urban mobility. Our case study covers a particular context and cannot be generalized to other cities or countries. However, both the basic concepts and the methodological design can be applied in other urban environments, taking into account local specificities.

In MaaS, the mobility services are merging to form a "continuum" of different options. In this system, the traveler's choice will depend more on the price and performance (quality, comfort, flexibility, etc.) than on the mode. We conclude, in this study, that the practice of casual carpooling could be a viable proposal and could be implemented in MaaS.

However, this practice is certainly not due to all contexts. Thus, like other mobility solutions, the environment must be analyzed. This low-tech solution does not suit all users. Indeed, we identified four main motivators factors for casual carpooling: (1) driver's solidarity/benevolence, (2) simplicity and agility, (3) no costs to passengers and trustworthiness, and (4) positive influence of institutionalized pickup points.

The act of drivers sharing their vehicles with strangers without expected rewards, in a certain way, mitigates the personal boundaries imposed by materialism. Casual carpooling may be more efficient (even without tips) in places where some unified social contact exists, such as universities and enterprises.

Nevertheless, we noted that the consumers' acceptance of casual carpooling could be further stimulated and improved the lack of sharing culture or solidarity. For this, as a strategy to implement casual carpooling in a MaaS, we identified four pillars: (1) Unified drop-off points; (2) Modal customization; (3) Credit rewards in MaaS; and (4) No cost for passengers.

The unified drop-off points and modal customization are needed to stimulate "sharing in" and keep the act of casual carpooling simple. The credit rewards system is intended to reward drivers who offer voluntary rides, this bonus would not be in cash, but in credits (or discounts) in MaaS subscription packages. Attracting and possibly maintaining the loyalty of these drivers within the MaaS proposal, thus generating positive feedback-loops, and reducing rebound effects as stated by [60].

Finally, the lack of costs to passengers seeks not to configure casual carpooling, even inserted in MaaS, as a service but still a form of sharing. This implementation logic can be problematic for a city. Indeed, as there is no question of profitability, the city will have to take financial responsibility for the infrastructures (pick up points, and data management) and manage the environmental impacts created on this occasion (traffic jams). MaaS is about building a strong business partnership alongside the public authorities in charge of strategic mobility planning. However, how to insert actors who have the same objectives of smart mobility but who have a logic of sharing and no business? By following the [62] typology, we could identify the business model as being that of "route planners". Casual carpooling service is run by the public transport operator and integrated with global offer. The city that is built around a solid local base offers this service not as a user-centered innovation but as a social innovation aimed at greater inclusion. In this way, casual carpooling may prove to be a feasible transport option supplementing MaaS schemes in first and last-mile commutes or places where public transport is not efficient.

As the motivating factors for the use of casual carpooling' act identified in Lavras, certainly in other contexts, other motivating factors could be found, to the implementation of casual carpooling or other forms of transport. Although this study needs more in-depth analysis, we have brought initial thoughts about casual carpooling in a MaaS scheme, which, to the best of our knowledge, has not yet been addressed in the literature.

As a future agenda, we propose to expand our sample to other developing countries, in places where there is a lack of suitable Public Transportation network, such as cities in Latin America´s and Asia´s countries. We could also question the opportunity to develop

such a system in rural areas in developed countries. However, the minimum threshold of exchanges to guarantee quality carpooling could be a problem. In addition, it may be interesting to look at models of the casual carpooling outside of MaaS. Experiments within universities, replicating the motivating factors of casual carpooling identified and testing other variables, can be a good start.

One central aspect that must be confronted in future research includes the recent impacts of the COVID-19 on the willingness to offer and use the carpooling mode among drivers and users. Ref. [63] thus show that the COVID-19 crisis had an immediate negative impact on MaaS development's scalability because of lower demand for shared modes. However, in the middle term, MaaS can increase system resilience by providing more information on safety and mobility options to strengthen users' trustworthiness.

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