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How strong is demand for public transport service in Nepal? A case study of Kathmandu using a choice-based conjoint experiment

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Abstract

A public transport system is the most efficient and equitable solution to the challenges of urban mobility and climate change. To improve public transport, technological innovations, policy interventions, and behavioral changes should all be applied appropriately; however, there is a lack of information about the demand for public transport services in developing countries. This paper aims to measure the degree of demand for public transport services by comparing various factors used as a case study in Kathmandu, one of the most congested urban areas in a developing country. We designed a choice-based conjoint experiment with five attributes: mode of transport, waiting time, one-way fare per km, commute time per km, and payment method. Our results indicate that 73% of the respondents are in favor of changing the current transport policy and wish for a shift to public transport, which means that most commuters are in favor of the proposed mode of transport, that is, MRT. On the other hand, the study reveals that respondents have a negative evaluation of motorbikes, one of the most popular modes of transport in Kathmandu. Our results, showing users' unsatisfactory situation with motorbikes as a transport measure, provide transport planners guidance for addressing current public transport policies, indicating a massive rapid transit system with a low fare would be highly welcome in a typical congestion area like Kathmandu.

1 Introduction

Kathmandu Valley belongs to Bagmati Province and extends into three administrative districts of Nepal, namely, Kathmandu, Bhaktapur, and Lalitpur, with a total area of 899 sq km (Fig. 1). The three districts have two metropolitan areas, the metropolitan city of Kathmandu and the metropolitan city of Lalitpur, and 16 municipalities. Kathmandu is the capital of the Federal Democratic Republic of Nepal and is the country's most important political, administrative, educational, cultural, and commercial center. In the 2011 census year, the total population of the Kathmandu Valley was 2,517,023, with an annual growth rate of 4.63%. This represents 9.32% of the country's total population, in just 0.49% of the country's area. The Central Bureau of Statistics of Nepal predicts that

Fig. 1 Kathmandu valley and ring road covered area. (Source) Bhattarai et al (2019)

the population of the Kathmandu Valley will reach four million by 2035 (CBS 2018; JICA 2017).

The road transport system provides the main mode of mobility in Nepal. Rapid urbanization and increasing economic activities in cities have dramatically increased the demand for vehicles in urban areas. Due to ineffective public transport services, people are attracted to private vehicles, and the number of private vehicles is increasing rapidly compared to that of public vehicles. In the last 15 years, the number of motorbikes and low-occupancy modes of public transport, that is, minibusses and microbuses increased rapidly. Although the government has invested in the expansion of roads in the city of Kathmandu, the increasing number of private vehicles means that the traffic situation remains unchanged. This shows that expanding the road alone is not a sustainable solution for improving public transport. Considering the geographic area and the distance of the city from business and official areas, it is necessary to offer reliable public transport and nonmotorized transport even in cities such as Kathmandu. The Kathmandu Valley is completely dominated by motorbikes, which constitute 79.1% of the total fleet, followed by private vehicles (cars, vans, and jeeps) at 12.42%, heavy-duty vehicles at 4%, and public transport vehicles at 2.67%, and others, with an overall annual growth rate of 14% (DOTM 2019). The share of low-occupancy vehicles, that is, minibusses and microbuses, represents 94% of all public transport vehicles, and large buses make up only 6% (JICA 2017). For the past decade, the road transport service in the Kathmandu Valley has been affected by insufficient road length, narrow and busy roads, unattended traffic, poor traffic management infrastructure, a mix of old and new vehicles, and a multimodal public transport system. Kathmandu Valley faces an unprecedented level of traffic congestion, frequent vehicular accidents, and an increasingly unreliable public transit system (Bhattarai et al. 2019). The quality of service of the current public transport system in Kathmandu is poor, and public transport involves more travel time than private modes of travel. A mass rapid transit (MRT) system should be implemented to reduce congestion, decrease fossil energy consumption, and decrease air pollution (Dhakal 2006; JICA 2017; KSUTP 2014, 2016; MoUD 2017; IBN 2017, Bajracharya and Shrestha 2017; ICIMOD 2017). The current public transport system in the Kathmandu Valley is complex, and the quality of service is poor (World Bank 2019). Due to its bowel-shaped geography, gusty winds rarely remove vehicular emissions from the urban atmosphere, making Kathmandu one of Asia's most polluted cities, the 100th city on the global pollution index (Bhattarai et al. 2019).

Transport is the most important social and environmental issue in the world (Kingham et al. 2001). Transport is the infrastructure of infrastructures (Pokharel and Acharya 2015) and is considered fundamental for urban development. The government of Nepal has prioritized the development of the transport sector. The main objective of the "National Transport Policy is to develop a reliable, cost-effective, safe, facility-oriented and sustainable transport system that promotes and sustains the economic, social, cultural and tourism development of Nepal as a whole" (National Transport Policy 2001). Chen and Chai (2011), using the theory of planned behavior, the technology acceptance model, and the concept of habit, studies the intentions of commuters to switch to public transit in Kaohsiung City, Taiwan, and finds that the habitual behavior of private vehicle users obstructs a commuter scheme to switch from private vehicles to public transit. JICA (2017) recommends the appropriate timing for the commencement of MRT system operation in Kathmandu, based on the introduction of mass transit systems in 24 Asian megacities and related to the gross income and population of the city. In each of these cases, the first MRT operation is launched when the respective city's gross product is \$3 to \$30 billion. In the Kathmandu Valley, the population is projected to be four million, and per capita GDP will exceed US\$ 900 by 2030. Thus, "based on experience in other Asian megacities, it shall be appropriate to introduce the 1st MRT system in the Kathmandu Valley between 2020 and 2030" (JICA 2017, p. 122). Shrestha et al. (2013) finds that increasing vehicle speeds would reduce vehicle emissions, and that increasing urban mobility would improve the overall quality of life in the Kathmandu Valley. Das et al. (2018) states that technological change may play an important role in minimizing vehicular air pollution in Kathmandu. Ashalatha et al. (2013), applying multinomial logistics (MNL), finds various factors affecting particular modes of transport. In a case study in the city of Thiruvananthapuram, India, the main reason for shifting from buses to two-wheelers or cars is that the bus transport service is inefficient and unreliable. Jain et al. (2014) identifies reliability, comfort, safety, and cost as the main criteria for the modal shift from private vehicles to public transport, with Delhi as a case study. Using the pairwise weighing method (analytical hierarchy process), they find that safety is the most important criterion (36%), followed by reliability (27%), cost (21%), and comfort (16%). Lin and Guo (2015) studies the utility and weight of factors related to bus transit service quality in Nanjing, China, by applying conjoint analysis.

The private sector is responsible for almost 99% of the investment in public transport services in Nepal. There is no integrated policy for the management of public transport services. Government regulations and monitoring capacities are weak. Along with reducing the attraction of private vehicles, encouraging nonmotorized transportation and the use of public transport is an urgent agenda item for sustainable urban mobility. The solution to Kathmandu's air pollution can be achieved only when the government takes the leading role in addressing the situation (Saud and Paudel 2018). For the effective implementation of such an intervention, it is best to know users' preferences. This study examines the main attributes affecting commuters in the modal shift to public transport service in Kathmandu. Mass transit systems help to connect communities, support local economies, and improve the living standards of disadvantaged individuals. Therefore, a wide range of studies has been conducted in the field of public transport around the world. Researchers are constantly studying ways to improve public transport. They have focused mainly on the infrastructure sector, the behavioral sector, and the psychological sector. The current study is designed to understand the preferences of Kathmandu Valley commuters regarding the modern transport system before implementing future public transport policy, through a case study that provides a unique opportunity to investigate people's perceptions of potential new services and their willingness to implement them.

The main objective of the choice-based conjoint experiment in this research is to examine the attributes affecting the choices and behaviors of commuters for improved public transport services in Kathmandu by answering the following questions: What factors are associated with commuters' adoption of an improved public transport service?; Which attributes of the public transport service cause a modal shift?; How does each attribute affect the probability of various preferences?; What is the interaction with the passenger and the causal effect of the attribute? To answer these questions, we have generated attributes of hypothetical improved public transport services that have numerous external impacts on the surrounding environment.

2 Methodology

This experiment is carried out in Kathmandu, Nepal, where the main mode of mobility is road transport. Over the past decade, Kathmandu Valley has experienced rapid urbanization, high population growth, uncontrolled urban sprawl, and increased motorization, leading to problems with congestion, vehicular conflict, traffic accidents, environmental degradation, and poor public transport services. The government of Nepal plans to carry out various projects to improve the existing system. This study helps us to understand the preferences of commuters for improving public transport services in a very densely populated area.

For our study, the data are collected in two phases: the pilot survey and the main survey. The surveys are carried out within the periphery of the Ring Road, which is 27.3 km in length. For the study, we deliberately chose a list of 71 main stops and divide the city into four study areas by central main stop, and then separate the list of 71 stops into four zones. The main survey lasts 9 days and uses the paper-based street survey method. For the everyday survey, the authors prepare a random list of stops/streets in a randomly selected area using the Excel randomization function, from the selected list of stops with that value that connect to the Ring Road area (Fig. 1).

The Ring Road area is purposively selected based on four criteria: (1) it covers the central area of the city of Kathmandu; (2) it has connections to the Lalitpur and Bhaktapur districts; (3) it has a high population density; and (4) almost every commuter in Kathmandu Valley must use the Ring Road to get around the city. In the area selected for the study, all federal ministries and offices are situated in there, and the selected districts like Lalitpur and Bhaktapur are one of the most congested areas of Nepal. During the survey, we approached 400 commuters, and 373 commuters participated in our survey, with a response rate of 93.25%.

Conjoint analysis is used to study how buyers appreciate the characteristics of products or services and to predict buyer behavior (preference). It can be used to estimate the psychological trade-offs that commuters make when evaluating different attributes together. In this study, a randomized conjoint experiment is used to obtain the stated preferences of the respondents. In a conjoint experiment, the respondent evaluates profiles based on their attributes and levels, and then either chooses the option that gives them the highest utility or ranks the options. It is assumed that the respondent determines the overall utility by adding the utility provided by each attribute level. Through this experiment, we can determine the influence of each attribute level on the respondent's choice (Hainmueller et al. 2014). While experimenting, we develop survey questionnaires with four parts: (1) information, (2) scenario, (3) choice-set of the randomized conjoint experiment, and (4) background information about the respondent, including age, sex, marital status, level of education, occupation, regional location, employment status, monthly income, the average monthly cost of commuting, vehicle ownership, main mode(s) of transport, typical usage time, and household members.

As suggested by Kløjgaard and Søgaard (2012), the attributes and levels relevant to the conjoint analysis of the public transport system are identified through quantitative methods. First, a literature search is conducted to identify the relevant attributes of public transport services from the commuters' perspective. Second, a pilot survey is conducted among 28 commuters from different areas of Kathmandu City using a virtual interviewing method.

Table 1 Attributes, levels, and baseline

No.	Attributes	Levels				
1	Mode of transport	**Bus**	Microbus	Taxi	Motorbike	MRT
2	Waiting time	5 minutes	**15 minutes**	30 minutes		
3	Fare	**NRs. 14**	NRs. 30	NRs. 45	NRs. 60	
4	Commute time	< 5 minutes	**5-15 minutes**	>15 minutes		
5	Payment method	E-payment	**Cash**			

Bold and italics indicate the baseline. NRs represent Nepalese rupees

In this study, the randomized conjoint experiment consists of five attributes, each with two to five different levels. The attributes and levels of each choice profile are assigned randomly. Details of the attributes, levels, and baseline are shown in Table 1. In the table, bold items in each attribute show baselines to compare with other levels, which means whether users prefer the level compared with the baseline level.

After reading the scenario, respondents are asked to consider three sets of choices—choice set (A), choice set (B), and choice set (C)—and then rank these 1, 2, and 3 based on their preference for enhanced public transport services. Each profile is designed with different alternatives. An example of the choice set is shown in Fig. 2.

In this study, we try to identify commuters' preferences for hypothetically improved public transport policies by estimating the probability of internal choice and external choice. Regarding internal probability, we estimate respondents' preferences under two hypothetical alternative policies: choice (A) and choice (B), which means if there are only two choices like (A) and (B), which choice do you prefer? For external choice probability, we estimate respondents' preference between the status quo and two alternative hypothetical policies. Each profile has three alternatives; from the left, the first two are hypothetical alternatives with five attributes and levels, and the third alternative is the status quo. The profile means that if there are three choices including the status quo (C), which choice do you prefer? These attributes are randomized for each respondent to avoid any possibility of an ordering effect. Similarly, to avoid cognitive strain, the order is randomized for all three profiles given to the same respondent. To estimate the probability of internal and external choice, we're following the approach suggested by Hainmueller et al. (2014). These authors nonparametrically identify the average marginal component effect (AMCE) for each of the attributes and levels based on the probability of choosing a profile by randomized conjoint analysis. The attribute levels are assigned randomly, and ordinary least squares (OLS) are used to estimate the AMCE of each attribute as a

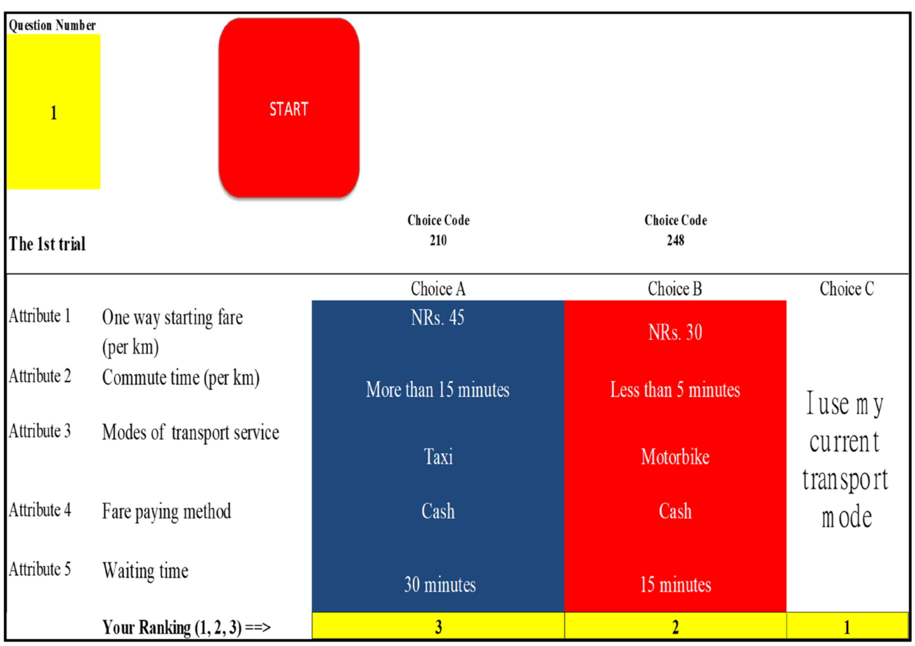

Fig. 2 An example of the choice set

coefficient based on a linear regression of the indicator of choice over the set of dummy variables for the attributes and levels. The model is as follows:

$$y_{itj} = \beta_0 + \sum_{l=1}^{L} \sum_{d=2}^{D_l} \beta_{ld} \times a_{itjld} + u_{itj},$$

where the possible outcome of individual i in trial t of policy j is defined by y_{itj}, l stands for several attributes, and D_l indicates the number of levels of each attribute l. β_{ld} is the coefficient of each component to be estimated, a_{itjld} is a dummy variable for the dth level of policy j in task t of respondent i, and $u_{itj} \in \{0,1\}$ is an error term. In the internal choice probability estimation, y_{itj}= 1 if the preference rank of policy j is higher than its alternative policy and 0 if the rank is smaller. Similarly, in the estimation of the external choice probability, $y_{itj} = 1$ if the preference rank of policy j is higher than the status quo.

3 Results

During the survey, some general information about the respondents is collected and analyzed. As Table 2 shows, the gender balance is nearly equal: 49.06% are female, and the rest are male. In terms of age, almost 69% of the respondents belong to the 17–40 years category, which represents the young adult population in Nepal. The highest proportion of our respondents (42.36%) has a university degree, followed by secondary education

Table 2 Demographic and public transport service characteristics of respondents

Variables	Total (%)	Variables	Total (%)
Age group		Occupation	
<40	69.17	Student	19.8
41–60	23.86	Public service	19.6
>61	6.97	Business owner	19
Gender		Private business	15.6
Female	49.06	Farmer	9.12
Male	50.94	Housewife	7.51
Educational attainment		Unemployed	7.51
Illiterate	8.56	Others	1.88
Basic level	15.01	Purpose of commute	
Secondary level	34.05	Work	43.16
University level	42.36	School	20.11
Average monthly commute expenses		Shopping	15.28
Up to NRs. 900	9.63	Recreation	7.24
NRs. 900 to 1800	47.95	Currently using transport	
NRs. 1801 to 2700	11.8	Bus	47.45
NRs. 2701 to max	31.13	Minibus	9.12
Public bus stops (satisfied)		Micro bus	23.59
Yes	9.92	Tempo	3.75
No	83.11	Taxi	1.88
So So	6.97	Motorcycle/scooter	12.33
Safety feeling from public transport		Others	1.88
Yes	8.85	Marital status	
No	76.14	Single	33.24
So So	15.01	Married	63.27

(34.05%), basic education (15%), and no literacy (8.56%). Similarly, 43.16% use public transport to get to work, 20.11% for school, 15.28% for grocery shopping, and 7.24% for leisure. In terms of vehicle ownership, 64% of the respondents have no vehicle, 16.62% have a motorbike, 11.8% have a car, and 2.68% have a bicycle. The respondents' current travel mode is split between bus (47.45%), microbus (23.59%), motorbike (12.33%), minibus (9.12%), and tempo (auto-rickshaw) (3.75%).

The average marginal component effect (AMCE) is the causal quantity of estimation using a pooled sample for external choice probabilities and internal choice probabilities. AMCE reflects the probability that profile (A) or (B) will be chosen by the respondent (Hainmueller et al. 2014). This survey also includes the status quo (C), which allows us to analyze a hypothetical proposal for improved public transport features based on the current Kathmandu public transport service. An airplane dot plot is used to show the corresponding coefficient on the X-axis, with the 95% confidence interval shown using horizontal bars, and the vertical axis shows the proposed attributes and their levels.

First, as a baseline, the most commonly used values for the public transport of each attribute level *(written in italics and bold letters in Table 1)* are used to compare Choice (A) and Choice (B), with the status quo (C), including to analyze the external probability. In the second part, we analyze the internal probability using a baseline the same as the external probability, and we compare the proposed hypothetical policies Choice (A) and Choice (B) only, without the status quo.

The probability of external choice shows that commuters accept the new and improved characteristics of the public transport service compared to the current situation (status quo). The constant term of the regression is 0.7288, which means that 73% of the respondents chose profile (A) or (B) rather than (C). The estimated average marginal treatment effect (AMCE) on external choice probability finds a significant impact for all attributes. The results show that the attributes with the highest impact on the probability of choosing a hypothetical policy are one-way starting fare and mode of transport.

As Fig. 3 shows, the first attribute, modes of transport, had five levels, with the baseline set to bus. However, the second level (microbus) and the third level (taxi) are not significant. The fourth level (motorbike) is negatively significant. Fourteen percent of the respondents do not like to use a motorbike as a form of transport. The fifth level (masstrans = MRT) is preferred over the baseline by 20%. This shows that commuters are eager to move from the current situation to a new public transport system. The second attribute, waiting time, has three levels: 5 min, 15 min, and 30 min. When we set 15 min as the baseline, a waiting time of 5 min has a positive impact probability of 12%, and a 30-min waiting time has a negative influence of − 12% when implemented. For the commute time (per km) attribute, 5–15 min is set as a baseline, and the level of few than 5 min has a positive impact of 12%, while the level of more than 15 min has a negative effect of − 12%, which means respondents do not like an increase in commute. The attribute one-way starting fare is the most influential key attribute in terms of external probability. If the new one-way starting fare is set to 60 Nepalese rupees (NRs), the probability of respondents taking the new public transport is negatively affected by − 54%, by − 45% when set to NRs 45, and by − 28% when set to NRs 30, which is useful information for developing a new policy. The fifth and last attribute, the fare payment method, has a significant effect. It comprised two levels: e-payment and cash. When we set cash

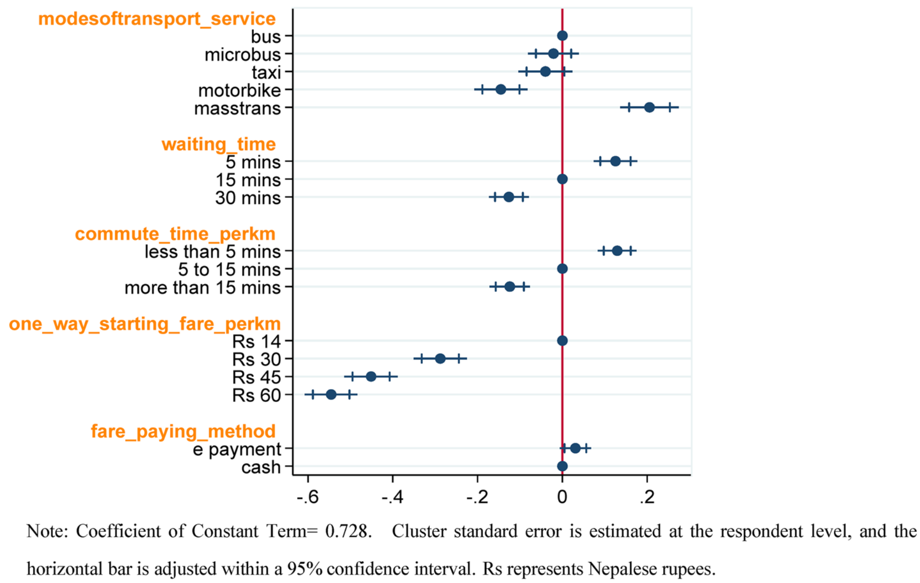

Fig. 3 Average causal effect on the external choice probability. Coefficient of Constant Term = 0.728. Cluster standard error is estimated at the respondent level, and the horizontal bar is adjusted within a 95% confidence interval. Rs represents Nepalese rupees

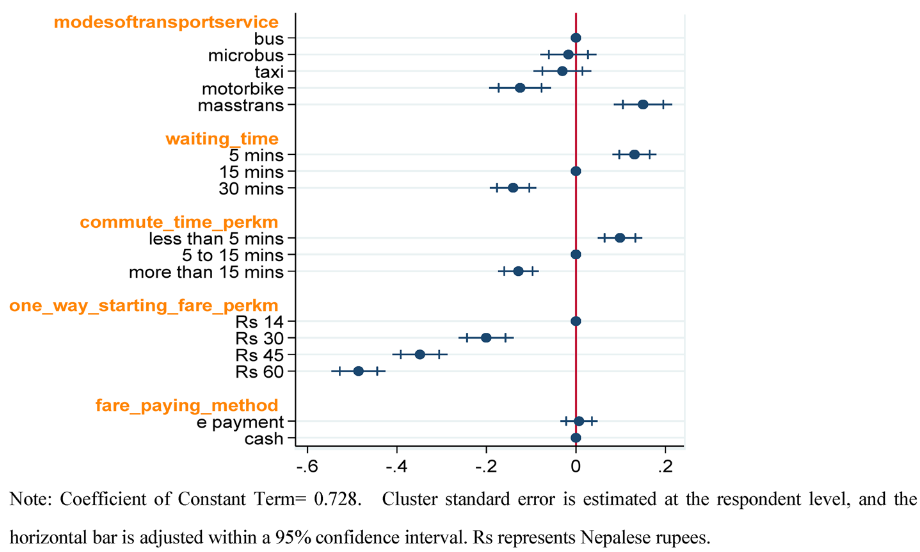

Fig. 4 Average causal effect on the internal choice probability. Coefficient of Constant Term = 0.728. Cluster standard error is estimated at the respondent level, and the horizontal bar is adjusted within a 95% confidence interval. Rs represents Nepalese rupees

as the baseline, the choice of e-payment has a positive impact of 3%, which means that respondents like to use e-payment.

Also, as Fig. 4 indicates, the internal choice probability reveals respondents' preference between the two proposed public transport improvement packages, package (A) and package (B). They prefer the improved service, which includes a mass transit system, less waiting, shorter commute times, and a lower fare per km. Although it improves the service, they do not care about the fare payment method. The first attribute, mode of transport, has five levels, with the baseline set to bus. However, the second level (microbus) and the third level (taxi) are not statistically significant. The fourth level (motorbike) is negatively significant, and 12% of the respondents do not like to use a motorbike for public transport. The fifth level (MRT) is preferred by 14% over the baseline. The second attribute, waiting time, has three levels: 5 min, 15 min, and 30 min.

Similar to Fig. 3, for the waiting time, the 5-min waiting time increases the positive probability by 13%, and the 30-min level has a negative influence of − 4%. For the attribute commute time (per km), compared to 15 min, 5 min less has a positive impact of 9%, and 15 min more has a negative impact of − 12%. The one-way starting fare attribute is highly negatively significant with a level of NRs 30, NRs 45, and NRs 60 resulting in − 20%, − 34%, and − 48%, respectively.

To simplify the results above, a comparison of the results of both external and internal probability is summarized in Table 3 by picking some significant points up. For the probability of internal choice, we propose two hypothetical policies on improved public transport service based on the bundles of attributes and estimate the preference of respondents who answered the question, *"Which is the most influential among the proposed policies?"* For the external choice probability, we include the status quo as an answer to the question, *"Do we need a new proposed transport policy?"* The result of the estimation shows that the preference trends are similar except for the fifth attribute; for the probability of internal choice, respondents do not care about the payment method. The comparative results of external and internal choice probability are presented.

4 Discussion

In the context of switching to a new public transport system, several attributes (mass rapid transit as the mode of transport, less waiting time, less commute time per km, and e-payment) had a clear influence on the approval of an improved system. However, commuters had negative feelings toward the use of motorbikes as public transport as well as toward increases in fare, waiting time, and commute time per km, and they did not prefer microbuses and taxis.

Due to the unreliable and inefficient nature of the public transport service, the use of two-wheelers, in particular motorbikes and scooters, has increased rapidly in the Kathmandu Valley, presenting a major challenge for maintaining sustainable urban mobility.

Table 3 Comparative AMCE results of external probability and internal probability

Attributes	Levels	External (%)	Internal (%)
Mode of transport	Motorbike	− 14	− 12
	MRT	20	15
Waiting time	5 min	12	13
	30 min	− 12	− 14
One-way fare per km	NRs. 30	− 28	− 20
	NRs. 45	− 45	− 34
	NRs. 60	− 54	− 48
Commuting time (per km)	< 5 min	12	9
	>15 min	− 12	− 12
Payment method	E-payment	3	

This result confirms the JICA study, which stated: "At present, about 90% of buses in the Kathmandu Valley are low-occupancy vehicles, i.e., micro/minibusses. Smaller buses should be replaced by larger ones to operate the public transport system efficiently. The current transport network system of Kathmandu Valley is dependent on private vehicles and will not meet future demand; the introduction of a new public transport system, such as AGT or BRT, is recommended" (JICA, 2017 p. 114). Shrestha et al. (2013) claimed that low-speed buses and motorbikes were the main sources of emissions in the Kathmandu Valley. Moreover, our results support their finding that commuters are in favor of mass rapid transit.

From our results in Figs. 3 and 4, we found that MRT, low fares, less waiting time, less commute time, and cashless payment methods are influential attributes promoting switching to public transport for nearly all commuters of different backgrounds. However, Jain et al. (2014) found that safety is the most important criterion for encouraging urban commuters to shift from private vehicles to public transit, followed by reliability, cost, and comfort. Chen and Chao, (2011) concluded that the habitual behavior of private vehicle users somewhat hindered individual intent to switch from private vehicles to mass rapid transit. In this study, individual characteristics, such as gender, vehicle ownership, sense of security of the current public transport system, and level of education, may affect modal shifts from private to mass transit differently. Ashalatha et al. (2013), in their study of the mode choice behavior of commuters in the city of Thiruvananthapuram, India, found that the preference for a car increases with increasing age, while the preference for two-wheelers decreases. Therefore, the switch from private vehicles to public transit depends upon time per distance and cost per distance. The results of a subsample analysis using the background information in this study supported their findings. In a case study of the city of Kalamaria, Greece, commuters placed importance on the attribute of comfort, followed by fare, information provision, and accessibility to a transit network (Tyrinopoulos and Antoniou 2013). However, commuters gave comfort (i.e., MRT and negative views of motorbikes) and fare almost equal preference in Kathmandu. Likewise, IBN (2017) proposed investments in mass transit system projects, i.e., MRT, LRT, BRT, flyovers, and tunnelway systems, for the sustainable mobility of the Kathmandu Valley. This study empirically outlined the effective implementation of proposed mass rapid transit projects in Kathmandu Valley. However, Pathao and Tootle have been using motorbikes and scooters as public transport in Kathmandu since 2018. Legal provisions do not allow the use of two-wheelers as a public transportation service in Nepal. According to the Motor Vehicles and Transport Management Act of 1993, commercial vehicles must obtain a permit to operate and must have registered their public transport service in the DoTM; however, Pathao and Tootle have been operating two-wheelers without registering with the transport service, which is illegal (OAGNEP 2020 p. 304). Motorbikes are the main cause of traffic congestion, air pollution, and road accidents (Shrestha et al. 2013). The results of this study confirm that respondents are not in favor of two-wheelers in the city of Kathmandu.

Azimy et al. (2020) found that acceptance probability of proposed saffron production promotion policies in Herat Province, Afghanistan, which support to change the current policy of transport system. The improvement of the current public transport system is the most important and urgent agenda item for the overall development of the country.

Although the government has made efforts to improve the public transport service sector in Kathmandu, these efforts have not been effective. The weak capacity and authority of the regulatory body, scarce resources, weak policy enforcement, and the low participation of stakeholders are the main problems for sustainable implementation.

Both Figs. 3 and 4 indicate that commuters are in favor of a new improved public transport system. It implies while formulating a new policy, it would be best to focus on the introduction of MRT with the e-payment method for public transport services, and to consider low fares or other schemes, such as monthly or yearly ticketing or family packages, to motivate commuters to embrace the new system. Public transport should run on a timely basis, which would enhance commuters' trust in addition to their comfort and the price. This study also envisages the effective implementation of the BRT project on the Ring Road in Kathmandu, proposed by the IBN, and recommends applying the minimum fare with the cashless payment method. Referring to the subsample analysis, commuters whose permanent residence is outside of Kathmandu Valley also preferred MRT, which shows that MRT is the best means of transport for urban mobility in other large cities as well.

5 Conclusion

This study has focused on examining commuters' preferences for improved public transport services in Kathmandu Valley. A choice-based conjoint experiment was conducted that included five attributes and 17 levels, all of which may affect commuter preference in terms of switching to public transport.

Now, we can answer our research questions set up in the introduction part according to our results:

First, commuters are strongly interested in changing current transport services including a public one like a bus to a new type of public transport service like MRT, considering cost and time. They are in favor of a modal shift to mass rapid transport and against motorbikes. However, introducing the MRT to the region must usually be costly so financial support like ODA would be necessary to overcome budget constraints. This budget matter is not within the scope of this study, but independently it should be considered.

Second, concretely using attributes such as waiting time for the service, commuting time, service fare, payment method as well as the type of transport service, all five attributes had the expected significant impact on the intention to switch to a new mass transit service. The most significant attributes are one-way fare per km and the mode of transport. They are strongly against increases in the current fare, waiting time, and commute time. Meanwhile, they prefer to switch from cash to e-payment.

Third, however, the improved public service of the bus has been likely to be selected by many commuters. According to our results of choice probability, about 73% of commuters showed their expectations toward a new or improved public transport service.

This case study has focused on an area with high traffic congestion and its suburbs. The results will support transport planners in formulating and implementing an effective transport policy that takes people's preferences into account. Especially, a massive rapid transit system with a low fare would be highly welcome in a typical congestion area like Kathmandu.

Meanwhile, focusing on one area is a limitation of this study. The congestion problem is very common and serious in many developing countries. Many empirical studies based on the causal inference approach are strongly expected further in other regions and countries as well.

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Author contributions
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Availability of data and materials
The dataset used and analyzed during the current study is available from the corresponding author upon reasonable request.

Declarations

Competing interests
The authors declare no conflict of interests.

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References

Ashalatha R, Manju VS, Zacharia AB (2013) Mode choice behavior of commuters in Thiruvananthapuram City. J Transport Eng 139:494–50. https://doi.org/10.1061/(ASCE)TE.1943-5436.0000533
Azimy MW, Khan GD, Yoshida Y, Kawata K (2020) Measuring the impacts of saffron production promotion measures on farmers' policy acceptance probability: a randomized conjoint field experiment in Herat Province Afghanistan. Sustainability 12:4026. https://doi.org/10.3390/su12104026
Bajracharya AR, Shrestha SJ (2017) Analyzing influence of socio-demographic factors on travel behavior of employees, a case study of Kathmandu Metropolitan City, Nepal. Int J Sci Technol Res 6:111–119
Bhattarai K, Yousef M, Greife A, Lama S (2019) Decision-aiding transit-tracker methodology for bus scheduling using real time information to ameliorate traffic congestion in the Kathmandu Valley of Nepal. J Geogr Inf Syst 11:239–291
CBS (2013) Central Bureau of Statistics, Government of Nepal. Available online: www.cbs.gov.np. Accessed 5 Feb 2019
Chen C-F, Chao W-H (2011) Habitual or reasoned? Using the theory of planned behavior technology acceptance model, and habit to examine switching intentions toward public transit. Transp Res Part F 14:128–137
Das B, Bhave PV, Puppala SP, Byanju RM (2018) A Global perspectives of vehicular emission control policy and practices: an interface with Kathmandu valley case, Nepal. J Inst Sci Technol 23:76–80
Dhakal S (2006) Urban transport and the environment in Kathmandu valley: integrating global carbon concerns into local air pollution management. First, Retrieved June 2020. Available online: https://www.iges.or.jp/en/publication_documents/pub/policyreport/en/449/iges_start_final_reprot.pdf. Accessed 10 Feb 2020
DoTM (2019) Department of Transport management. Vehicle Registration Statistic Department of Transport Management, Government of Nepal, Kathmandu. Available online: www.dotm.gov.np. Accessed 16 Feb 2020
Global mobility report (2017) Available online: https://sustainabledevelopment.un.org/content/documents/2643Global_Mobility_Report_2017.pdf. Accessed 9 Jan 2020
Hainmueller J, Hopkins DJ, Yamamoto T (2014) Causal inference in conjoint analysis: understanding multidimensional choices via stated preference experiments. Polit Anal 22(1):1–30
IBN (2017) Investment Board Nepal, Government of Nepal. Transportation Sector Profile of Investment Board Nepal. Available online: https://ibn.gov.np/transportation/. Accessed 28 Dec 2019
ICIMOD (2017) International Centre for Integrated Mountain Development, The status of glaciers in the Hindu Kush-Himalayan region. https://doi.org/10.1659/mrd.mm113. Accessed 5 Dec 2019
Jain S, Aggarwal P, Kumar P, Singhal S, Sharma P (2014) Identifying public preferences using multi-criteria decision making for assessing the shift of urban commuters from private to public transport: a case study of Delhi. Transp Res Part F 24:60–70
JICA (2017) Japan International Cooperation Agency. The Project on Urban Transport Improvement for Kathmandu Valley in Federal Democratic Republic of Nepal Final Report May 2017. Available online: https://openjicareport.jica.go.jp/pdf/12289674.pdf. Accessed 18 Mar 2020
Kingham S, Dickinson J, Copsey S (2001) Traveling to work: will people move out of their cars. Transp Policy 8(2):151–160
Kløjgaard M, Bech M, Søgaard R (2012) Designing a stated choice experiment: the value of a qualitative process. J Choice Model 5(2):1–18

KSUTP (2014) Kathmandu sustainable urban transport project, public transport restructuring. Available online: https://www.scribd.com/document/370110066/Public-Transport-Restructuring. Accessed 27 Apr 2019
KSUTP (2016) Kathmandu sustainable urban transport project. A sustainable transport project status and progress 2016, Presentation slides.
Lin J, Guo T (2015) Utility and weight of factors of bus transit's service quality analysis in Nanjing. J Harbib Inst Technol 22(3):115–122. https://doi.org/10.11916/j.issn.1005-9113.2015.03.017
MoPIT (National Transport Policy) (2001) Vision paper, National environment transport Strategy 2025–2040. Available online: www.mopit.gov.np. Accessed 20 May 2020
MoUD (2017) Ministry of urban development, national urban development strategy, 2017. Available online: www.moud.gov.np. Accessed 2 July 2020
OAGNEP (2020) Office of auditor general, 57th annual report of auditor general, 2020 Available online: https://oagnep.gov.np. Accessed 15 July 2020
Pokharel R, Acharya SR (2015) Sustainable transport development in Nepal challenges, opportunities and strategies. J East Asia Soc Transp Stud 11:209–226. https://doi.org/10.11175/easts.11.209
Saud B, Paudel G (2018) The threat of ambient air pollution in Kathmandu, Nepal. J Environ Public Health. https://doi.org/10.1155/2018/1504591
Shrestha SR, Oanh NTK, Xu Q, Rupakheti M, Lawrence MG (2013) Analysis of the vehicle fleet in the Kathmandu valley for estimation of environment and climate co-benefits of technology intrusions. Atmos Environ 81:579–590
Tyrinopoulos Y, Antoniou C (2013) Factors affecting modal choice in urban mobility. Eur Transp Res Rev 5:27–39
The World Bank (2017) Available online: https://www.worldbank.org/en/topic/transport/overview. Accessed 2 July 2020

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