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Evaluating the Social Impacts of Safa Tempo in Kathmandu Valley

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Abstract
Safa tempo is one of the three options for public transportation within Kathmandu Valley. Introduced in 1995 in order to outlaw and replace the city's diesel-powered three-wheelers, Safa tempos are battery powered three wheelers which make up roughly 3% of the modal share on public transportation. Imported components are assembled to manufacture the main body in Kathmandu. The city holds the distinction of being the first in South Asia that operates zero emission vehicles for public transportation. While many innovations do not pass the experimentation phase, this electric vehicle technology not only successfully went beyond its testing but was also managed to penetrate the transportation market overcoming all odds. Since Nepal have no fossil fuel reserves and heavily relies on imports, shifting to electric modes is more required now. But this innovative technology has been struggling and is at the moment experiencing deep crisis. It is neglected and forgotten that there is such technology in our city and we are in search for solution to fuel crisis elsewhere. It is important that we understand what went wrong. Social impacts are often overlooked when studies are conducted on the economic and environmental benefits. Through observation, interview and questionnaire survey, this study aims to assess the social impacts of safa tempos. The results of this report are hoped to be helpful.

Keywords
Safa Tempo, Public Transportation, Electric Vehicle, Social Impacts

1. Introduction

The Kathmandu Valley, sometimes referred to as the Nepal Valley, is situated in Nepal's central region. With around 5 million population [1], it is Nepal's largest and most developed urban area. In the valley, there are three districts: Kathmandu, Lalitpur and Bhaktapur. The valley is Nepal's economic hub because it contains the majority of the country's offices and corporate headquarters. It is popular among the tourist as well for its distinctive architecture and varied culture.

There are three alternatives for public transportation in Kathmandu Valley. The first two alternatives, which differ only in size, are either bus or microbus, both powered by non-renewable fuels. Safa tempo, the third choice, is distinct from the first two. It is three-wheeled battery-powered vehicle resembling a huge white tin box with an open back entry and benches for 12 passengers. In Nepal, road transportation predominates. In the valley, buses are among the most popular forms of public transit, followed by microbuses and three-wheelers (tempos). According to[2], approximately 27% of trips in Kathmandu are made via public transportation, with buses making up 16.6% of those trips, minibuses 8% and tempos 2.3%. The number of bus registrations significantly increased after 2010, but tempo registration came to an end because of the government ban. The tempos in use right now are therefore at least a decade old. With the exception of cheaper import tariffs for this category of vehicles, the government does not promote public transportation in any way. Vehicles used for public transportation are often old and poorly maintained.

The history of electric vehicles dates back to 1975 when trolley buses were first introduced in the Kathmandu Valley along a 13 km route connecting Kathmandu and Bhaktapur. After several decades of operation, trolley buses were shut down because of maintenance, financial and political concerns. In the meantime, Safa Tempo was launched in Kathmandu in 1995 to replace the city's diesel-powered three-wheelers. They were assembled in Kathmandu using imported parts, with assistance from the Global Resources Institute (GRI) from the USA. The chassis

was made in India, the main body was constructed in Kathmandu, and imported electronic parts included the battery, converter, motor controller, fuel gauge, connector contact, carbon brush etc. The city holds the distinction of being the first city in South Asia to operate zero emissions vehicles. Some sources even asserted that Nepal had the highest per-capita EV density of any city in the world. It was thought to be the most environmentally friendly mode of transportation for Kathmandu. This EV technology, in contrast to many other new technological innovations, not only survived testing but also managed to overcome all odds to enter the transportation market [3].

Figure 1: Safa Tempo in operation

1.1 Problem definition

Electric mobility presents a tremendous opportunity to cut greenhouse gas emissions because the transportation industry is responsible for around one-third of all worldwide GHG emissions. In Nepal, a clean energy transition is essential for improving life quality, socioeconomic growth, and overall climate change mitigation and adaptation in the face of escalating urbanization and air pollution. The enormous hydropower potential of Nepal can boost energy independence and offer a more environmentally friendly fuel alternative to fossil fuels. The potential has sadly not been realized. Infrastructures are not suited for the alternatives to fossil fuel. Nepal currently has inadequate or limited indigenous capability for the EV manufacturing, operation and maintenance. From the outside, the safa tempo industry appears to be a "success story", prospering despite corruption and resistance from fossil fuel transportation group known as the "diesel mafia". In actuality, the sector is having trouble and is currently experiencing a severe crisis. Several major cities in South Asia were reported to have requested for advice on how to promote electric vehicles. But now, things don't seem as bright as they were yesterday. Entrepreneurs are now less interested to get involved in this business.

1.2 Need and Importance

What became of the development of this technology, which appeared to have all the necessary components for success? Understanding what went wrong is needed. By encouraging and expanding the user base, electric vehicle reach must be extended. The Safa Tempos, which serve as the present electric three wheelers, are fairly dated, therefore a redesign is absolutely necessary to improve comfort, safety and efficiency. Like it or not, Nepal will have to import exclusively EVs in the future because of the global policies and policies of the neighboring countries. However, switching to electric vehicles is not the solution here. Electric cars can assist to lessen the air pollution and the nation's reliance on the fossil fuels, but the issues related to cars will exist. Still, traffic will clog up roads. The number of accidents will still continue to rise. Safety for cyclists and pedestrians will still be at stake. The cost of inequitable road infrastructure will keep rising. Access to mobility will remain unequal, and it could get worse. Transport should be planned beyond cars and social equity and environmental concerns should be taken into account. The primary focus should be on providing accessible, inexpensive and environmentally friendly transportation for all people, regardless of their class, age, gender or physical capabilities. The failure to prioritize social justice in urban design and transportation results in more unequal and unjust cities. This calls for a change in policy and investment priorities in favor of electric public transportation, safer sidewalks and streets and networked bicycle lanes. To accomplish this, we must fundamentally alter how we view and organize or transportation system. Hence, this study is believed to be important in assisting the relevant authorities in formulating the best strategies and policies for the use of electric vehicles in the Kathmandu Valley.

1.3 Research objectives

- To evaluate the social impacts of Safa Tempo
- To study why Safa Tempo adoption in the Kathmandu valley has lagged behind expectations
- To study the problems and challenges and pinpoint potential solutions for the long-term

positive outcomes in the society regarding the Safa Tempo

1.4 Scope and Limitations

In this report, Safa Tempo is specifically highlighted as part of the public transportation system in the Kathmandu valley. This study does not take into account other types of transportation, such as private electric vehicles and scooters, buses and microbuses. End-users are the only stakeholders considered for the purpose of this study.

2. Literature Review

2.1 Safa Tempo

2.1.1 Introduction to EV Technology of Safa Tempo [3]

Electric motors that draw power from rechargeable batteries fuel electric vehicles that emit no pollution. Electric vehicle (EV) technology is frequently costly, with the battery making up the majority of the cost. In Kathmandu City, electric vehicle (EV) technology was already developed. The vehicle, known as "the Safa Tempo" here, is unique to Kathmandu City. The 3-wheeler public transportation was chosen for variety of reasons. Due to their established routes of operation, these public transport vehicles offer superior conditions for battery charging and replacement. Displacing polluters Bikram Tempo with clean ones would guarantee quick approval and attention from the general public and the authorities. In Nepal and throughout South Asia, three-wheelers are regarded as the most affordable low-cost mode of public transportation.

The Safa Tempo is made up of a composite of many parts, including a steering wheel-equipped chassis that serves as the vehicle's skeleton; an advanced D.C. body, motor (either a Prestolite motor or another type), a motor controller, 72 volts of battery power, a reverse-forward switch, motor mounting plates, couplings, a carbon brush and a fuel gauge. The majority were easily accessible from other nations. The vehicle, when maintained properly, can endure for many years because it has fewer parts than traditional fossil fueled vehicles. Lead acid batteries with a deep cycle are the type of batteries utilized. They typically last for 700 to 800 cycles, with each cycle covering a state from 100% charge to 80% discharge. Since the vehicle is used near to the design limitations, the design is ideal. Because of the straightforward technology, it is both affordable and acceptable.

Because of heavy batteries, the additional load capacity of the vehicle is only 550 kg for 10 passengers plus driver. The highest speed is 45 km/h and the maximum distance for a battery charge is 60 km. Two sets of batteries are required for each Safa Tempo to operate on a daily basis. In metal "baskets" that weigh about 180 kg apiece, the batteries are arranged six to a basket on either side of the Tempo's seats. Each battery undergoes a daily cycle, and given the nature of this specific Safa tempo operation, the battery life duration is roughly 750 cycles, or 22 to 24 months. EV batteries need to be charged and maintained with great care. Battery degeneration may result from overdriving and overloading the vehicle. Additionally, the range is significantly decreased at high speeds.

2.1.2 Social Dynamics on Launching Safa Tempos in Kathmandu Valley [4]

On the basis of the cultural theory, Individualist, Egalitarian, Hierarchic and Fatalist are four categories into which the actors who are active in supporting, opposing, questioning and managing the launch of EVs in Kathmandu can be placed. Based on where they stand with their own personal interests, the actors may fit into one or more categories.

The Individualist: The individualist is the one who starts an action based on his or her own interests, yet they may also be allies of the hierarchical and egalitarian. The idea for EV generation was based on individual desire, which is why it was developed with individual concerns. The group was inspired to manage the EV industry because of their concerns over the harm that diesel and gasoline Tempos were causing to the valley. The Department of Transport Management had stated that all "3-wheeled Tempos", regardless of kind, were prohibited, therefore the initial group of NEVI were not allowed to register their Tempos. As a result, the hierarchical structure hindered the individualist group.

The Egalitarian: When something improper or undesirable is anticipated during the process, the egalitarian is the one who speaks up. The egalitarian is aware of the occurrence and ensures that it has no negative effects on the established society. Because Safa Tempo is the only functioning vehicle with zero emissions and is also locally built, the Safa Tempo

business owners argued that the government should give maximum subsidies to the Safa Tempo makers. The owners also contended that they need to have access to soft financing options. They contend they should receive more discounts when it comes to electric tariff issues. Egalitarians ran campaigns against diesel-powered three-wheelers, which were also supported by environmental organizations, in favor of the use of Safa Tempos. Some of the people argued that the valley needed more conscientious organizations to reduce vehicle emissions. It was possible to clearly see the alliance between the individualist and egalitarian groups.

The Hierarchic: The hierarch creates the laws and ordinances governing the phenomena and frequently serves as the government body's representative. The government assumed that they had given the Safa Tempo business owners all the available subsidies. Although government officials claimed that the Safa Tempo owners had received lenient financing, the requirements for approval were strict. This highlighted the stark contrast between the private and public sectors. Since the time that diesel Tempos were forced out of the valley, the government has been providing subsidies for the introduction of Microbuses. Owners of Bikram Tempo ran a campaign against the functioning of Safa Tempo during the period when EVs were effective in partially replacing Bikram Tempo. Both the drivers' and the entrepreneurs' livelihood were questioned.

The Fatalist: The emergence of the new trend doesn't bother the fatalist. Although the bulk of the general public were enthusiastic and supportive of Safa Tempo's operations, there were a small number of fatalists who felt that the switch from Bikram Tempo to Safa Tempo didn't really make a difference. Some individuals didn't care what they were employing as a mode of transportation. Some of the passengers were concerned about paying a higher Safa Tempo fee and refused to shoulder the societal cost, regardless of the favorable outcomes. The lower fare offered by Bikram Tempo was the only factor that bothered them; all other information was irrelevant to them. The ones who had suffered were discovered to be a different group. Safa Tempos were unable to expand their reach. Regardless of the environmental advantages, the residents of such routes felt discriminated against and simply blamed the battery-operated tempos.

2.1.3 Fall of EV industry in Kathmandu [3]

Reversal of governments' policies: While the EV business was expanding, the government also gave LPG 3-wheelers preferential treatment. Additionally, custom taxes and VAT were waived for the LPG 3-wheelers. The result was that both EV and LPG vehicles were operating as "pollution free vehicles" on the streets. To accommodate the demand for public transportation, the LPG vehicle fleet grew. This significantly increased the cost of EVs. The rise of government support for microbuses caused EVs further problems. Then, Safa Tempo had to contend with two other vehicle types that produced more pollution but received the same government subsidy.

NGOs lobbying against LPG vehicles and microbuses: The NGOs first believed that LPG was an additional choice to clean transportation. As soon as the complete prohibition on Bikram tempo put a stop to the NGOs' crusade against it, they started fighting LPG 3-wheelers and microbuses. Although LPG is a clean fuel that is used in many nations, Nepal's LPG technology wasn't as clean. Only after a sizable number of LPG vehicles had already hit the market did NGOs focus on these vehicles.

Allegation of battery pollution: With claims of battery pollution, LPG vehicle supporters used a variety of media to start a campaign against Safa tempo. This attempt to discredit the Safa tempo's pristine reputation was effective. In response, supporters of electric vehicles (EVs) argued that fewer than 7% of all batteries thrown out in Nepal originated from EVs and the remainder from fossil-fueled cars, trucks, and buses. They claimed that EV batteries had a huge demand in India and had a high resale value.

Loss of income by entrepreneurs: Entrepreneurs started to complain about the loss of money as their batteries began to run down, their vehicles broke down regularly, and their vehicles began to lose passengers to less expensive microbuses and LPG 3-wheelers. Some owners discontinued using their vehicles when their batteries ran out of power because they lacked the resources to replace them. Many of the components had to be imported from abroad for repair and upkeep, which put some owners through expensive vehicle breakdowns. The operators started to notice that their vehicles weren't carrying enough passengers, which cost them money day after day.

Human resources need: Numerous owner-entrepreneurs that rented out vehicles have employed drivers with experience in Bikram tempos. Despite great continuity in the private sector and NGOs' endeavors, there were no appreciable advances in technology or the availability of skilled labor. Nevertheless, a number of NGOs began instructing EV drivers.

Ban on the new registration for the Safa Tempo: According to the Department of Transport Management, the increased numbers exceeded the capacity of the roads, resulting in excessive traffic congestion and pollution. The Ministry of Labor and Transport Management decided to forbid the registration of any new three-wheeled vehicles inside the ring road without conducting any research to support this observation. The judgment represented a setback for electric automobiles whose main market was located within that area. The government reversed the decision for a certain time then expanded the prohibition to include all four-wheelers and three-wheelers, reintroducing the registration band under the justification that there were more vehicles on the road than it could accommodate. As a result, all Safa tempo production came to an end in October 2000, weakening entrepreneurs' faith in the EV sector.

The EV industry fails to establish itself in the public transportation market: The EV sector had struggled to establish impact in Kathmandu's transportation market. The registration ban caused the industry's potential to start to decline and the end of vehicle production. The value at secondhand was less than the value after depreciation. Public interest in EVs rapidly dropped.

2.2 Methodological Literature Review

2.2.1 Measuring Social Impact [5]

A social impact is specifically defined as something that is perceived or felt in either a corporeal (bodily, physical) or perceptual (cognitive) sense, at any level, such as at the level of an individual person, an economic unit (family/household), a social group (circle of friends), a workplace (a company or government agency), or by community/society as a whole. An impact or action that causes an impact will have a different effect on each of these different levels.

Since "social impact" is defined as everything related to a project that has an impact on or is of interest to any affected stakeholder group, virtually anything may have a social impact if it is significant to or appreciated by a particular group of people. Because people rely on the environment for their livelihoods and because they could have a sense of attachment to the locations where projects are located, environmental effects can also have social effects. Social repercussions, then, are alterations to a person's way of life, culture, community, health and well-being, fears and ambitions, environment, governmental system, or personal and property rights, as well as how these alterations are felt.

Social impact can take on a variety of forms: they can be real or perceived, huge or tiny, short-term or long-term, good or negative. They may be the outcome of technological and cultural innovation, as well as environmental and/or socioeconomic changes. The goal of analyzing social impacts is to determine whether an activity will affect a community's quality of life and sense of well-being, as well as how people, groups, and communities will adjust to these changes.

2.2.2 Five dimensions of impact

1. **What** tells us what outcome the enterprise is contributing to, whether it is positive or negative, and how important the outcome is to stakeholders.
2. **Who** tells us which stakeholders are experiencing the outcome and how underserved they are in relation to the outcome?
3. **How Much** tells us how many stakeholders experienced the outcome, what degree of change they experienced, and how long they experienced the outcome for.
4. **Contribution** tells us whether an enterprise's and/or investor's efforts resulted in outcomes that were likely better than what would have occurred otherwise.
5. **Risk** tells us the likelihood that impact will be different than expected.

3. Case Studies

The indigenous public transport modes for a certain transport service in a particular city or region can be referred by LAMAT (Locally Adapted, Modified and Advanced Transport). [6] With inadequate mass transit system, LAMAT has a major role in the urban mobility in Asian cities. Most of the LAMAT modes

are either non-motorized or fossil fueled. The electric powered LAMAT modes are less common. However, the development is being carried out in different countries and most of them are under trial and test phase.

Figure 2: Electric Shuttle Bus for Tourist *(source: downtoearth.org.in)*

Electric Shuttle Bus, India: This vehicle is a 14-Seater Electric Bus operating at 72V DC with 7.2 kW motor. The maximum loading weight is around 1100 kg. The technology is based on the golf cart design. This shuttle is capable of self-driving using laser sensors, camera sensors, global positioning sensors and inertial measurement sensors which allow it to drive autonomously and drop passengers from one point to another. The vehicle can run approximately 100 km on a single charge and is capable of speed up to 40km/h. It is powered by embedded systems and computer powered in the background that allow it to detect obstacles and stop and safely navigate. However, the electric shuttle bus is running without regulations governing it.

Figure 3: COMET e-jeepney *(source: wheninmanila.com)*

COMET e-jeepney, Philippines: COMET, short for City Optimized Managed Electric Transport is a safe and eco-friendly 20-seater shuttle using Lithium Iron Phosphate (LiFeP04) batteries. It is fully charged in a 5 hours' time and has a range capacity of 80 km in a single energy transfusion. The speed is limited at 60 km/h. This electric jeep is equipped with Wi-Fi connectivity, CCTV camera and a flat screen television. It uses a cashless fare system through the use of cards. The COMET operates with its own network of dedicated stops which ultimately make for a more efficient system and less congestion on the roads. [7]

Figure 4: Electric bus in Trondheim, Norway *(source: atb.no)*

Public Transport System, Norway: In Norwegian setting, there are no small vehicles such as Safa tempo driving around for public transportation. What they do have is that some electrification of ordinary buses that drive in the transportation network. What is more special about Norwegian context is that Norway has one of the highest shares of electric vehicles in the world. But these are private vehicles owned by normal citizens. When assessing the impact, Norway have a high share of electric cars and they are subsidized but not everyone can buy a subsidized car in Norway because there are people with low-income group which creates a social inequality in a sense that ones who buy these subsidized cars are medium or high-income people. The low-income groups, students, pensioner however can't afford a car so they are not able to receive the numerous benefits that EVs offer. This raises a question on distributive justice, someone is winning and someone is losing. The public transportation in Norwegian cities is quite good. So, even people who can't afford a car can get around the city easily. However, this was not always the case. The cars used to cram the city. But, in 2019,

the shift was made to public transportation system. The bus system was completely redesigned making the system more effective for the vast majority of users. New long and frequent superbuses in the style of trams were operated. This was integrated with Tram and Train such that with a monthly ticket, any of the three mode of transport could be used anytime. Digital payment and timetable apps help plan the journey and live arrival times at the stop provide convenience to the users.

4. Methodology

This research follows the qualitative approach which includes interviews, discussions, participant observation, ethnography, literature review and questionnaire survey at user level. This qualitative research involves collecting and analyzing non-numerical data (e.g., text, video or audio) to understand concepts, opinions or experiences. It has been used in order to gather in-depth insights into the problem and generate new ideas for the research.

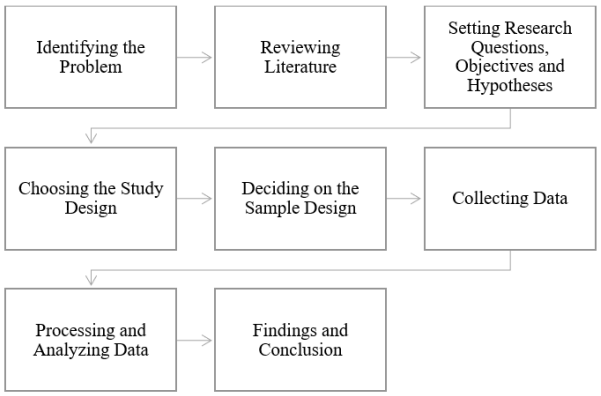

Figure 5: Research Methodology

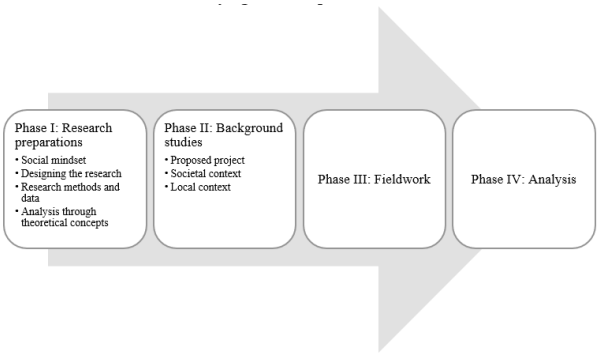

Figure 6: Research Framework

5. Framework and Data Collection

The generally recognized definition of equity or justice states that it is the ethically appropriate distribution of burdens and benefits among members of society. Although this distributive strategy is not the only aspect of equity, it is seen as a crucial aspect. Based on this inclusive definition, three essential elements can be distinguished:

1. The benefits and burdens that are being distributed
2. The population and social groups over which they are distributed
3. The yardstick or distributive principle that determines whether or not a given distribution is considered "morally proper"

Each of the three elements must be critically analyzed in order for the operationalization to succeed. Four important aspects of transportation-related equity are addressed under benefits and burdens: (i) Mobility/accessibility, (ii) Traffic-related pollution, (iii) Traffic-related safety and (iv) Health

The data collection was done based on the following framework:

Data Required	Method of Collection
1. Benefits and Burdens	Questionnaire Survey, Observation
Mobility / accessibility	Questionnaire Survey, Observation
Traffic related pollution	Questionnaire Survey, Observation
Traffic related safety	Questionnaire Survey, Observation
Health	Questionnaire Survey, Observation
2. Population and social groups	Census Data
3. Yardstick/ Distributive principle	Literature

At first, participant observations were done at different locations. The tempo stops were visited and the behaviors of users were studied. Several trips were also made as the vehicle user. During this time, a few interviews were taken with the users and the drivers. Based on this primary observation and literature studies, a questionnaire was prepared for the survey to collect the views of the different users. This questionnaire was prepared using Kobo Toolbox and distributed online through different mediums. The sample size for the survey was calculated as per Krejcie and Morgan, taking the confidence level of 95%, margin of error 15%. The sample size hence obtained was 43. So, a data with minimum of 43 males and 43 females were collected. The respondents from different social groups were

selected for the analysis which included variation in the age, employment status, ethnic group, income, disability etc.

6. Findings and Analysis

From the result of the survey, it is seen that there are a greater number of private vehicle users than the public transport users. Among the users of public vehicles, only 32% of the respondents said that they use tempo as their means of transportation, other use either bus or microbus. The impacts and analysis of the responses under different indicators are discussed below.

6.1 Benefits/ Burden

6.1.1 Mobility/ accessibility

Focal Variable	Equity measure	Impact
Resources	Availability	Public transport network in narrow streets has become easier
	Walkability	Available within walking distance for 21% of the users, 32% users have no any access to the tempo network
Opportunities	Access to destination	16% users have easy access to their destination whereas 31% users can't access their destination on tempo
Outcomes	Trip frequency	Majority of the users use tempo only when required, frequent users make only about 9% of the respondents
	Trip distance	The distance travel in transport is high for other modes and not tempo as it is secondary means for 65% of the users
	Transport costs	The fare for tempo is similar to that of other vehicles, also no student discount is allowed which makes it costlier often
Well-being	Satisfaction with vehicle	Average satisfaction score is at 69.6%
	Enjoyment of travel	Average satisfaction score is at 70%
	Enjoyment of activities	Average satisfaction score is at 71.1%

The distribution of the Safa Tempo route is uneven. There are only 17 routes. The people near the route use it because it is available within their walking distance and many of them can reach their destination easily. On one hand, this transport mode has made public transportation readily available in the narrow streets but the use is primarily because this is the only mode of transportation available for them in the walking distance. The irregularity however makes the users choose other modes of transport where 'Pathao' is the common option for the ones who have no private vehicle of their own. But this is only common among the more than average income group and among the youths. General public choose to stay with the Tempo and will however happily shift to diesel vehicles as soon as it becomes available.

The operation of Safa tempo is generally within the residential locations. Due to this, for the users, the mode is easily available from home and to home but their job locations and other destinations such as health centers are most of the times at certain walking distance. For youths and middle-aged group, this may not be a lot of trouble. But in case of elders and disabled people, the problem can be noticed and as a result, they are bound to select other transportation modes for their easy accessibility. However, people who have schools or jobs at a farther distance discard tempo because of the slower speed although the option is readily available for them.

During the busy hours from 8 am to 11 am and 4 pm to 6 pm, there are a number of passengers rushing to get to their workplaces resulting in the crowded situations. On average, the frequent users travel once a day, to or from school or work in which female users make a majority. Male population prefer private modes of transport such as motorbikes for this purpose. Only those male population with low income who cannot afford private vehicles use this mode on frequent basis. Other people use this mode when this is only the option available for them. People mostly avoid this mode on group travels because it has only 11 seats and if they are not in time to get all the seats, they have to split. Only people travelling solo or with one or two companion choose this transport mode. Other people are in search of other modes of transport.

The users are only mildly satisfied with the vehicle. There is no difference in cost of transportation while choosing diesel modes and electric modes. So, people will choose any option available for them regardless of the pollution that diesel vehicles generate. The comfort level in diesel modes such as micro bus is better if one is lucky to get the seat. This does not apply to the case of tempo. No matter if the user gets a seat or not, there is always a certain level of discomfort and so people cannot enjoy the travel much. The only

thing the users will be thinking is how soon can they reach their destination and get out of this as quick as possible. Also, since there is no conductor in this vehicle, paying fares is a bit time consuming. The best option is to make the changes ready on hand and give it to the driver from the inside. Else, people have to come out from the back door, get around the vehicle to the front door and make the payment. People are generally not satisfied due to this. Also, Safa tempo, although its name literally translates to 'clean', the tempos operating at present are more than a decade old and most of the parts are old and reconditioned making the vehicle look like an old rusted metal box. This has made some impression that people who use it are lower- and middle-class people and upper-class people generally avoid this mode of transportation.

6.1.2 Traffic related pollution

Focal Variable	Equity measure	Impact
Resources	Exposure to air pollution	No GHG emission
		Dust pollution due to the bad road conditions
	Exposure to noise pollution	Certain level of noise pollution due to loud engine sound
Risks	Risk of cardiovascular diseases	Low risk
Outcomes	Morbidity	No respiratory diseases due to tempo was reported
Well-being	Satisfaction with quality of local environment	Average satisfaction score is 56.9%
	Levels of stress	Average stress level reported is 61.1%
	Health status	Average score resides at 56%

Since the vehicle is electric, there is no any air pollution experienced. As a result, the per capita pollution of vehicle is reduced to some extent. But again, the small capacity and small size of this vehicle does not make a lot of difference in the whole carbon reduction potential. On the context of the whole city, this per capita reduction of pollution is not noteworthy. The tempo on the other hand is a bit louder than diesel counterparts. The low speed of this vehicle and the engines working at design capacity could be the primary factors behind this. On the busy narrow streets of Kathmandu, the noise from tempo may not be much but still it contributes to the noise pollution to some extent. For some reason, the noise is experienced louder by the users inside than the people outside, may be because of open design.

There are no recorded incidences of diseases due to Safa Tempo since it uses clean energy. On the other hand, the LPG tempo which operates along with Safa tempo as equal produces an odor people prefer to avoid. The smell of the gas they produce have the negative impacts on the people's health mostly experienced by the people along the route of the tempo. As there is no designation of tempo only routes in the valley, the quality of local environment is barely measurable in terms of contribution by the Safa tempo. It contributes to the reduction of air pollution surely but other modes increase pollution so high in number that the contribution to the reduction by Safa tempo becomes negligible. There is no any reported level of stress or health hazards due to the use of Safa tempo.

6.1.3 Traffic safety

Focal Variable	Equity measure	Impact
Resources	Level of safety when traveling	Average safety score of safa tempo is 64.7%
Risks	Exposure to traffic risks	Low risk due to low speed of the vehicle
		Moderate risk because it also operates in the narrow streets
Outcomes	Involvement in traffic accidents	60% users never encountered any tempo related accidents
	Costs of lack of traffic safety	91% of the encountered accidents were very minor
Well-being	Satisfaction with traffic safety	Score for overall feeling of traffic safety is at 58.7%

In terms of level of safety when traveling, the safety score of vehicle comes at average. Due to its open design, people feel more comfortable inside although they have to sit tightly with strangers. The operation of vehicle stops in the evening when the battery charge starts to fade, so there is no late-night traveling on this vehicle. More number of female drivers increases this safety score for female passengers. Female users feel more comfortable in the Safa tempo.

The small design and three-wheel system of this vehicle makes this vehicle unstable in certain situations. The vehicle cannot be overloaded with passengers because that could shift the center of gravity towards the back which puts the vehicle at risk

during uphill traffic. The open door at the back increases the risk of people falling from vehicle in case they lose their balance. This is more risker if there are children or older people traveling in the vehicle. On the other hand, the comparatively lower speed of this vehicle decreases the chances of severe injuries to the passengers and the pedestrians in case of accidents. But then, there is again this mode of payment system. When the people go around to pay their fares towards the driver seat, which is on the right-hand side where the traffic flows, this puts them at a major risk from the incoming traffic. The behaviors of the drivers are also complained. They stop at random because there are no designated stops. This causes congestion and overcrowded situations resulting in traffic vulnerability. Overall, the feeling of traffic safety is mildly satisfactory for all the social groups.

6.1.4 Health

Focal Variable	Equity measure	Impact
Resources	Availability	Within 15-minute walking distance for 45% of the respondents (only 10% have access within 5 minutes)
	Walkability	Quality of the footpaths varies with location
Opportunities	Access to destination by other modes	Destinations are easily accessible for Bike/ Scooter users for more than 68% of the times
	Access to destination by tempo	Destinations are easily accessible for Tempo users for only 17% of the times
Outcomes	Frequency of other transport means	Private vehicles preferred more than 66% of the times
	Use of tempo	32% of share of total trip on public vehicle
Well-being	Level of stress	59.3% stress level as from the respondents
	Satisfaction with health	50.7% satisfaction with health

The walkable distance is reduced for the users because the users who enjoy this service are at a very minimum walking distance from their home and destinations. The vehicle itself does not negatively impact on the people's health but during the walk from home to vehicle and vehicle to destinations, the quality of environment varies and this variation determines whether there is positive or negative impact on the user's health. The routes, not considering the fact that they are limited, have made easy accessibility to the users. But this easiness is more realized when the routes of tempos are not being overlapped with the routes of buses or micro buses. This makes people on limited budget travel to the different locations easily without having to walk. The frequency of tempos is however not reliable. The key factor becoming the traffic congestion in the city. Once stuck, there is no guarantee on when one can get out. The smaller size of the vehicle however eases the traffic congestion resulting in the reduction of stress level to the passengers and hence people are satisfied in terms of the health and well-being from the use of Safa tempo.

7. Discussion and Recommendations

Safa tempo, because of its smaller size, is more fit to the condition of the city like Kathmandu. But the speed of the vehicle and irregularity of the system makes it unreliable mode. To make the system more reliable, the regular operation should be carried out. Drivers here work on the commission basis, i.e., more the passengers, more their income. One first step could be that the system be handled by some organization who then employs the driver on the salary basis. This will control the drivers' intention to get more passengers and their primary focus will shift towards reaching their designated stops in time. In this digital age, the whole system can be digitalized. Users can get real time data of the vehicles in their personal devices along with the arrival times. The reliability of the system can be increased through this.

The operation of Safa tempo can be increased to more routes. In Kathmandu valley, with this increase in urban sprawl, the road network has increases drastically in the last few decades and there are still many roads where public transportation is not easy. The route expansion of public transport can be taken over by this Safa tempo with their digitalized system which can make it more accessible in different parts and people can explore without having to stress much.

The frequency of use is limited to commuting for majority of the people. Other users include people with health conditions and elderly people who complain that they have to pay a lot for even a short distance. If the system is to be upgraded to more digitalized and user-friendly transport system, a certain system of ticketing system can be introduced such as a weekly ticket or monthly ticket where a user

can have any unlimited trips for a single ticket. Feasibility study should be done for this considering the number of users, number of vehicles and vehicle capacity as the key variables.

The fuel for this vehicle is cheap but the vehicle fare is in line with the other vehicles. The fare could be decreased so as to encourage the use of this mode of public transport. The comfort level could be increased with better seats and realignment of the existing seats. Multiple seating compartments can be introduced so as to increase the efficiency and passenger capacity of the vehicle which could be possible because one engine would be used to drag the multiple seating compartments. The number of compartments would be fixed based on the number of users at different routes. The payment system can also be digitalized. E-sewa, QR codes and other digital modes can be introduced for payment. This improvement can then attract more people towards using this vehicle.

The average safety score of the vehicle can also be improved. The installation of CCTV cameras and the lights can help people feel more secured. The doors or at the least, bars can be introduced at the vehicle doors which reduces the probability of the accidents due to fall and people need not be at risk due to this factor. Designated stops should be introduced and strictly followed by the users and the drivers. The routes of the tempos should all be revised so that they have more coverage, easy accessibility and most importantly, not overlapping with the bus and micro bus routes. The frequency can be increased and congestion can be controlled.

8. Conclusion

Safa tempo was introduced as a promising technology and it continued to be so for a few decades but the political and economic factors hindered in the development of this promising technology. Political hinderances can only be controlled by the good system of governance and political stability which seems farfetched for the context of Nepal but we can still hope for it. The economic, environmental and social concerns can however be addressed. Despite being environmentally friendly, the analysis shows that Safa Tempos has not been able to have a favorable social impact. One of the primary concerns is that, the tempo network is not well established as a result of which only 21% of the users have easy access to the service whereas 32% of the users don't have any access. Another concern is that the destinations are not easily accessible by tempos. Hence, the users prefer the private modes of transportation. With the expansion of network and making the system more regular and reliable, more than 57% of the users would be happy to use the service on regular basis. Analysis shows that Safa Tempo was not successful in impacting any of the social group. If the variable named "safa tempo" was removed from the whole equation, there would be no any significant effect on anyone. The fault is not with the safa tempo itself but the whole management team who has been unable to have any impact on the users. For this system to have any impact at all, it requires a huge effort from the authorities.

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