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Measurement of the quality of service of the informal transportation mode mototaxi in Mexico

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ABSTRACT

This work presents an approach to assessing the significance of the elements that constitute the quality of service (QS) from the user's perspective of the emerging transportation mode named "*mototaxi*". This emergent transportation mode is meant to provide last-mile mobility to people in certain population strata and has an interactive role with others already established. The motivation of this work is to provide information that might help during the regulatory process of this service by allowing alignment of the offered service characteristics and avoiding mistakes that transportation authorities have incurred in the past with other public regulation processes. The methodology used to assess the QS from the user's perspective consisted of identifying the essential features that encompass the QS vector for the mototaxi. Later, a discrete choice experiment was designed, and a Stated Preferences (SP) survey was conducted to design a Logit model to estimate the weights of the critical factors in the QS vector. This methodology was applied in a study case in a Mexico Valley Metropolitan Zone municipality. The results indicated that *travel cost, travel time*, *driving style*, and *comfort*, were the essential factors perceived by the mototaxi captive users. The conclusions reached are meant to improve the users' perception of this transportation service and assure its permanence.

1. Introduction

In emergent economies, the terms: *informal*, *non-conventional*, *paratransit*, *low-cost intermediates technologies*, *non-regulated, and intermediate transportation service* are frequently used to refer to public transportation systems with managerial, operational, and quality features of low standards. There is no proper definition to denote this range of transportation services. A specific denomination comes from the perspectives or characteristics from which it has been previously studied. In this sense, Vuchic (2005) establishes two transportation groups according to the level of regulation conducted by governmental entities: the one from developed countries and the one from developing countries. The last one is frequently tagged as "disorganized" and called *paratransit*. This term is the most generalized because it encloses a type of transportation system that is perceived as the competitor of the official transportation system (Salazar, 2015). Even today, exist uncertainty about these boundaries, prevailing what Rimmer (1980) defined almost four decades ago as "somewhere between private transport and conventional public transport".

On the other hand, the term "informal transportation services" has been frequently used to refer to the ones adopted in specific regions of the world: Africa, several parts of Asia, and Latin America. Although these are territories where informality predominates, informal transportation services also exist in so-called developed countries (Cervero, 2000), and therefore, it is mistaken to associate informal transportation services with developing regions. For instance, in Brazil, the Integrated Transportation Network, the ancestor of the Bus Rapid Transit (BRT), a formal and innovative system with high standards, was first implemented in the 1970s. Moreover, at the beginning of this millennium, in Colombia, the Transmilenio was launched, a BRT system that eventually became a successful worldwide study case. Hence, the relationship between informal transportation services and emerging countries should be considered incorrect.

In this context, the label "informal" refers to transportation modes whose existence and operations are not regulated by the official sector (Cervero & Golub, 2007). This definition is the most appropriate since it accurately expresses their operation characteristics and does not necessarily suggest perpetrating illegal activities (Cervero, 2000;

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McFarlane, 2012). This assertion is adopted in this work, remembering that in most cases, the authorities somehow recognize the operations of informal transportation services, either by charging them some taxes or by allowing them to operate. Eventually, mototaxis satisfy users' mobility needs by complementing the public transportation network.

2. Framing the mototaxi concept

According to Cervero (2000), informal transportation modes can be embedded into five classes depending on the capacities of the vehicles. These classes are buses (class I), *minibuses* and *microbuses* (class II and III), three-wheelers and motorcycles (class IV), and those non-motorized like *bicitaxis* (bicycle-taxis) or those drawn by animals (e.g., horses). In this sense, mototaxi is classified as a class IV vehicle. This classification must be carefully used since, in emerging countries, the *bicitaxi* and mototaxi modes (whose difference lies in human propulsion or combustion engine) both have opposite legal connotations. In the case of the Metropolitan Area of the Valley of Mexico, the mototaxi is informal, while bicitaxis are formal. Bicitaxi mode was given the name *Ecobicitaxi* during an official recognition process conducted by the authorities almost two decades ago (GEM, 2004a; GEM, 2004b; GEM, 2019). Oppositely, mototaxi was excluded from the governmental transportation framework because of greenhouse emissions.

The mototaxi transportation service is categorized as an *alternative public transportation service* and it is also classified as paratransit (Gwilliam, 2002), whose function is to provide spatial coverage in areas not fully served by routes of conventional transportation services (Cervero, 1997).

In Mexico, mototaxi emerged due to the poor coverage in populated or low-income zones where people without formal jobs were searching for opportunities to participate in economic activities. The first attempts were held in the late 1990 s when some small investors intended to provide a service with a bicycle and a homemade chassis attached to a structure in a shell form to protect users against sunlight and weather. This service was named *bike-taxi*.

Given the immediate users' approval due to its economy for short trips against taxicab services, this service quickly spread over the boundaries of the Mexico Valley Metropolitan Zone (characterized as "dormitory zones"). It was mainly used as a feeder for route-based public transportation services. Primary users were students or stay-at-home parents carrying daily food supplies; the service became broad and popular among low-income people for regular door-to-door short and last-mile trips.

Bike taxis are widely used in many countries around the world. This concept is also known as *pedicab* in the USA, Canada, most European countries, and Oceania; *cycle rickshaw* in South, Southeast, and East Asian countries; *velotaxi* in Germany; *cyclo* in Vietnam and Cambodia; *beca* in Malaysia; *becak* in Indonesia; *trisikad* in the Philippines; or *trishaw* in Singapore. The term *rickshaw* comes from the Japanese word *jinrikisha* (human-powered vehicle). In Asian cities, its orientation is basically for regular everyday trips in contrast to the touristic orientation given in North America and European cities. Amorós (2013) provides a more detailed classification of this informal or alternative transportation mode.

Mototaxi emerged when bike taxi service providers changed bicycles to low-cost utility motorcycles and scooters with an engine with displacements ranging from 50 to 150 cc. With this technology, physical effort and travel time were reduced in exchange for increased operational costs. This scheme is equivalent to the *auto-rickshaw* widely used in African countries and India. Some ultimate innovations took place in India with the solar rickshaw designed by the Council of Scientific & Industrial Research (CSIR) in 2012, and the Indian Postal Service currently uses it.

The accelerated, increasing rate of mototaxi in several countries has led the governmental authorities to take measures to control the growth of small operators, such as acceptance, recognition, regulation, or even prohibition (Cervero, 2000). Regulation depends on the context: the demand characteristics, the origins and destinations served, the urban street network, the technology at hand, and the existence of public dependencies in charge of the regulation.

In most cities in developing countries, significant demand exists to ensure profitability in mototaxi service areas at reasonable service levels. Without regulation, the transportation systems would eventually reach the worst performance features of an emerging market. Regulation could help to organize the market to prevent congestion and to guarantee the system features, such as a specific service level, vehicles qualification, skilled and trained operators, and the eventual incorporation of users' insurance (Guillen, 2004; Cervero & Golub, 2007; Urdaneta & Ocaña, 2008). Even during regulation processes, more wide-ranging actions can be considered for planning purposes, such as providing additional infrastructure for system operations and operations design based on route scheduling of mass transportation systems. In this sense, mototaxi is included in conventional transportation systems modeling in some regions of Asia. In Latin America, the mechanical and operating parameters of mototaxi have been incorporated in studies of vehicle flow microsimulation (Enam & Choudhury, 2011; Lazo & Araujo, 2017).

The present work's motivation is to provide the technical elements from a quality service user's perspective that the authorities/decision-makers can consider in an eventual regulation process to integrate mototaxi into the already existing public transportation system in a short horizon planning. This starting point would allow authorities to set the initial criteria to reduce utopias or market assumptions and eliminate mistakes made in the already settled public transportation regulation processes (Van de Velde, 2011; Van de Velde & Wallis, 2012).

This work aims to identify and calculate the importance of the elements that comprise the Quality of Service (QS) of the informal mode mototaxi in an empirical case in the Nezahualcoyotl municipality located in the east of Mexico City.

The paper is organized as follows: section 2 presents the adopted methodology consisting of two stages: a) identification of the main factors that constitute the QS vector for mototaxi and b) the significance of each main factor of the QS vector by the estimation of a discrete choice model (DCM). Section 3 describes some of the characteristics of this transportation service for the case study. Later in section 4, a discussion about the main QS factors identification is made. Section 5 illustrates the process of modeling conducted for the empirical case, and later, the most noteworthy results are discussed. Finally, the paper ends with the main conclusions reached.

3. Methodology

The process followed in this work to determine the factors' weights that constitute the QS is displayed in detail in Fig. 1.

The methodology shown in Fig. 1 involves stages whose robustness was already demonstrated. Then, a similar methodology is followed in the present study. Here it is assumed enough reliability of the results obtained in previous studies. For example, Hensher & Prioni (2002) calculated a service quality index (SQI) for public transportation buses from thirteen identified factors that constituted the quality of service. Later, in Eboli & Mazzulla (2007), the authors formulated a model that relates public transportation customers' satisfaction to service quality attributes. Part of their methodology consisted in identifying up to sixteen elements of the quality of service. Then, Eboli & Mazzulla (2008) estimated the willingness to pay for implementing specific QS standards in bus transportation systems. The estimated model was a discrete choice model defined by nine factors of the QS, which were previously selected and their variation levels. In summary, most QS studies of public transportation services consider, with certain variations, two phases: the factors identification and its subsequent quantification.

Another consideration is that the absence of official information has been attempted to be compensated by gathering data from several case

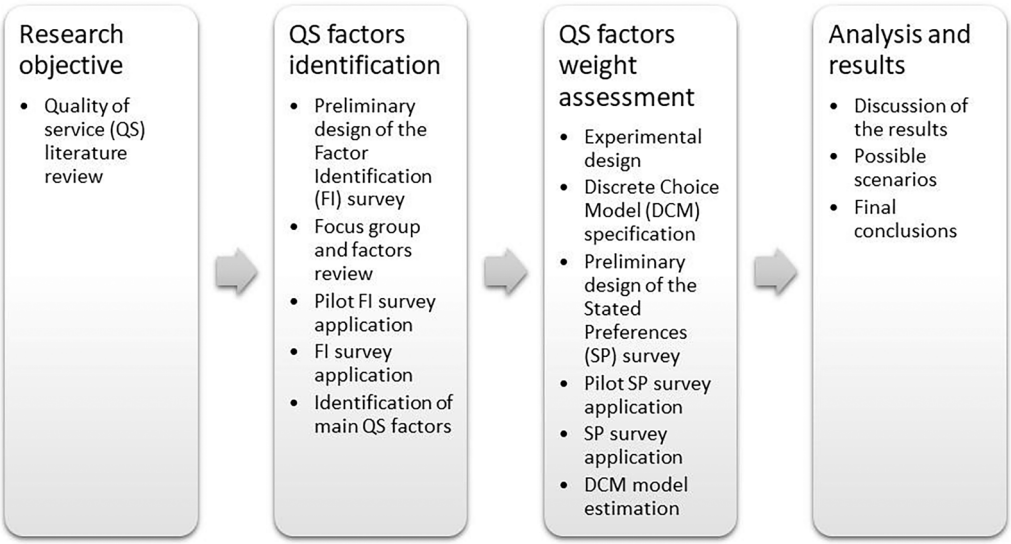

Fig. 1. Methodology for the QS factors identification and quantification process.

studies. In this sense, the methodology used in this study considered fieldwork that, given the absence of documental information, it was necessary to obtain from primary sources directly from the mototaxi operators and users; those efforts allowed to obtain and sustain the findings. Even sometimes, it was necessary to complement the information with direct observation to compare "what users said", "what users do", and "what users observed" (Aceves-González et al., 2015).

4. Study case: Nezahualcoyotl municipality

A study case was selected to apply the methodology described in the previous section. The study area selected was within the limits of Nezahualcoyotl, a municipality located in the Mexico Valley Metropolitan Zone. This place was selected due to the vast existence of the mototaxi services (see Fig. 2). Nowadays, there is no mototaxi service regulation nor established mototaxi stations. On the other hand, this service is provided on a territorial basis since groups of operators with some affinity to political parties exist and circulate in the surrounding streets in search of the users. In general, mototaxi drivers know the market dynamics, particularly the schedules. Drivers gather the mototaxi units in high-demand zones such as schools, health centers, or markets/supermarkets.

There is no official record of the number of mototaxi operating units in the Mexico Valley Metropolitan Zone; unofficial estimations consider the existence of at least 45,000 units (Pasajero7, 2020), and half of this number is concentrated in Mexico City. Nezahualcoyotl is one of the

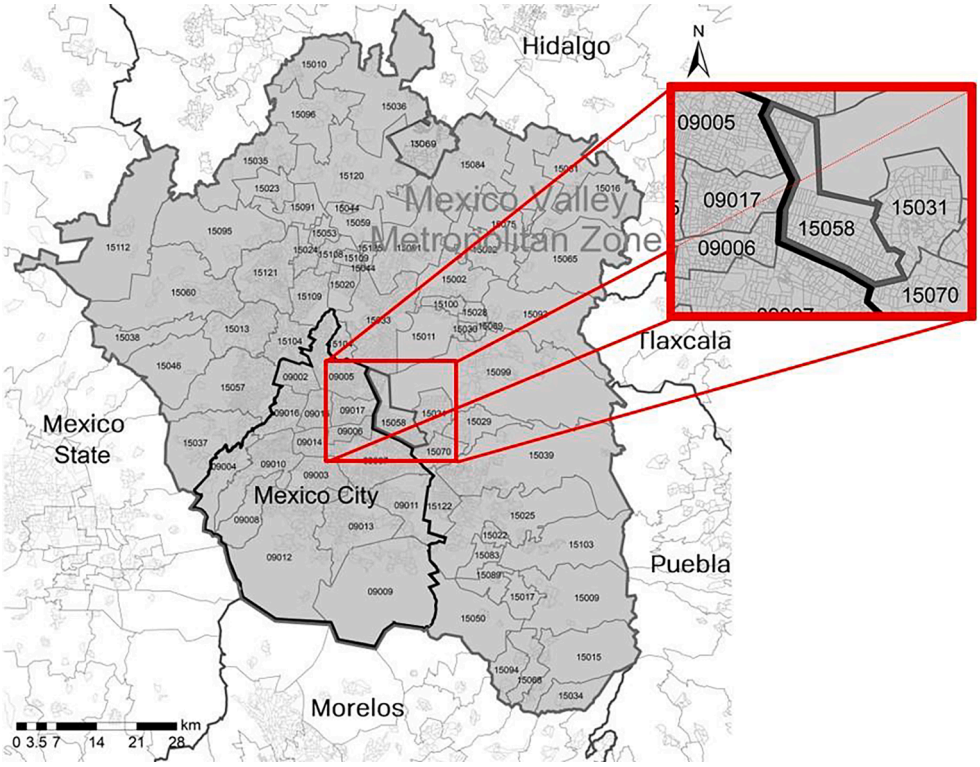

Fig. 2. Context of the study case in the Mexico Valley Metropolitan Zone. Source: INEGI, 2022.

municipalities where this phenomenon has proliferated the most. The last is a symptom of the acceptance of this mobility alternative. Nevertheless, uncertainty remains about the number of people employed (unit drivers) and the vehicle fleet size.

The lack of external regulation of the service (Cervero & Golub, 2007) is manifested in the pressure on the leaders of mototaxis organizations by social organizations, political parties, and even the local police. This internal coordination (a kind of "self-regulation") is demonstrated mainly by the mototaxi drivers' pressure on such organizations to "have the right" to provide transport service within its territory or other verbal agreements between them.

The lack of regulation is not only for the case study itself, but it is a characteristic of the entire Mexico Valley Metropolitan Zone, where this informal transportation mode prevails. There are also districts in Mexico City where this unregulated service or even variations with more precise characteristics exist, such as the one in Iztapalapa called golfitaxis. This informal passenger service uses golf carts for people's mobility. On the other hand, in Mexico City, specifically in the Historical Center or the downtown area, it was already made an approximation of the mototaxis service regulation, where this service went from initially being a touristic transportation service to a public transportation mode named ciclotaxi. The regulation focused on determining the number of authorizations for a specific type of vehicle and an approved service fare.

The mototaxi has recently proliferated in the limits of Mexico City and the Mexico Valley Metropolitan Zone. Mototaxi represents an employment option for individuals with no economic activity or seeking additional income in a part-time job. From the economic perspective, the mototaxi service would only subsist and proliferate with users' demands. Data provided by some mototaxi drivers indicate that their monthly incomes are equivalent to USD 464 (18.1 MXN = 1 USD) (El Universal, 2007); although Berrones-Sanz (2018), from interviews with mototaxis operators found more conservative monthly earnings of USD 246. Therefore, drivers' salary levels are difficult to reach working in a factory or other formal service jobs. Additionally, drivers do not require letters of recommendation, a certain academic level, or special permissions. The low cost of acquiring a motorcycle/bike and the *calandria* (a cabin or structure where the passenger remains during the trip, see Fig. 3) contributed to its proliferation.

The mototaxi perception has labeled it as a dangerous transportation mode that attempts to the physical integrity of users and pedestrians who share the streets. In this sense, society's opinion about this service is divided. For those who make their trips by private car or using a public transportation mode is a dangerous mobility option; this society sector considers the need to prohibit mototaxi and its variants. In contrast, the feelings toward the mototaxi are favored by captive users; mototaxi allows them to perform their activities with fewer setbacks, e.g., bringing them closer to massive transportation modes stations or when making short door-to-door trips. Additionally, the number of mototaxis circulating in the principal streets in the study area originates drawbacks to traffic flow. Cervero and Golub (2007) quote the World Bank (2002) in that "…the provision of informal public transport is seen as part of the problem rather than part of the solution…". Besides, there is a highlighted perception that informal transportation costs exceed the benefits.

From the mobility point of view, mototaxi serves two purposes. First, to move people on short trips within the districts (short-distance trips), and second, to take users closer to public bus transportation stations or bus stops already established or vice versa (last-mile trip). Mototaxi assures people mobility out of the bus routes coverage and serves as a feeder service to other public or mass transportation modes (e.g., existing Bus Rapid Transit systems). Finally, mototaxi contributes to people's accessibility, subjective welfare, and equity, especially in developing countries. For example, in the Indian city of Bengaluru, the modal percentage attributable to three-wheeled scooter taxis (equivalent to mototaxi) reaches 11.56 % of the more than six million city trips. Similarly, in the surroundings of Mexico City, this service represents 1.8 % of daily trips, which is a higher proportion than the reached by other formal transportation modes and even some routes of mass transportation services such as light rail or trolleybus (INEGI, 2017).

It is noteworthy that even with its technical deficiencies and low-quality standards, the mototaxi meets most passenger demands. The mototaxi provides amplitude in its service, acceptable operational speed, fair rates, and door-to-door trip coverage.

5. Factors identification for the qs vector

A set of fourteen factors related to the QS vector was defined and grouped in dimensions related to the driver, the vehicle, and the service operation. A focus group consisting of twelve captive mototaxi users in Nezahualcoyotl was invited to validate the concepts of the QS factors used in a Factors Identification (FI) survey.

Concerning the size of the vehicle, the mototaxi consists of two separate elements: the traction part and the structure where the user stays during the trip (see Fig. 3). In the focus group meeting, it was agreed that the term *vehicle* should be changed to the word *calandria*, which users and operators use daily. Another clarification was related to the propulsion vehicle, whether it was provided with a bicycle or a motorcycle. This difference was included as a QS factor. The *calandria* appearance refers to its degree of wear or physical state (e. g., an unpainted or damaged structure), its covering material (plastic, metal), and the comfort experienced that depends on the seat dimensions and the available space inside the vehicle. The focus group participants confirmed the QS elements.

Regarding the driver, this dimension consisted of *physical appearance of the driver* (e.g., well-dressed, and clean), *driver's courtesy*, *driving style*, and *accident risk onboard*. This factor was initially considered within the operation dimension; however, while the focus group session, it was agreed that *accident risk onboard* is more related to the drivers because of their *driving style*. The elements related to the operation were: *travel cost*, *travel time* (onboard the vehicle), *waiting time* to use a mototaxi, *time at which the service is provided*, *walk distance* (to find a unit), and the accessibility to a *station location*. Table 1 presents a summary of the QS factors.

The FI survey was designed to determine the most important of

Fig. 3. Examples of informal transportation services in the study area: a) bicitaxi; b) mototaxi; c) golf taxi.

Table 1
QS factors related to mototaxi identified in the FG meeting.

Dimension	Factor (attribute)
Vehicle	Shell structure material (plastic, fabric, metal)
	Vehicle (*calandria*) physical aspect
	Bike or motorcycle (vehicle)
	Comfort (seats design and material, space inside)
Mototaxi driver	Driver courtesy to the users
	Driver appearance (dressing, cleanness)
	Driver operational behavior (driving style)
	Accident risk onboard
Operation	Transportation fare
	Time onboard (travel time)
	Moto-taxi station location
	Service scheduling
	Boarding waiting time
	Walking distance

fourteen QS factors for mototaxi users to include them in a utility function later to be estimated. This factor selection led to a better experimental design by decreasing the number of combinations and reducing bias in answers, e.g., due to participants' fatigue when making pair-wise comparisons. For a more detailed explanation, see Louviere et al. (2000) or Ortuzar (2000).

The FI survey consisted of three sections: a section with data about the application location, the interviewer, and some other elements related to the implementation phase were also registered; the second section consisted in documenting the trip characteristics of mototaxi frequent trips, such as *travel time*, *waiting time*, *travel cost*, *walking distances*, as well as gender, age, and income user. Later, the group of fourteen factors was shown to the participants, and was asked to provide their appreciation about the level of importance, using a previously determined scale for each factor to assess their importance using the following scale (Grigoroudis & Siskos, 2010): unimportant (1), small (2), important (3), very important (4) and too important (5). A pilot exercise was conducted to validate the FI survey format before the final application, the use of the right words' use and their complete understanding.

The FI survey was applied at five different trip attractors or activity centers in the study area: schools, markets, and health centers. It was assigned a quantitative value v_j (from 1 to 5, the higher, the more important) to each level. The quantitative assessment for each factor (V_i) was obtained through the expression $V_i = \sum_{j=i}^{n} a_{ij} v_j$, where a_{ij} represents the election frequency of factor i for the hierarchy order j (from 1 to 5) (Romero, 2005). Later, the descending sorting of the quantitative assessment of each factor provides the list of essential factors (values greater than V_i) and those with less importance (values lesser than V_i).

Table 2 shows that, based on three groups of importance, the one with the highest evaluated factors scored between 515 and 645 points (*accident risk onboard*, *driving styler*, and *driver's courtesy*). The second group of intermediate importance scored between 443 and 495 (*driver's appearance*, *comfort*, *shell structure material*, *travel time*, and *vehicle physical aspect*). Finally, the group of less importance consisted of *vehicle type*, *station location*, *service schedule*, *boarding waiting time*, and *walking distance*. In this last case, given that the mototaxi service is territorial and operates in any street in the study zone, the *waiting time* and the *travel time* are certainly short, having no repercussions on the stations' location. The high and intermediate-importance groups include attributes that affect the service perception more directly. For instance, *travel cost* is an element of equal importance compared to *bus services*, or *driver's appearance* and *driver's courtesy* are significant due to the interaction with the user. In case of *accident risk onboard*, this is more related to the *driving style*, possibly explained by the poor user protection that the mototaxi vehicle offers.

In this way, the four key factors of mototaxi quality service from the user's perspective were:

- the risk of experiencing an accident onboard (*accident risk onboard*),
- the driver's operational behavior (*driving style*),
- Fare (*travel cost*), and
- the driver's courtesy to the users (*driver's courtesy*).

Table 2
Importance of the QS factors.

Attribute	Assessment scale					Score	Importance group
	1	2	3	4	5		
accident risk onboard	7	1	5	9	117	645	
driving style (driver's operational behavior)	2	3	19	29	86	611	High
travel cost (fare)	3	8	46	39	43	528	
driver's courtesy (to the users)	2	11	51	37	38	515	
driver's appearance (dressing, cleanness)	8	19	37	37	38	495	
comfort (seats design and material, space inside)	6	9	61	39	24	483	
shell structure material (plastic, fabric, metal)	6	23	39	42	29	482	Intermediate
travel time (time onboard)	16	18	50	31	24	446	
vehicle physical aspect	11	27	46	35	20	443	
type of vehicle (bike or motorcycle)	30	37	26	16	30	396	
station location (mototaxi)	31	29	40	15	24	389	
service scheduling	36	31	31	14	27	382	Low
boarding waiting time	33	38	28	23	17	370	
walking distance	35	42	37	14	11	341	

6. Evaluation of the weight factors of the QS mototaxi

The factors used to design the SP survey were *accident risk onboard*, *driving style*, *driver's courtesy*, *driver's appearance*, *comfort*, *travel cost*, and *travel time*. Table 3 shows the attributes and levels defined in the experimental design for the attributes' final selection according to the FI survey results. The user's perception of experiencing an accident while using this transportation mode was considered connected to the operator's driving style. For example, Romero (2005) found in a focus group exercise that public transportation users did not perceive the chance of having an accident by bus since this variable is implicit in the variable *driving style*. Users perceive a lower probability of experiencing an accident with better driving, so it was decided to consider only the variable *driving style*. Also, variable *courtesy and driver's appearance* were merged into a single variable to reduce the number of variables in the experimental design. Also, variable *travel time* was integrated into the utility function, which allowed the estimation of the subjective value of *travel time* for the mototaxi trips.

The five variables were managed at two levels, while the values of the current level were obtained from the information obtained from the FI survey. Specifically, the concept current level refers to *courtesy and driver's appearance*, *comfort*, and *driving style*. Several service levels were found for these three variables; for example, some operators drive bad, and others drive good or excellent. Similarly, there are both good and bad levels for *courtesy and driver's appearance*. Three designs were

Table 3
Variables and levels considered in the experimental design.

Variable	Type	Current level	Used levels
travel cost, $	quantitative	5, 7,10	−1.5, +2.5
time on board, min	quantitative	10	−5, +5
courtesy and driver's appearance	qualitative	Current	poor, good
comfort	qualitative	Current	poor, excellent
driving style	qualitative	Current	bad, excellent

obtained corresponding to the three current levels of *travel cost* (5, 7, and 10 MXN, identified in the FI survey). These fare values provided greater realism to the design. The SP survey was applied to the interviewees and presented the complete set of cards to match it to the mototaxi use. The three designs included 80 % of the *travel cost* values.

In the SP survey design, it was considered the existence of two mototaxi services. The first one, named *current service*, was defined from the values of the five variables the users perceive at mototaxi presently operates. In contrast, the second corresponds to a hypothetical situation in which it is admitted to introducing an improved service characterized by high standards in some involved variables relative to an increment in the *travel cost*. The SP technique helps to find scenarios that capture formal transportation modes' changing and flexible dimensions. It is worth mentioning that the levels of the variables of the current service in the eight combinations remain constant. This scenario is the reference when conducting the interviewees' selection process, ending up with more consistent parameters (Rose et al., 2008). For the *travel cost* factor, it was used at a lesser level (-1.5 MXN), and for the *travel time*, it was used at a greater level (+5 min). The formerly allowed compensation between the services considered in the experimental design.

Later, a Multinomial Logit Model (MLM) was estimated. In this model, the utility is defined as the sum of two parts: a systemic and a random component (Ben-Akiva & Lerman, 1985), and it allows the estimation of each factor's weight in the QS concept (Ortuzar, 2000). In this sense, the utility function for each alternative is given for the equation (1):

$$U_n = V_n + \varepsilon_n \tag{1}$$

Where V_n is the quantifiable part and ε_n is the random component that represents people's idiosyncrasies and preferences and incorporates measurement and observation errors. The first term can be expressed as shown in equation (2):

$$V_n = \beta_0 + \beta_{tc} tc_n + \beta_{tb} tb_n + \beta_{cour} cour_n + \beta_{comf} comf_n + \beta_{styl} styl_n \tag{2}$$

In the adjustment of the Logit model, all the variables were generic. Qualitative factors were managed as a dummy term in which a cero value was assigned to the more unfavorable levels (poor, bad) and a value of one for the highest levels (good, excellent).

The characteristics of the SP users' survey respondents are displayed in Table 4. Also, the users' characteristics that answered the SP survey are presented in Table 4.

In absolute values, *driving style* is the most critical factor (1.27), followed by *travel cost* and *comfort* (0.367 and 0.309, respectively), while *travel time* was less important. The factor *courtesy and driver appearance* was not significant at 95 %, and the *travel cost* was more statistically significant (t = 10). See Table 5. Considering the previous results, in a mototaxi regulation process: *travel cost*, *comfort*, and *driving style* are the service quality factors that the authorities in charge of its control must emphasize. The *driving style* is perceived as four times more important than an improvement in *travel cost* or *comfort* since this factor incorporates the *accident risk onboard*.

Table 4
Characteristics of the SP survey.

Gender	%	Motive	%	Age, years	%	Monthly income, MXN	%
Woman	56	School	29	Up to 18	7.2	No income	14
Men	44	Work	21	19 to 30	34.1	100 to 1,500	14
		Visit	14	31 to 40	25.7	1,501 to 3,000	17
		Shopping	26	41 to 50	22.8	3,001 to 4, 500	20
		Leisure	3	51 to 60	7.2	4,501 to 6,000	16
		Other	7	60+	3.0	6,001 to 8,000	17
						8,001 to 12, 000	2

Trips/week	%	tv, min	%	cv, $	%
1	17	Up to 5	15	Up to 5	16
2	18	5.1–10	35	5.1–7	25
3	15	10.1–15	25	7.1–10	33
4	4	15.1–30	22	10.1–15	23
5	38	30+	3	15+	3
6	5				
7	3				

Table 5
Logit model estimated.

Attribute	Coeff.	(*t*-ratio)
travel cost, $	−0.367	(-10.0)
travel time, min	−0.043	(-2.9)
driving style, 1 = excellent	1.270	(8.7)
courtesy and driver's appearance, 1 = good	0.126	(0.9)
comfort, 1 = excellent	0.309	(2.1)
Constant term (improved service)	−1.280	(-8.3)
Number of observations	1,022	
Log-verisimilitude	−579.2	

The statistical significance of the constant term in the model allows inferring that there are other attributes that mototaxi users consider when choosing the transportation mode. Its negative sign implies a disutility per se in the use of the service, possibly linked to the problems this mode causes on the streets or when using public spaces (Heinrichs et al., 2017). This fact would imply the need for a more extensive analysis. The results shown in Table 5 are counterintuitive to those reported by Victory and Ahmend (2016) for a case study of mototaxis in India, where the authors report a similar model with six variables: *reliability*, *comfort*, *convenience*, *travel cost*, *travel time*, and *trip length*. However, only four of these variables are significant; additionally, they exhibit the coefficient of *travel time* with a positive sign, which contrasts with the theoretical findings from Ortuzar and Willumsem (2011).

In Table 6, it is shown the *subjective value of the travel time* (SVTT) for mototaxi users and the *willingness to pay* (WTP) for the scenario with excellent *driving style*, good *courtesy and driver's appearance*, and excellent *comfort*; the corresponding SVTT value is 7.0 MXP. This value is high when it is considered that the average travel time onboard the mototaxi reported in the SP survey was 14 min. One possible explanation would be the limitation of the arrival time at the travel destination. The SP survey showed that 50 % of respondents made the mototaxi trip for school and work purposes (see Table 4) since there are restrictions on the arrival time. This result is consistent with the statement made by Toro et al. (2005), who showed, in a study of public transportation in the city of Cartagena, that the operational speed is an incidence variable for users; this is, there is a high probability of choosing a transportation mode for their trip.Table 5.

On the other hand, the high value of the related SVTT mototaxi could also be explained by the conditions in which typical trips are made. For example, during the FI and SP surveys implementation, it was noted that homemakers who shop or pick up their children at school use this service more often in the direction of travel where the conditions are less favorable. For example, when coming back from the market or school with their children, they are more likely to use mototaxi to avoid the physical effort needed for carrying heavy home supplies or school backpacks.

As for the *driving style*, the availability of users to pay for passing from the current level to an excellent level was 3.5 MXN. The old value should be taken with some caution since it is indirectly involved the likelihood of *accident risk onboard* the mototaxi due to driving speed. The last is a service feature, which might be attributable to the high competition to

Table 6
Subjective value of the *travel time* (SVTT) and willingness to pay (WTP).

SVTT		Willingness to pay		
(MXN/min)	(MXN/h)	*driving style*	*courtesy and driver's appearance*	*comfort*
0.12	7.03	3.5	0.3	0.8

finish trips quickly and offer more services in the study area. Moreover, *comfort* was the third highest-rated element of the QS, with a willingness to pay around 0.8 MXN (see Table 6). Finally, *courtesy and drivers' appearance* do not affect the user's choice of mototaxi for their travel; this is a logical outcome if it is considered that these elements do not directly affect the service's performance during the trip.

7. Conclusions

This research relied on two main aspects: the first was to identify mototaxi service-related aspects to how the service is offered, the time, and cost indicators, as well as some attributes related to *driving style*, *courtesy and driver's appearance*, and *comfort*, which are challenging to analyze due to their qualitative characteristics. The second was to provide information to be incorporated into the design of an efficient service and align it with the quality standards expected by the mototaxi users.

Once the regulator authority recognizes the factors better assessed by the mototaxi users, it can define directives to go in-depth and study specific points to incorporate in an eventual regulation process. Based on these ideas, it is emphasized that mototaxi service regulation involves incorporating elements from the QS user perception, which would avoid, on one side, making the same mistakes as those made in the past during the regulation of the bus services. On the other side, it will clarify the service specifications that should be included in a contract or regulation process, decreasing subjective interpretation.

Another point to highlight is that it is necessary to perform a complete study of this transportation mode for the study area to provide more specific evidence about the market dimension. For example, to conduct research to make a scientific approximation about the number of mototaxis needed in the eastern part of the Mexico Valley Metropolitan Zone to meet the user's actual needs. Similarly, to obtain information concerning the user's habits to meet mobility patterns and their interaction with other transportation modes.

The mototaxi, even with its limitations of low-efficiency standards, meets the purpose of transporting people of certain social strata and plays an essential role with other already established transportation modes. Therefore, its regulation process should be seriously studied before this mobility option might be officially incorporated as a complement to the well-established public transportation systems.

Finally, it has been confirmed the advantage of using the SP technique by obtaining information on informal transportation services, specifically for mototaxi, because it allows analyzing scenarios on actual operational conditions or changes that may occur shortly or in the medium or the long term.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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