MaaS perception study in Kathmandu from consumer context applying UTAUT2

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Abstract:

Human-induced climate change is causing immense damage to the environment affecting billions of people around the world. Carbon emission from transportation or mobility sector has been identified as one of the main causes of the damage. This thesis explores the concept of Mobility-as-a-Service or MaaS which has been claimed as a sustainable solution for the environmental problems caused by the mobility sector while providing efficient mobility services, economic growth as well as many other societal benefits alongside. MaaS is a digital platform where one can choose suitable mobility services from the available modes as required reducing the need of vehicle ownership which subsequently reduces emission and congestion. As such, Kathmandu valley, which is one of the most polluted and congested cities in the world, was chosen as the target market for implementing MaaS. The aim of the research was to investigate the user perception of a MaaS app in Kathmandu. This thesis utilized quantitative method to measure the user perception and identify the factors affecting adoption of MaaS. Primary data was obtained by conducting an online survey in Kathmandu valley. The survey questionnaire was based on United Theory of Adoption and Use of Technology (UTAUT2) model. Data analysis was performed using IBM SPSS and AMOS softwares. Results showed that price value was the primary factor affecting the intention to use the MaaS app followed by facilitating condition, hedonic motivation, effort expectancy and social influence. Similarly, education was identified as the major moderating factor with statistical significance. Lastly, the research concluded that MaaS was perceived positively by majority of the respondents in general.

Keywords:	Mobility as a Service, MaaS, Sustainable Mobility, Intelligent Transport, #MaaSKTM, UTAUT2
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FOREWORD

I dedicate this thesis to my hometown. Moreover, I would like to express immense gratitude to all; including my family, friends, colleagues, teachers and my thesis supervisor for their support. Also, a special token of appreciation to the survey participants. The data that they provided had proven to be highly valuable for this research.

Dipesh Ratna Shakya
Helsinki, 2023

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Glossary of abbreviations and acronyms

AB	Above Bachelor
API	Application Platform Interface
B2C	Business to consumer
BB	Below Bachelor
BI	Behavioural Intentions
DV	Dependent Variable
EE	Effort Expectancy
EMS	Electric Mobility System
EVs	Electric Vehicles
FC	Facilitating Conditions
GHG	Green House Gas
GPS	Global Positioning System
HF	High Familiarity
HM	Hedonic Motivations
II	Individual Innovativeness
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IV	Independent Variable
KV	Kathmandu Valley
LF	Low Familiarity
LMI	Level of MaaS integration
MaaS	Mobility-as-a-Service
MaaS-LC	MaaS for local context
MC	Motorcycle
MM	Multiple Modes
NFC	Near Field Communication
NoSQL	Not Only Sequential Query Language
P2P	Peer to peer
PAYG	Pay as you go
PE	Performance Expectancy
PM	Personal Mode(s)
PR	Perceived Risk
PT	Public Transport
PV	Price Value
QR	Quick Response
RFID	Radio Frequency Identification devices
SBBS	Station based bike sharing
SEMS	Shared Electric Mobility Services
SI	Social Influence
SP	Stated Preference
UN	United Nations
US DOT	United States Department of Transportation
UTAUT	Unified Theory of Adoption and Use of Technology
XaaS	Anything as a Service
DRMaaS	Demand responsive mobility as a service
UNFCCC	United Nations Framework Convention on Climate Change

1 INTRODUCTION

Although climate change is a natural phenomenon, it is accelerating in an unnatural pace due to human related activities among other causes (UN 2021). More specifically, burning fossil fuel for transportation is pointed out as one of the main drivers of human induced climate change which is causing global warming and extreme weather patterns (IPCC 2021). However, transportation is also considered an essential part of the society, economy and life in general despite being one of the main culprits of climate change and a society cannot function and develop without transportation or mobility (Casady 2020; Hoerler et al. 2020). So, a solution which can provide mobility without affecting the environment is the need of the hour.

This thesis explores the concept of “Mobility-as-a-Service” or “MaaS” which has been considered as a sustainable solution for the problems related with transport. MaaS has been claimed as a sustainable solution because it reduces the need of personal mobility modes by utilizing already existing public and private mobility modes in an efficient way, by filling in the gap where public transportation is not available as well as by offering environment friendly mobility modes to the users as per their mobility needs and demand. It has also been claimed that the implementation of MaaS can reduce vehicular emissions and congestions subsequently.

MaaS was first conceptualized as servicizing of mobility by aggregating different mobility means and modes in a digital system which provides an interface between consumers and mobility service providers to create a tailored mobility solutions suiting consumer’s needs and demands (Heikkilä 2014; Hietanen 2014). According to Kamargianni et al. (2016), MaaS is a platform where mobility users are able to purchase mobility services as needed, instead of purchasing the mobility means. By integrating different mobility operators in one platform, the user’s need to own personal transportation modes, including cars, could be minimized (Kamargianni et al. 2016 p. 3295).

The integrated platform provides multi-modal mobility services such as ride hailing, temporary car ownership through peer-to-peer car rentals, shared community vehicles, micro mobility modes such as e-scooters, e-bikes as well as pedal powered city bikes. When these modes are offered to the users in conjunction with the public transport, seamless mobility is created and the need for owning personal mobility modes are decreased.

1.1 Background

Transportation sector is one of the major sources of worldwide greenhouse gases (GHG) emission. Within this sector, passenger road transportation has been identified as the main factor causing the most damage to the environment and a recent study reveals that passenger road transportation has produced more than three gigatons of carbon dioxide in the last few years (IEA 2021). Furthermore, global population growth along with increasing purchasing capacity are acting as catalysts for the increment of number of cars on the street creating traffic congestion in urban areas as well as causing damage to the environment. (IEA 2019.)

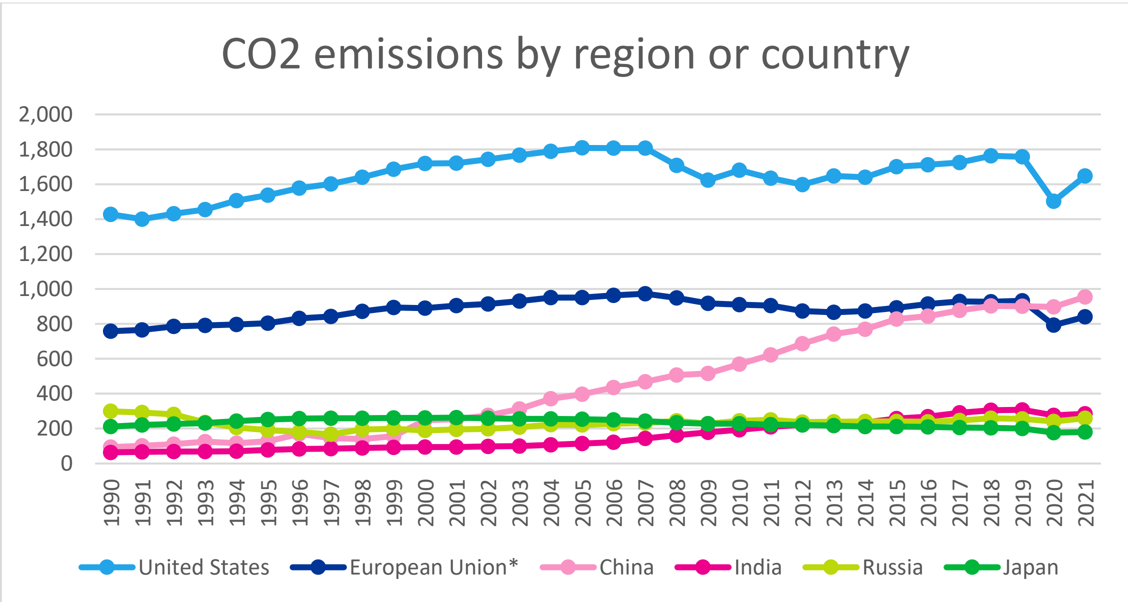

Figure 1:Transport sector CO2 emissions worldwide by country or region from 1990 to 2018 in million metric tons (EDGAR/JRC 2022).

During the past three decades, emissions have exponentially grown by two hundred percent along with the economic growth in the Asia-Pacific region. Country wise emission data shows that China and India are the biggest sources of greenhouse gases in the Asia (Figure 1). The neighbouring country of Nepal is also witnessing the negative effects of GHG emission. Kathmandu, the capital of Nepal, has been ranked within top ten most polluted cities in the world. Increased number of vehicles and vehicular emissions have been identified as the major causes of environmental hazard as well as traffic congestion inside Kathmandu valley. (IQAir 2021)

According to a recent climate report, the critical threshold of 1.5°C warming earth of will be soon crossed if the carbon emissions are not immediately cut otherwise irreversible environmental disaster is impending (IPCC 2022). Nevertheless, transportation is also an enabler for the movement of goods and persons for economic and general purposes which makes it an overly critical factor of a successful economy and the society (Casady 2020). Transportation or mobility is an ever-growing basic need driving society forward (Hoerler et al. 2020). It is also one of the fundamental human rights to be able to move around. Therefore, the author finds that it is quite contextual and imperative to explore MaaS, a proposed solution, which claims to have the ability of mitigating environmental hazards while providing efficient mobility services, economic growth as well as many other societal benefits to the society at the same time.

1.2 Research Question

The research aims to investigate the consumers' perceptions regarding a possible MaaS platform in Kathmandu valley. As such, the main research question (RQ) can be worded as:

RQ: What is the general perception of MaaS in Kathmandu from consumer context?

Also, in order to achieve the answer to the main RQ, the following questions were investigated (IQ):

- **IQ1:** What factors affect the MaaS adoption by potential users?
- **IQ2*:*** What factors moderate the intention to use MaaS app?

1.3 Demarcation

Although MaaS is being trialled all over the world, research is focused on the country of Nepal. More specifically, the primary research is targeted for the cities of Kathmandu, Lalitpur and Bhaktapur located within the valley of Kathmandu (KV).

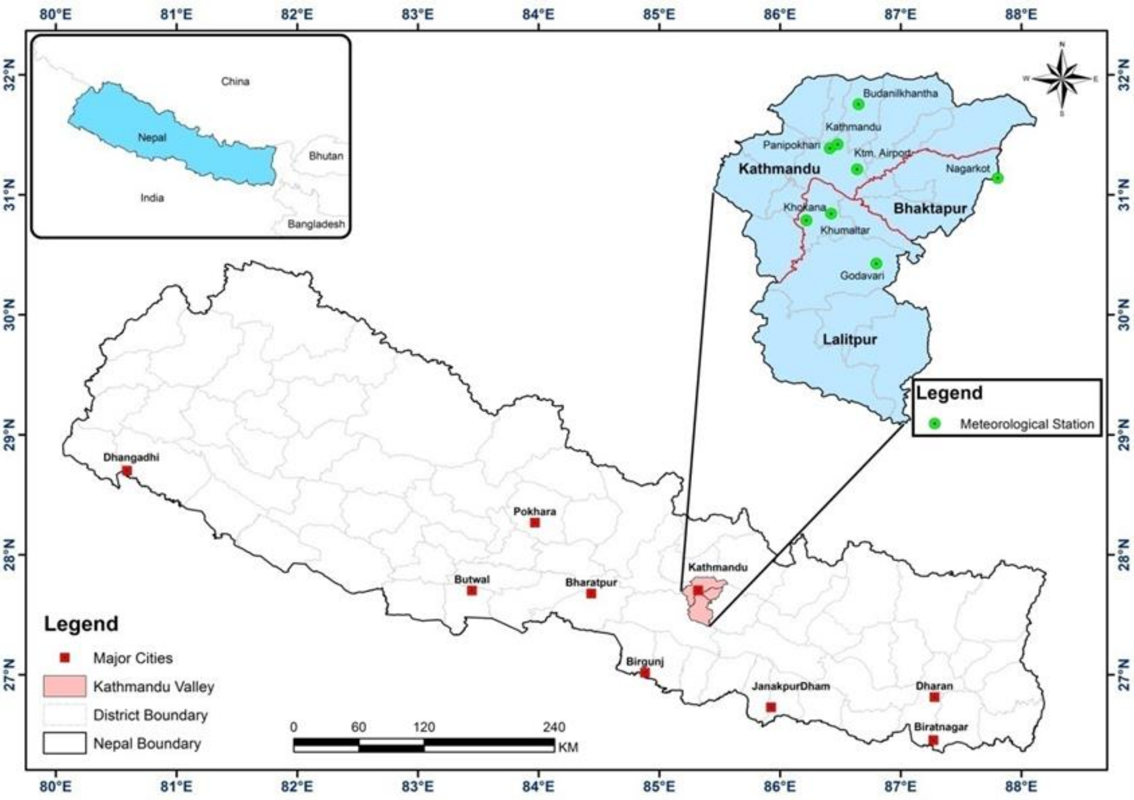

Figure 2: Map of Kathmandu Valley (SEPCL 2020).

And even though advanced mobility services such as unmanned aerial vehicles, autonomous road vehicles and water-based mobility could be integrated within a comprehensive MaaS platform, the thesis aims to study specifically human driven land-based mobility services.

1.4 Key Concepts

MaaS	Mobility-as-a-Service is a digital platform which puts together all available mobility modes to create an efficient mobility service for the mobility users as and when required in a seamless manner with integrated payment system.
Micro Mobility	Small modes of travel such as electric scooter or city bike used for short distance travel.
Multi Modal	The usage of multiple types or modes of transportation in order to fulfil the mobility need or to complete a journey.
Servicization	Creation of services from any products, processes, data, infrastructures without the need of owning any.
UTAUT2	Unified Theory of Adoption and Usage of Technology Second.
Behavioural Intention	User intention to adopt and use a technology.
Effort Expectancy	User’s perceived easiness or hardness in using a technology.
Facilitating Condition	Infrastructure and conditions needed to use a technology.
Hedonic Motivation	User’s perceived fun when using a technology.
Performance Expectancy	User’s perceived values and benefits by using a technology.
Price Value	User’s perceived monetary values by using a technology.
Social Influence	User’s perceived influence by others in using a technology.

2 LITERATURE REVIEW

This chapter presents a brief history of MaaS as well as the elements and stakeholders associated with MaaS ecosystem followed by summary of the trials and research of MaaS conducted around the globe along with their key findings as well as main adoption factors.

2.1 Rise of MaaS

Before the novel concept of Mobility-as-a-Service or MaaS emerged, a very similar idea of managing mobility services or "Mobility Management" was mentioned in a report prepared for the United States Department of Transportation (US DOT). According to the report of US DOT (1991), mobility management is a process of facilitating local transportation services delivery by utilizing the use of modern information technologies to organize and integrate transportation resources, public or private, so as to achieve service cost-effectiveness. The main function of Mobility Management was to combine the roles of a travel agency and also of a financial agency to deliver efficient mobility services (US DOT 1991).

Mobility Management visualized the use of electronic technologies to integrate different mobility modes, process payments as well as to provide information of the available vehicles which is remarkably similar to the concept of MaaS. Kamargianni and Matyas (2017) visualized MaaS as a seamless mobility provider to the users by aggregating various mobility modes operated by public and private operators on a local, intercity as well as international levels through a single system which also offers users planning, booking, real time information as well as payment for the mobility services. Similarly, Lyons et al. (2020) also agrees that MaaS is actually not a new concept but has evolved from its predecessors of transport integration and it is based upon operational, informational, and transactional integration of mobility services in an application.

There is an infinite possibility of converting anything into service. According to Haselwander et al. (2022 p.503), MaaS is a part of "Anything as a Service (XaaS)" paradigm. XaaS is the concept or business model in which anything like products, processes, data, infrastructures are offered as a service. Similarly, in the transport sector, mobility can also be '*servicized*' to create tailored mobility services utilizing different mobility products or mobility means such as e-scooters, bicycles, motorcycles as well as cars. Consumers of such mobility services are able fulfil their needs of mobility without even owning any mobility means. Also, due to the changing market demands and shift in consumer behaviour, traditional product-based business models are adopting service-based business models (Kindström 2010).

Demographically, people are moving from rural areas to the cities and will continue doing so in the coming years as well. The global megatrend of Urbanization has forced the urban dwellers and planners to put sustainability at the highest level of priority when it comes to urban mobility. As such, autonomous and electric vehicles (EVs) as well as the concept of sharing vehicles are gaining popularity among urban mobility users as they are considered to be sustainable. Hannon et al. (2016), have forecasted that MaaS will become the management platform of these future mobility trends.

Therefore, it could be said that the traditional mobility sector is evolving due to the global megatrend of urbanization. This evolution is being supported by the digital and technological developments such as; fast and easy access to internet and the Internet of Things (IoT). At the same time, servicizing of passenger transportation combined with the platform-based business models such as; ride hailing and peer to peer car sharing, popularity of collaborative consumption of mobility modes such as; free floating e-scooters, station-based bike sharing (SBBS), community cars are fuelling this transformation of mobility sector.

In addition, there is also a growing demand of sustainable mobility modes by environmentally conscious consumers which is forcing the mobility services providers to supply the mobility modes and services accordingly. However, from the perspective of Gartner, MaaS is going through the slope of disillusionment but within five to ten years it will be commercially viable and reach the plateau of productivity (Gartner 2020; cited in SAE 2022).

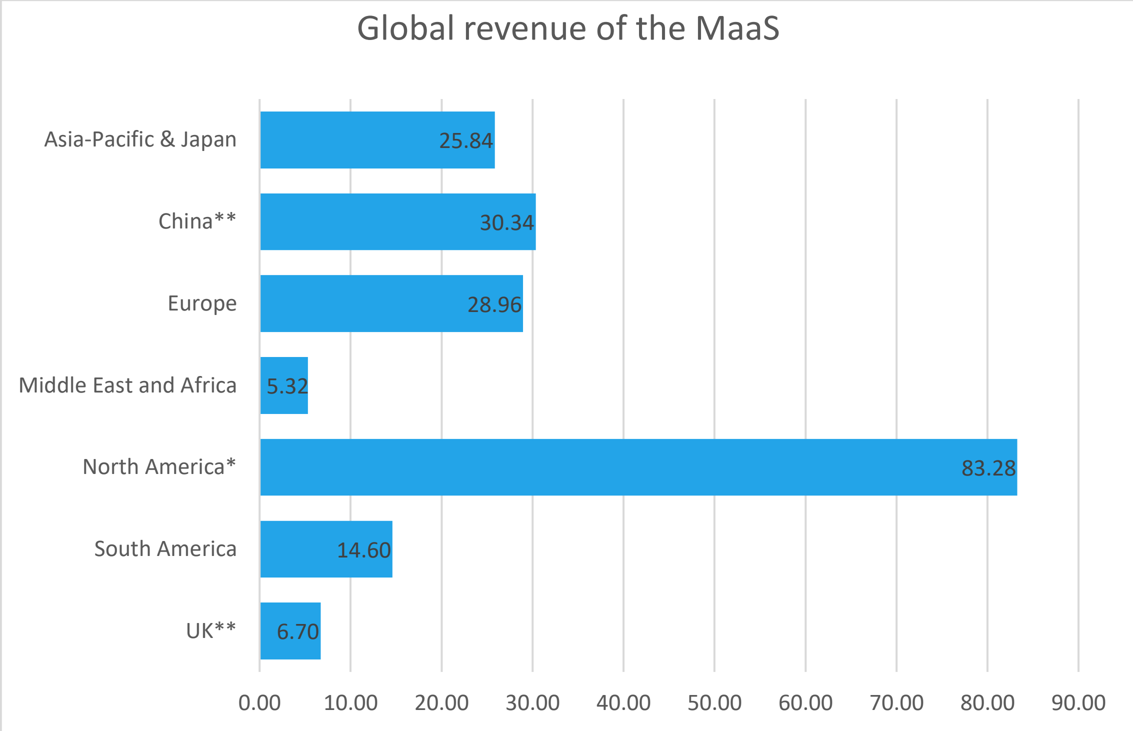

Figure 3: MaaS market size worldwide in 2019 in billion U.S. dollars (BIS Research 2022).

2.2 Definition of MaaS

As MaaS is a novel concept, its definition is still evolving. Some researchers define MaaS as an ‘aggregated’ platform of multi modal mobility services with public transportation at its core (Heikkilä 2014; Hietanen 2014). Leviäkangas (2016) has defined MaaS as a simple readymade package of different mobility services, public and private, offered to the consumers through smart phone applications with digital payment system. And according to Kamargianni and Matyas (2017 p.4), “Mobility as a Service is a user-centric, intelligent mobility distribution model in which all mobility service providers’ offerings are aggregated by a sole mobility provider, the MaaS provider, and supplied to users through a single digital platform.”

Other researchers define MaaS as ‘individual’ mobility operators providing single mode of mobility services such as ride hailing, car sharing and micro mobility platforms which are not integrated with public transportation (Alyavina et al. 2022.) Regardless of its definition, common elements have been found in both the single mode as well as multiple mode MaaS platforms. According to Kamargianni et al. (2016 p.3295-3298), these elements are:

- **Fare*:*** Fare integrated MaaS offers users to pay for and use various modes of mobility through one ticket, either digital or physical.
- **Services:** Service integrated MaaS offers a package, bundle or scheme which includes multiple mobility services and modes which can be paid in advance.
- **Technology*:*** Technology integrated MaaS is offered through a smart phone application or a website providing real-time information to the users about the mobility modes.

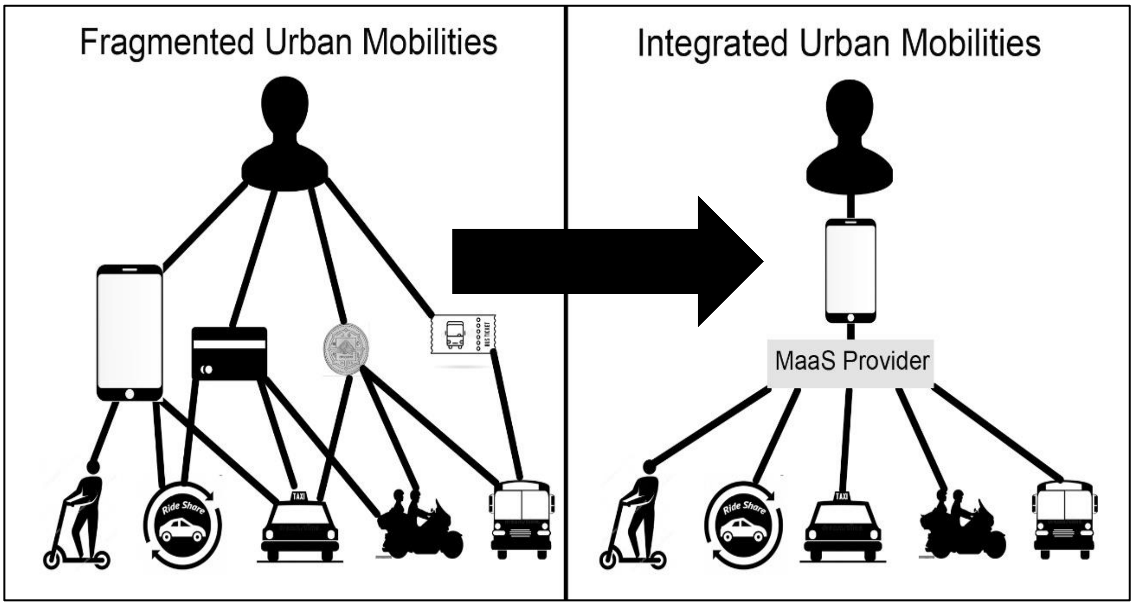

Figure 4: Fragmented and Integrated urban mobility adapted from Kamargianni and Matyas (2017 p.5).

MaaS operator acts as an intermediary between mobility service providers and mobility users by buying services from the mobility service suppliers and reselling them to mobility users. As an intermediary, MaaS eliminates the need of multiple transactions with multiple mobility service providers. MaaS creates an ideal combination of available mobility modes for each journey from real time data analysis. The data can be obtained through Application Programming Interfaces (API) between various mobility providers with the MaaS operator. With this data, MaaS can also optimize the supply and demand of mobility services. (Kamargianni and Matyas 2017.)

Similarly, Alyavina et al. (2022) have also identified some common elements and features associated with MaaS which are discussed below:

- **Integrated Mobility:** MaaS integrates all modes of passenger transportation, including public and private, seamlessly to reduce the need of owning a personal mobility means.
- **Digital Platform:** Mobility services are accessed through a digital platform in the form of a smartphone application or through a website.
- **Mobility Planner:** MaaS acts like a journey planner using different mobility modes while providing real-time information as well as digital payment execution.
- **Packages of services:** MaaS offers mobility packages in which users can customize the use of each mode of mobility mode as required.
- **Digital Payment:** Users can pay for the mobility packages on recurring subscription basis or pay-as-you-go basis.
- **Influencing travel behaviour:** MaaS can influence the travel behaviour by promoting eco-friendly modes through campaigns and incentives.
- **Extra services:** MaaS has the possibility of expanding into delivery of goods as well as providing parking spaces.

2.3 Integration of MaaS Elements

Based upon the elements incorporated into MaaS, Kamargianni et al. (2016) have classified integration of MaaS into three categories. First category is called “Partial Integration” in which elements such as tickets/fares, payment system and ICT are partially integrated but other elements are lacking. Second category is called “Advanced integration” in which elements such as payment, tickets, fares as well as ICT are fully integrated, and users can pay for different mobility modes offered through a mobile application or web interface but lacks mobility packages. And the last category is the “Advanced integration with mobility packages" in which mobility packages or bundles are integrated with all elements from the previous categories.

Similarly, Sochor et al. (2018) have categorized MaaS Integration into five different levels ranging from 0 to 4. Level 0 refers to no integration at all in which different mobility service providers operate independently. Higher levels of integration are discussed in the following sub chapters:

2.3.1 Integration Level 1

In this level, information such as available mobility modes and the prices of using those modes are provided to the user for planning the journey by self. Revenue generation of level 1 MaaS operator is usually through commission if the user chooses the service from the platform, through advertisements and also through the sale of mobility related data of the users to the city infrastructure planners as well as to the traffic management. Level 1 MaaS 'users' are not considered as 'customers' because users usually do not pay only for the information. (Sochor et al. 2018 p. 10.) 'Google Map' is a prime example of level 1 MaaS platform.

2.3.2 Integration Level 2

In this level, booking and payment option is provided in addition to the information mostly for single trips. So, the users can plan and pay for the required mobility services, including public transportation and taxi, directly through the level 2 operator. Unlike level 1, users of level 2 MaaS could become regular or random customer who actually are willing to pay for the service. Similar to level 1 integration, aggregated and anonymized data on users' mobility related patterns and habits cold be sold to cities for traffic and mobility management in addition to the commission and brokering fees. Level 2 MaaS operator takes care of validity of tickets and correct booking details but do not take responsibility of the actual mobility services on field. (Sochor et al. 2018 p. 10-11.)

2.3.3 Integration Level 3

In addition to the elements mentioned in level 1 and 2, level 3 integrates mobility services; contracts and assumes more responsibilities. So, integration level 3 is more similar to the concept of MaaS which offers bundles of mobility services mostly in subscription basis providing holistic mobility services which has the potential to replace the car ownership in which users usually pay for the multi modal mobility services through a platform, app or web-based, creating value for the end users as well as the suppliers. Revenue is generated by selling mobility bundles but some bundles with higher profit margin and some for even loss. Therefore, Level 3 MaaS operator requires a large customer base willing to subscribe for a mobility bundle in recurring basis so as to generate profit. The element of ICT is also a requisite for the level 3 operator, but it is not necessary to integrate all available service providers. The operator could choose the most suitable service provider for each mode and develop the multi modal mobility bundle. (Sochor et al. 2018 p. 11.) *'Ubigo'* and *'Whim'* are the examples of level 3 integration of MaaS operator.

2.3.4 Integration Level 4

The highest level of integration in MaaS can be achieved by integrating societal elements, including sustainability and accessibility, with all other elements mentioned in levels 1,2 and 3. Incentives and policies play key role in converting consumer's mobility choices towards more sustainable modes. Cooperation between public-private mobility provider is also important to integrate MaaS into level 4. The main objective of level 4 integration of MaaS is to achieve societal goals and to keep MaaS profitable for both service providers as well as operators. (Sochor et al. 2018 p. 11-12.)

While Sochor et al. (2018) focused on the customers, service providers and business model for service operators, Lyons et al. (2020) have included operational integration as well as cognitive user effort to develop a taxonomy called Levels of MaaS Integration (LMI) taxonomy. According to Lyons et al. (2020 p. 27-28), integration of MaaS can be indexed into five different levels starting from "Basic Integration or L1" where information element of available mobility modes is integrated in order to plan a journey without any other transactional elements. Second level is “Limited Integration or L2” where informational elements of different mobility modes are integrated in addition to the integration of transactional element and operational element followed by “Partial Integration or L3” in which mobility users are offered multi modal mobility service or a journey plan through one platform in a certain pre-defined origin and destination. E.g.: Uber offering bike and/or transit modes with ride hailing service.

Table 1: Summary of Integration Perspectives.

Kamargianni et al. (2016)	**Sochor et al. (2018)**	**Lyons et al. (2020)**
-	Level 0 (No Integration)	Basic Integration (E.g.: Google)
Partial Integration E.g.: Tampere ticket Integration (see chapter 6)	Level 1 (E.g.: Google)	Limited Integration (E.g.: Retypes)
Advanced Integration (E.g.: HSL app)	Level 2 (E.g.: Moovel)	Partial Integration (E.g.: Uber with bikes)
Advanced Integration with Mobility Packages (E.g.: Ubigo, Whim)	Level 3 (E.g.: Ubigo, Whim)	Full Integration with certain conditions (E.g.: Ubigo, Whim)
-	Level 4 (Integration of Societal goals)	Full Integration with all conditions (E.g.: MaaS Global’s roaming concept)

According to Lyons et al. (2020 p. 27-28), the “Full Integration (certain conditions) or L4” which has the full integration of pre-defined but not all modes through a service intermediary in the area where mobility means are present. Door to door mobility is achieved if the mobility service providers are present in the point of origin as well as in the point of destination. E.g.: Whim in Helsinki, Moovel in Germany, UbiGo in Sweden. The highest level is called “Full Integration (all conditions) or L5” in which all informational, transactional as well as operational elements are fully integrated in one service platform. It serves not only in local area but all domestic long-distance mobility needs. E.g.: The ‘roaming’ concept of MaaS Global which combines different cities as well as countries. (Lyons et al. 2020 p. 27-28.)

2.4 Ecosystem of MaaS

Apart from the elements and their integration, MaaS also consists of various actors and stakeholders. The whole concept of MaaS can be materialized through cooperation between different stakeholders such as mobility service providers, service operators, ICT and data service providers, infrastructure developers and regulators as well as customers or mobility users (Alyavina et al. 2022 p. 2). Kamargianni and Matyas (2017 p.7-12) have identified different actors who help in creating a business ecosystem of MaaS which are discussed in the following sub-chapters:

2.4.1 MaaS Operator

At the core of this business ecosystem is the MaaS service provider or the MaaS operator which can either be a public transport (PT) authority or a private entity. As PT is considered the backbone of MaaS, it would be natural for a PT authority to become an MaaS operator by integrating all other available modes with the PT. And most of time PT authority are also the regulators which makes it easier to create rules and regulations for MaaS. However, the transformation of PT authority into MaaS operator could be slower as bureaucracy within PT authority can hinder innovation. In case of private entity becoming a MaaS service provider, MaaS platform is expected to be developed much faster as they are driven by profit maximization and innovative service designs. (Kamargianni and Matyas 2017.)

However, König et al. (2016) has suggested that a Public Private Partnership would produce an effective MaaS operator in the rural context whereas PT authority would be more effective MaaS operator in urban context where comprehensive PT infrastructure already exists.

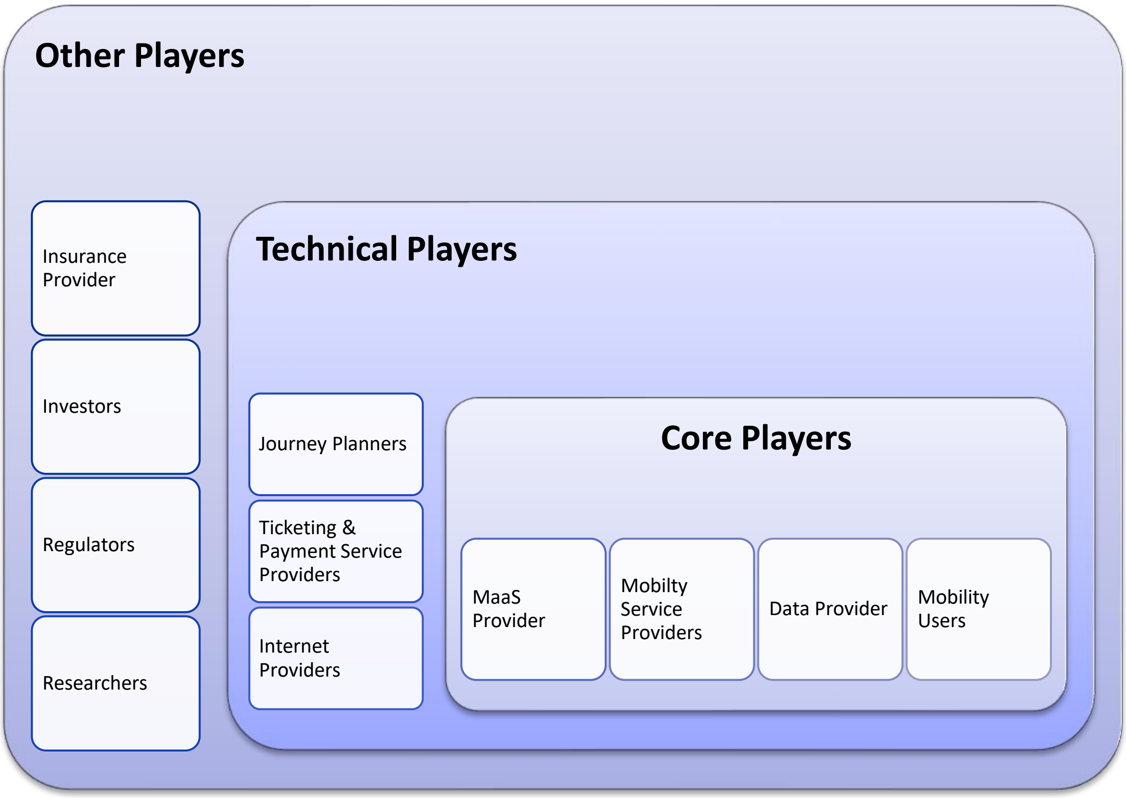

Figure 5: Ecosystem of MaaS adapted from Kamargianni and Matyas (2017 p.7).

2.4.2 Mobility Service Provider

Another primary actor in MaaS ecosystem is the service provider or the supplier of mobility modes and related services such as electric vehicles charging infrastructures. They sell their mobility capacity to the MaaS operator as well as provide real time data through Application Programming Interfaces (API). In order to generate the data, the service providers must use technologies such as Global Positioning System (GPS) sensors and Near Field Communication (NFC) systems.

The cooperation between MaaS service providers and MaaS operator creates value in the forms of wider market access for the service providers, optimization of supply and demand mobility services in real time for the MaaS operators and increased customer satisfaction level when customer demand is fulfilled. (Kamargianni and Matyas 2017.)

2.4.3 Data Providers

Another critical player in the core ecosystem of MaaS is the data provider who can store, process, analyse as well as present the data in interoperable format to the MaaS operator. The data provider(s) must be able to store and retrieve the data quickly but securely. The data generated by the mobility service providers are used to generate real time information as well as to suggest optimal journey suggestion to the MaaS users. As these data are large and agile, usage of NoSQL database technology would be more productive. (Kamargianni and Matyas 2017.)

2.4.4 Mobility Users

Last but not the least player in the core ecosystem of MaaS are the mobility users or the customers of MaaS. They are important players because MaaS is supposed to be user centric platform providing value to the users as well as the society. Value for the customers must be in the form of affordable and efficient mobility services while providing easy and smooth user experience at the same time. MaaS operators should be able to offer the customizable MaaS bundles according to the preferences of the customers. Customers can either be individuals, firms or both. (Kamargianni and Matyas 2017.)

2.4.5 Technical Actors

In the extended MaaS ecosystem, technical actors are the backbone of any MaaS business model. These actors are in the form of journey planners capable of creating many journey plans using the available real time data of multiple modes of mobility, ticketing and payment processors able to provide smooth and fast payment gateway to the customers through their smartphones, internet providers who can provide access to the internet to the users, operators as well as service providers in order to enable real time data processing. (Kamargianni and Matyas 2017.)

2.4.6 Insurer and Investor

Insurance is an important factor in any business model. Insurance companies could utilize MaaS platforms to expand their services and increase revenue. As MaaS is a growing and evolving, the exact terms and conditions of insurance claims, and the division of responsibilities of such claims needs to be clarified through further research. In order to materialize the concept of MaaS business model, investment is needed from the private as well as public sectors. Investment can be retrieved from the venture capitalist, public authorities to subsidize MaaS as well as through crowd funding. (Kamargianni and Matyas 2017.)

2.4.7 Regulators and Researchers

As mentioned earlier that MaaS is an evolving concept, researcher can play a lead role in providing quantified evidence of possible implications of MaaS and its impact in many areas. Such evidence and data can be used by the regulators to create a safe framework which guarantees fair competition, customer rights, data privacy and security as well as a more sustainable, inclusive and safer society. (Kamargianni and Matyas 2017.)

2.4.8 eMaaS

According to García et al. (2019), electric Mobility as a Service or eMaaS can be described as an alternative form of MaaS which offers multiple types of electric mobility modes within the comprehensive MaaS ecosystem to provide mobility service in an eco-friendly manner while providing seamless mobility function to the users. While PT is considered backbone of the original MaaS, shared electric mobility services such as e-car sharing, e-bike sharing, e-scooter sharing, e-bus and e-taxi are the main modes of eMaaS. The combination of Electric Mobility Systems (EMS) and Shared Electric Mobility Services (SEMS) is actually eMaaS (García et al. 2019).

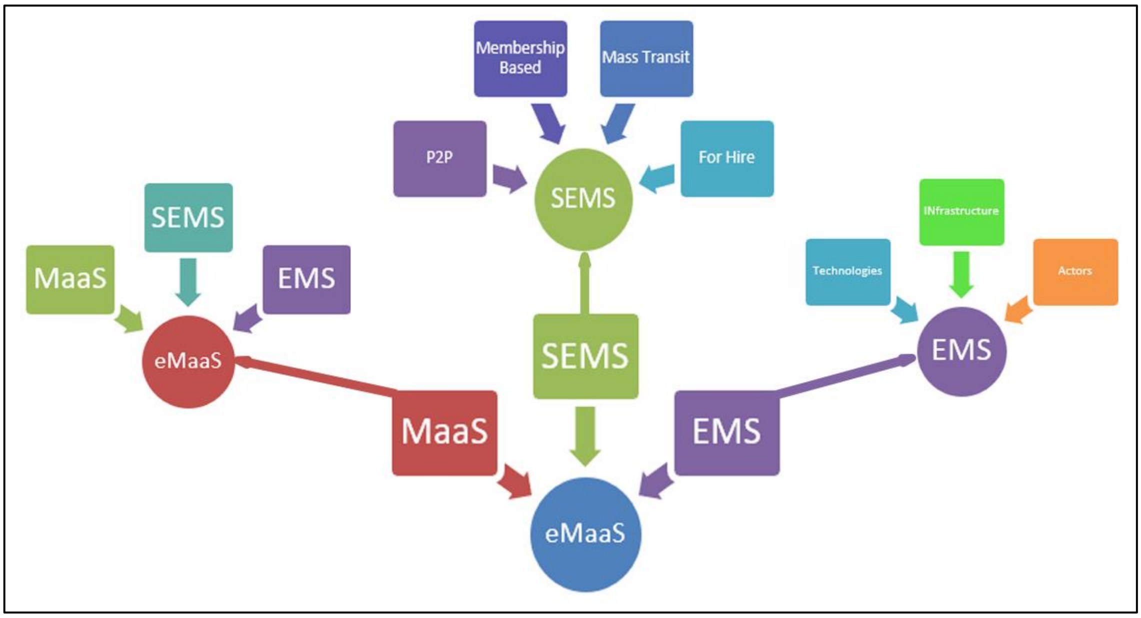

Figure 6: Ecosystem of eMaaS (García et al. 2019 p.7).

2.5 MaaS Trials in the Nordics, Europe and Australia

This chapter explores some of the first field trials of MaaS conducted in some Nordic countries, mainland Europe and Australia.

2.5.1 Ubigo

Ubigo is referred to as the first trial of MaaS before the term MaaS was coined, conducted in Gothenburg of Sweden from 2013 to 2014 (Hensher et al. 2020). In the trial, four main categories of UbiGo users were identified which are: "Car shedders," "Car accessors," "Simplifers" and "Economizers" (Strömberg et al. 2018). Among these categories, some participants used UbiGo to reduce their usage of cars and used alternative means to minimize their environmental impact whereas some participants used the trial to gain access to a car as needed instead of owning one. In other categories of participants, one group used UbiGo for its ease of use and efficiency whereas the remaining group of participants used UbiGo to save transportation related costs.

2.5.2 Whim

Helsinki city is also at the forefront of utilizing the concept of MaaS. Since 2016, a mobile application named as *Whim*, has been serving as a MaaS platform which combines public and private transportation as well as different private car rentals, taxis as well as micro mobility modes. From the app, consumers are able to purchase either a suitable mobility package as per their needs in a monthly occurring subscription basis or use the mobility services separately in pay-as-you-go system (Whimapp 2022).

2.5.3 EC2B

In another field test, a MaaS platform named as EC2B is being used since 2019 among the residents of an apartment complex in central Gothenburg of Sweden. Residents of the apartment were granted exclusive access to EC2B app from where they could book and pay for local public transport, communal vehicles as well as car sharing service. According to Smith et al. 2019c; cited in Hensher et al. (2020), primary users of EC2B were younger people who did not own a car, residents having access to EC2B gradually increased the use of the app for all mobility needs and purposes and the main factor of using the app was to reduce time and hassle as well as to gain the sense of independence regarding mobility.

Notably, the apartment did not have any private car parking area but an underground bike storage with maintenance tools as well as charging ports for e-mobilities. And the users of EC2B could get real time information of the available cars from the shared pool as well as customer service from the app.

2.5.4 Mobil-Flat

In 2017, a MaaS platform called Mobil-Flat was trialled in Augsburg, Germany. Mobil-Flat offered trial participants a two different scheme of mobility services included certain duration shared car usage and shared bike usage as well as access to city's local transportation. This scheme was relatively cheaper than the total cost of purchasing each mobility mode individually. The main objective of the trial was to study the travel behaviour affected by the mobility bundles as well as its efficacy in retaining customers. (Hensher et al. 2020.)

2.5.5 Tripi

With the objective of enhancing user experience of the mobility users by offering then multi modal mobility modes as well as to provide an alternative means of mobility other than a personally owned car, Tripi began its trial in Sydney; Australia in 2019. Until the restrictions were applied due to Covid-19, Tripi offered four different MaaS bundles in addition to pay as you go (PAYG) option over the trial period. This trial provided quantitative data to analyse the correlation ship between MaaS bundles and the change in travel behaviour of the bundle users. (Hensher et al. 2020; 2020a).

2.6 MaaS in Asia

As the rest of the world, developing countries in Asia are also facing the problems related with mobility such as traffic congestion as well as air and noise pollution. According to Hayashi et al. (2004), mobility related problems are induced by population growth and urbanization. Furthermore, economic growth in South and South-East Asia is leading to the motorization and an increase in car ownership and when road infrastructure is designed to suit the car and other four wheelers, safety of other mobility modes is compromised leading to higher rate of accidents related with two wheelers, like motorcyclists, which is the most dominant mode of mobility in South and South-Ease Asia (Khaimook et al. 2019).

And Hasselwander et al. (2022 p. 502) claim that MaaS has the potential to be a sustainable solution for the mobility problems in developing countries if the developing countries would follow the similar change in the mobility behaviour as witnessed during the trial of Ubigo (see chapter 2.5.1) in the developed country like Sweden. Hence, by inducing a change in attitude towards using collective mobility means instead of personally owning one and promoting the use of eco-friendly mobility modes, MaaS can become a sustainable mobility solution.

2.6.1 Manilla-Philippines

After realizing that MaaS has the potential to address the problem of transport and environment from the trials and research in the developed countries, Hasselwander et al. (2022) conducted a survey in the city of Manilla; Philippines in order to investigate the willingness of using MaaS as well as to identify the potential adopters of MaaS in one of the developing countries of Asia.

The survey was conducted in the form of an online questionnaire in which MaaS was explained in words, in pictures as well as in a video. After comprehending the concept of MaaS, majority of responders (84%) stated their willingness to use it. In fact, 90% of the respondents were already familiar with mobility service, such as ride-hailing, and using them through their smartphones.

Regarding the motivation to use MaaS, the survey highlighted that the most motivating factors of the respondents to adopt MaaS are the reliability, cost effectiveness and availability of multiple mobility modes. However, the environment factor did not turn out to be so dominant as in other developed countries but nevertheless, MaaS still has the ability to become sustainable alternative by promoting the use of PT. (Hasselwander et al. 2022 p. 514.)

2.6.2 Phuket-Thailand

The most used mode of mobility in South and Southeast Asia is motorcycle (MC). MC is used by many because it is very affordable, and efficient compared to PT. But, in Thailand, it is one of the leading causes of traffic related deaths (Khaimook et al. 2019). So, a “MaaS for local context (MaaS-LC)” was developed and studied in Phuket, Thailand for increasing safety awareness and enhance road traffic safety by combining “Safety Index” and “Walkability Index.”

For the survey, MaaS-LC platform, called GoTH was developed for both computers and mobile and trialled in Phuket. Out of the total respondents, 68% stated that GoTH was useful to find directions as well as to find real time information. In addition, a majority (78%) participants of the trial considered “safety” and “walkability” factors while choosing their trips. The results pointed out that usability and informative elements of the MaaS-LC app could influence and change the travel behaviour of the users as well as increase safety awareness. However, the trial was not so successful in influencing the users to use PT instead of a MC. (Khaimook et al. 2019.)

2.6.3 Kochi-India

In a city called Kochi of Southern India, the core concept of intramodality in MaaS was applied by putting together various mobility modes to form a MaaS project called ‘Seamless Transportation for Kochi.’ Like other Asian cities, Kochi has been also witnessing a rise in two-wheeler as well as four-wheeler due to economic growth. And this increased motorization is causing slow traffic, loss of productive time as well as road accidents. So, “Kochi One” which is India’s first digital MaaS platform was launched in Kochi in order to address the wider issues of private motorization and to reduce the demand for fossil fuel and decarbonize urban mobility (Singh 2020).

The “Kochi One” application is being used to plan journeys using different modes while a physical card of the same name is allowing the users to PAYG when using different modes. This platform integrated mobility service providers such as Kochi Metro, Private as well as State-Run Buses, Autorickshaws, water jetties and bike sharing services. Technologies such as Radio Frequency Identification devices (RFID) and Quick Response (QR) codes are used to facilitate payments. As Kochi One integrates elements such as real time information, journey planning with multiple modes as well as payment transaction element except mobility bundles, we can say that Kochi One is an example of Advanced Integration or Integration Level 2 **(**Chapter 2.3.2).

And from the analysis of Kochi One case, Singh (2020) highlights that MaaS has the ability to integrate Intermediate Public Transport (IPT) or traditional mobility modes such as autorickshaws with larger public transport to provide a seamless mobility service in the context of developing countries. Singh (2020) also mentions that MaaS has the ability to solve territorial disputes, induce socio-economic growth as well as increase operational efficiency.

2.6.4 Dhaka-Bangladesh

Some common mobility problems of developing countries related with PT are; non-conformity to schedule and traffic rules, longer waiting times, congested route as well as crowdedness. To address this issue, a “Demand responsive mobility as a service” or “DRMaaS” was piloted in the Dhaka, Bangladesh utilizing the shared economy model.

According to Kamau et al. (2016), DRMaaS is mode of mobility which is affordable as a bus and is available like a taxi as demanded by the customers in order to provide easier access to healthcare, education as well as economic activities. Field test of DRMaaS showed that waiting time was shorter than other modes of transport. DRMaaS does not only provided efficient and quality mobility to the users but also easy access to essential services like healthcare and education. Furthermore, DRMaaS can be made more affordable if the government provide subsidies. (Kamau et al. 2016.)

This concept integrates all the basic elements of MaaS such as fare, service, real time information, backend technology as well as payment without offering any mobility bundles but aims to fulfil higher societal goals of improving accessibility for the customers with low purchase capacity. So, DRMaaS can be categorized at Level 4 of MaaS.

2.7 MaaS Adoption Factors Extracted from Worldwide Trials and Surveys

From the key findings of MaaS trials and surveys mentioned in chapters 2.5 and 2.6, we can observe that MaaS users are influenced by the factors such as accessibility to multiple modes including access to cars for non-car owners, economic factors, psychological factor like need of belongingness in a peer group as well as hedonic factors like fun pleasure and enjoyment. Concerns of ones' own health improvement as well as the sense of environment conservation are also key enablers of MaaS use. Higher education as well as higher income have also been considered as enabling factors. (See Table 2)

And from the study of American millennials' mindset regarding their choice of mobility; major influencing factors have been identified as peers' social value, price, convenience, health benefit as well as environment impact (NAS 2013). Similarly, socio-economic factors of the users such as occupation, income level, disability, lifestyle and environmental consciousness as well as the size of the family are also important MaaS adoption factors (Kamargianni et al. 2015).

On the other hand, key barriers were also identified which are, lack of technological skills and the need of owning a car (See Table 2). From broader perspective, lack of partnership between public and private mobility operators, lack of subsidies from the governments as well as disinterest from the senior generations have been identified as barriers of MaaS adoption and use. According to Hannon et al. (2016), the process of MaaS adoption can be enabled by the integration of public and private mobility service operators. Similarly, offering subsidies to the MaaS subscribers could increase the demand (Ho et al. 2018).

The main findings and results from the trials and experiments from all over the world are summarized in Table 2, in addition to the findings from the cases discussed in chapters 2.5 and 2.6.

Table 2: Findings from MaaS Trials and Research adapted from Hasselwander et al. (2022 p. 504)

Author (Year)	**Literature**	**Case and Location**	**Research Method**	**Key Findings**
Karlsson et al. (2016)	*"Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovative travel brokerage"*	UbiGo, Gothenburg, Sweden	Mixed method based on trial	Decreases in private car use and increases in alternative modes such as car sharing and public transport.
Sochor et al. (2016)	*"Trying out mobility as a service: Experiences from a field trial and implications for understanding demand"*	UbiGo, Gothenburg, Sweden	Mixed method based on trial	Creating access to multi modes of mobility in one platform, simplicity; Accessibility; flexibility; and economy can increase demand of MaaS.
Ho et al. (2018)	*"Potential uptake and willingness-to pay for Mobility as a Service: A stated choice study"*	Sydney, Australia	Stated preference survey data analysis	Infrequent users of cars are most likely adopters of MaaS. Careful segmentation of the market and a cross-subsidy strategy is essential to generate market demand.
Matyas and Kamargianni (2019a)	*"The potential of mobility as a service bundles as a mobility management tool"*	Greater London, UK	Stated preference survey data analysis	Low-income households prefer MaaS bundles that include PT. MaaS bundles could be used to introduce more travellers to shared modes.
Mulley et al. (2020)	*"Mobility as a service in community transport in Australia: Can it provide a sustainable future?"*	NSW and Queensland, Australia	Stated choice experiment with survey data	The willingness to pay for bundled mobility services lower than the unit costs of mobility modes.
Guidon et al. (2020)	*"Transportation service bundling–for whose benefit? Consumer valuation of pure bundling in the passenger transportation market"*	Zurich, Switzerland	Discrete choice experiment with survey data	PT offered within a bundle is valued higher than separately offered. Bicycle & e-bike sharing, taxi was valuated higher individually. Willingness to pay for a multi modal MaaS app was high.

continued on next page…

Author (Year)	Literature	Case and Location	Research Method	Key Findings
Schikofsky et al. (2019)	*"Exploring motivational mechanisms behind the intention to adopt mobility as a service (MaaS): Insights from Germany"*	Germany	Qualitative and Quantitative	Psychological needs of autonomy, competence, the need for belonginess with peers and hedonic elements of pleasure, fun enjoyment are main motivational factors.
Fioreze et al. (2019)	*"On the likelihood of using Mobility-as-a-Service: a case study on innovative mobility services among residents in the NL"*	Netherlands	Mixed methods approach based on survey/focus group data	PT users who value health and environment are likely adopters of MaaS but frequent car users with own car are less likely to adopt MaaS.
Caiati et al. (2020)	*"Bundling, pricing schemes and extra features preferences for mobility as a service: Sequential port-folio choice experiment"*	Netherlands	Sequential portfolio choice experiment	Price for mobility bundle subscription important factor for adoption of MaaS PT is the most preferred mode for bundles.
Chinh et al. (2020)	*"Public preferences for mobility as a service: Insights from stated preference surveys"*	Tyneside, UK	Stated preference survey data analysis	Young generation of smartphone users are likely adopters of MaaS. MaaS could be a substitute for the second household car, but would not replace the first car.
María et al. (2020)	*"Drivers and barriers in adopting Mobility as a Service (MaaS)–A latent class cluster analysis of attitudes"*	Netherlands	Latent class cluster analysis of attitudes	Adoption barriers are the need of car and the lack of technological skills. Adoption drivers are high education/income
Butler et al. (2021)	*"Barriers and risks of Mobility-as-a-Service (MaaS) adoption in cities: A systematic review of the literature"*	Global	Systematic Literature Review	Absence of PPP, investment and political support, service coverage common vision is supplying barriers. Lack of demand from older generations, PT users, and owners of private mobility modes.

3 MAAS PERCEPTION STUDY IN KATHMANDU APPLYING UTAUT2

Kathmandu, which is the capital city of Nepal, located inside the valley of Kathmandu (KV) along with neighbouring cities of Lalitpur and Bhaktapur. According to UN DESA (2019 p.52), Nepal is the second fastest urbanizing countries in the world. At the same time, Kathmandu is one of the most congested but emerging cities in the world even though the city has lower GHG emission per capita (Oke et al. 2019 p.13). But despite having higher growth and development potential KV is highly congested and one of the most polluted cities in the world (see chapter 1.1)

Figure 7: A typical traffic scene in Kathmandu (Kathmandu Post 2023).

And due to the population growth, economic development, increased motorization, and continuous urbanization, KV is facing severe road congestion causing loss of productive time as well as accidents leading to the avoidable loss of valuable lives. It is estimated that the congestion in KV is causing an economic damage of hundreds of millions of Euros annually (My Republica 2019). As a member state of United Nations Framework

Convention on Climate Change (UNFCCC), Nepal is committed towards implementing low-carbon development policies. Among other strategies, government of Nepal has set targets to increase the number of Electric Vehicles (EVs), decrease dependency upon fossil fuel, develop sustainable hydroelectricity for rails at national level (NDC 2016).

Developing the existing infrastructure like widening the roads in KV was considered as one of the solutions to address the issue of congestion. But according to Khanal et al. (2017), widening of roads is just temporary solution and would not suffice in the long run when the number of vehicles keep increasing at the same time. Furthermore, Khanal et al. (2017, p. 113) warns that just making roads wider without taking sustainable urban mobility into consideration may cause negative effects to environment and disturb the social harmony.

Public Transportation (PT) such as buses, micro-buses, three-wheeler electric tempos as well as taxis, manual rickshaws are operating on the roads of KV. Privately owned mobility modes such as bicycles, motorcycles as well as cars are used in KV as primary mobility mode in addition to the PT. Motorcycle is the main mode of motorized transportation in KV (see Table 3) because of its ease of manoeuvrability on the narrow roads of KV. Regarding the quality and reliability of PT in KV, satisfaction level is extremely low among its users due to its unavailability as well as unreliability. As such, commuters are forced to use modes such as walking, bicycles as well as motorcycles for work and education related mobility needs (Bhagawat 2017 p.13-14). However, highest number of trips were made with the combination of Public and Active modes of mobilities (Table 3).

Regarding the integration of MaaS elements described in chapter 2.3, digital elements such as digital platform or smartphone application as well as embedded digital payment technology are utilized by ride sharing/hailing platforms and taxis. But PT modes in KV accept mainly cash as a means of payment of fare. Regarding the informational element, multi modal journey planning is not possible due to the lack of real time information of all the available mobility modes. However, it is possible to get real time information and journey planning (estimation of distance, duration and fare) through individual MaaS platforms active in KV. As an extra element, these MaaS platforms are also providing delivery services through the same application. From integration perspective, all mobility services providers in KV are operating independently and there is no digital integration or API of any elements, including fare and information.

Table 3: Mobility Modes of KV adapted from (Bhagawat 2017 p.13).

Mobility Mode	Number of Trips
Public Transportation Modes:	948464
Active Mode: Walking	1398378
Active Mode: Bicycling	52445
Car and Taxi	145980
Motorcycles	893126
Public and Active Modes combined	2399287
Total	3438393

Deploying MaaS in KV could alleviate mobility related problems as well as promote sustainability to some extent. However, a comprehensive MaaS platform does not exist in Kathmandu Valley (KV) but few ride-hailing and ride sharing platforms have already been operating in KV. These platforms can be considered as independently operating MaaS providers who provide single or dual mode mobility services. Such platforms utilize private motorcycle riders and car drivers, to the consumers connected by the smartphone apps.

As a comprehensive MaaS app does not yet exist in KV, the research would be based on stated preference experiment (SP) and UTAUT2 framework. SP is mostly used to gather user perceptions about the products or services that has not been launched yet in the market (Louviere et al. 2000). And the user perceptions related with MaaS would be measured using the factors or the constructs described in the UTAUT2 framework. These factors are Effort Expectancy, Performance Expectancy, Facilitating Conditions, Social Influence, Hedonic Motivation and Behavioural Intention which are described later in this chapter.

MaaS can be considered as a modern digital technology providing mobility services as required by the users. MaaS puts users at its core, so, an essential criterion for the success of MaaS is the adoption and use of the technology by the end users. The intention to use and to adopt a technology by the end user is affected by several factors which can be measured. One of the models which comprises some of the affecting factors is called Unified Theory of Acceptance and Use of Technology (UTAUT2). UTAUT2 is mainly used to study the influence of each factor in using a certain technology by the users.

According to Venkatesh et al. (2012), the primary factors affecting the adoption and use of a technology are: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV) and Habit Behaviour (HB). Secondary factors such as age, gender and experience moderate the Behavioural Intention (BI) or the perceived likelihood of engaging with the technology as well as the Use Behaviour (UB) or eventual use of that technology (Venkatesh et al. 2012.)

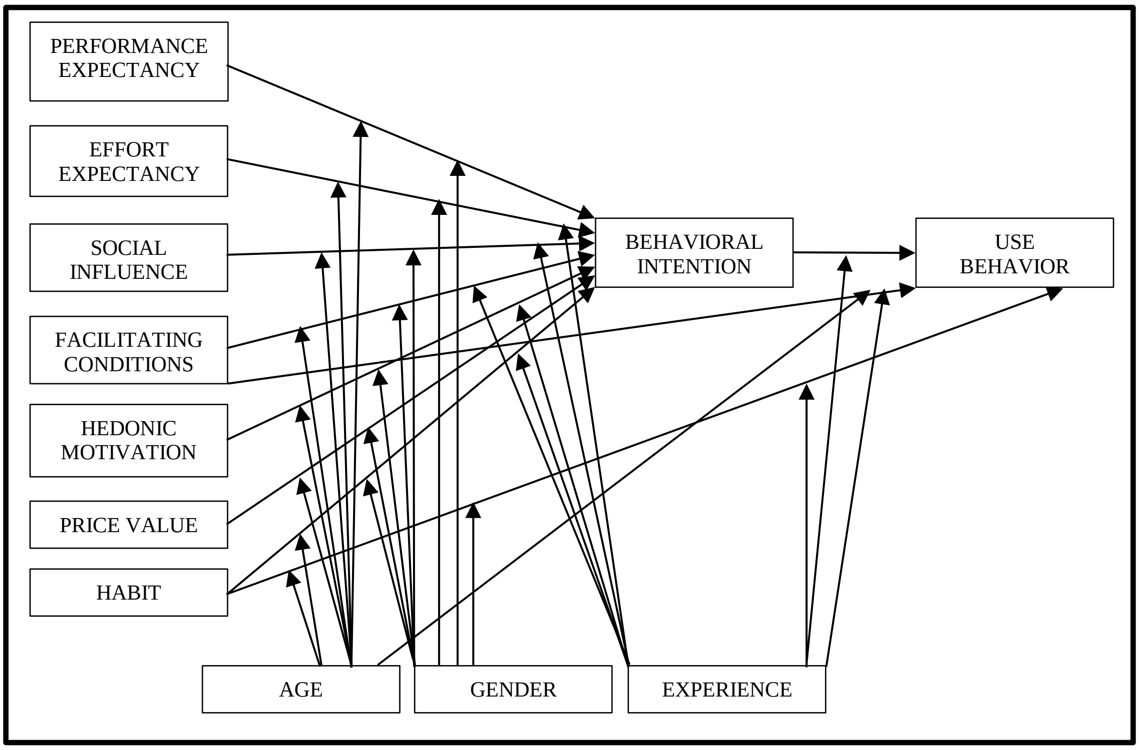

Figure 8: Original UTAUT2 Model (Venkatesh et al. 2012 p. 160).

According to Venkatesh et al. (2012), EE refers to the users' perception of easiness or difficulty to use of the technology whereas PE is the users' perception of usefulness, SI is the perception of the users regarding the importance of that technology in the society or a peer group, FC are the resources available to the users in order to use the technology, HM is the users' perception regarding the enjoyability of using the technology, PV is the users' own calculation of monetary profitability and the cost of using the technology and HB is the passage of time since the users first used the technology.

Although the UTAUT2 model with the original variables has been widely used to study the adoption of technology, some researchers claim that the adding variables like user perception of trust, associated risks, satisfaction, personal innovativeness could better predict the acceptability of a given technology (Chao 2019 p.2.). As such, in a modified study of willingness to use MaaS based on UTAUT model, additional variables like perceived risk (PR), individual innovativeness (II) as well as attitude (AU) towards using MaaS after launch were added with moderating variables of gender, age, membership experience as well as education and household car as added moderating variables. The study showed that PR had negative influence on BI whereas PE, SI, II and EE had positive influence on BI. Gender had some moderating affect between EE and BI, age had some moderating affect between PE and BI, experience or familiarity caused no significant moderating effect on BI or AU, education had significant moderating effect between EE and BI. (Jianhong et al. 2020 p.3-8.)

Another study of electric car sharing platform, similar to MaaS, in China was conducted using UTAUT2 model which showed that HM had significant effect on BI to use car sharing platform. Similarly, PR, EE as well as familiarity with the concept also affected the BI. Regarding the moderating variables, age has moderating effect on the relationship between HM and BI, gender had some moderating affect between EE and BI as well HM and BI. (Tran et al. 2019.)

Similarly, this research will also include an extra variable named as New Construct (NC) intended to measure the environmental consciousness of the respondents as independent variable as well extra moderating variables like familiarity, income and mode.

4 RESEARCH DESIGN

The process of research can be considered as a journey which is assisted by research design as navigator to reach the destination which is the fulfilment of aim, objective and purpose of the research. A research design starts with a clear definition of a research question followed by a plan to achieve the answer to it as well as the objectives required to do so. The research plan must mention the sources or data needed to answer the research question, how the data is collected and the method of data analysis. In addition, a research plan can also anticipate research barriers and ways to tackle them. (Saunders et al. 2019 p. 173.) This chapter provides justification for the method utilized in the research along with the description of the survey design, data collection method as well as the reliability and the validity of the data followed by the data analysis methods.

4.1 Methodology

Research methodology can be broadly divided into Quantitative and Qualitative or a mix of both methods. The quantitative method is primarily concerned with numbers, so data collection in quantitative method often involves questionnaire. As such, data can be obtained from surveys with questionnaires, experiments, observation as well as from content analysis. Surveys involve obtaining data from a large group of people using a pre-designed set of questions which is considered as an efficient way to collect data. Surveys can either be self-administered in which respondents independently answer the survey or it can be researcher-administered through street surveys, phone surveys. Researcher administers survey could be advantageous in the way that the misunderstandings of the responders regarding the questions can be cleared immediately but at the same time there exist the risk of researcher effect. (Saunders et al., 2019; Bryman, 2012; Oates, 2006; Christensen et al., 2001.)

The author has chosen quantitative method as the quantitative data obtained from the survey can be used to obtain the answers for the main research question and the related investigative questions specified in chapter 1.2. The data can also be used to generalize the finding to some extent which will serve the purpose of this study. So the author has concluded that the quantitative method is the most suitable method to fulfil the aims and objectives of this research and the research questions.

4.2 Survey Structure

Designing a survey questionnaire needs careful planning and questions should be tied with the main research question(s) and also with the related theories. The questions should be easily understandable by the respondents. The questionnaire must begin with an introduction stating the purpose of the survey in addition to the instructions, estimated time to complete the survey, deadline of submission and the assurance of anonymity. (Saunders et al. 2019 p. 174.)

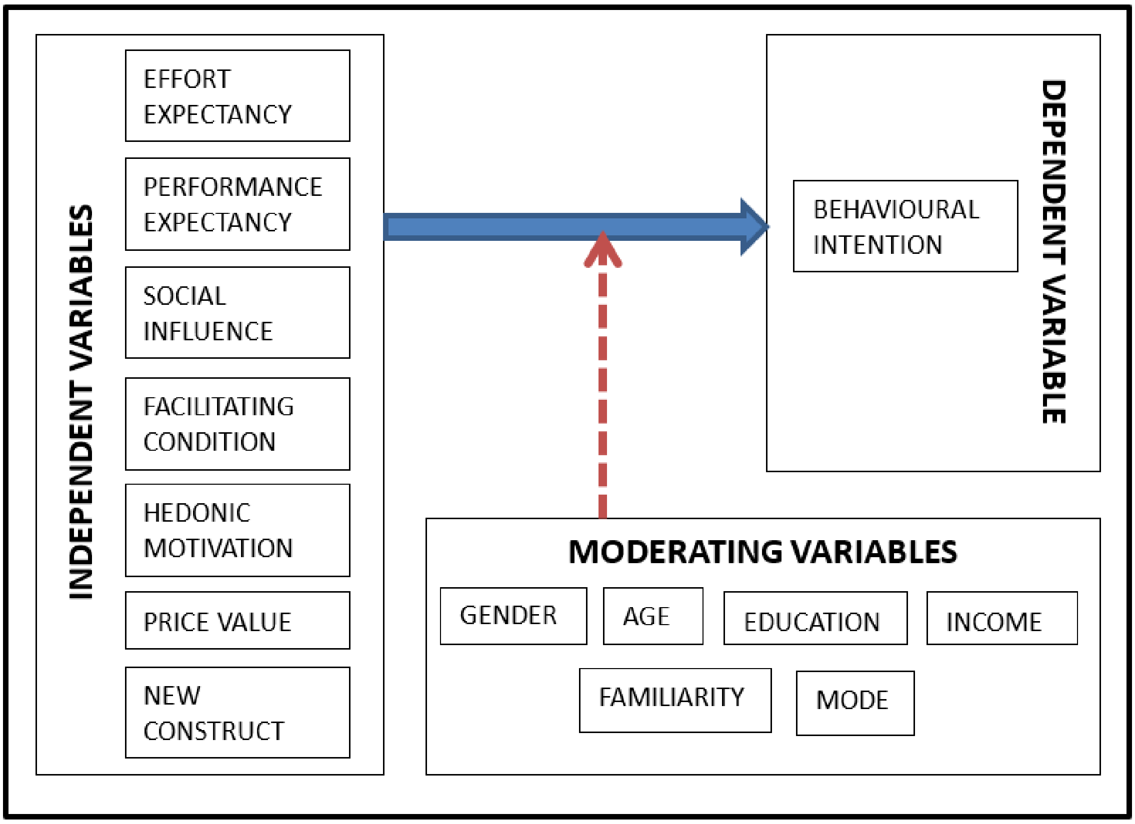

Figure 9: Research Model adapted from Venkatesh et al. (2012).

As such, a set of questionnaires (see Appendix) has been developed using modified research model (Figure 9). The survey begins with the statement of purpose of the survey along with the estimated time for its completion. The author has declared no conflict of interest and financial gains associated with the survey and has mentioned that the survey was for academic purpose only. The author has also provided an assurance of respondents' anonymity and the use of data for specified purpose only.

Figure 10: Poster of MaaS.

Then, the respondents were presented with a definition of MaaS in simple words along with the explanatory pictorial graphics (see Figure 10) as well as videos of already existing MaaS app to create an impression of MaaS and to familiarise themselves with the concept before proceeding further to answer the survey questionnaire. Same technique was used by Hasselwander et al. (2022) to investigate the willingness of using MaaS as well as to identify the potential adopters of MaaS (see chapter 2.6.1). Three hypothetical mobility service subscription packages were presented in the survey on the basis of Stated preference theory (see chapter 3). Also, to facilitate the easy understanding of the whole survey, the author suggested the respondents to translate the survey into the local Nepali language using translation feature of the web browser.

All items related with UTAUT2 constructs were measured in four-point Likert scale ranging from Strongly Disagree to Strongly Agree without the neutral option. Such type of Likert scale forces respondents to create an opinion in either direction, which is useful in studying perceptions regarding a certain product or a service (ProProfs 2023). Lastly, the survey was shared in different social media platforms using the link to the *google form*. The data was collected from 2022/06/13 until 2022/08/10.

4.3 Primary and Secondary Data

According to Ghauri & Gronhaug (2010), secondary data is the pre-existing data compiled by others through their research whereas primary data is the data collected by the researcher to solve their own specific research problem.

For this study, primary data was obtained through survey questionnaire. The survey was distributed through social media platforms such as Facebook, twitter and LinkedIn. The author posted the survey link in different social media groups active in the target market of Kathmandu Valley (KV). A total of 105 responses were collected from the survey.

The secondary data was mainly sourced through scientific articles and journals related with the topic. In addition, already existing statistical data, informative websites, newspaper articles, publications, tutorials as well as videos has been used to obtain the secondary data.

4.4 Description of Variables

Table 4: Description of Variables.

Variables	Label	Value	Value Label
Q1	**Gender**	1	Male
		2	Female
Q2	**Age**	1	18-30
		2	31-40
		3	41-50
		4	More than 50
Q3	**Income (NRS)**	1	1000-25000
		2	25001 - 50000
		3	50001 - 100000
		4	More than 100000
Q4	**Education**	1	Higher Secondary
		2	Bachelors
		3	Masters
		4	Higher
Q5	**Occupation**		Omitted from analysis
Q6	**Use Behaviour of other MaaS apps**	1	Use Frequently
	Data Reversed as in excel as Use Frequently=3, Use Sometimes=2, Never Used=1	2	Use sometimes
		3	Never used
Q7	**Mobility modes usage**		
	Car=Only car.	1	Car
	Motorcycle/Scooter = Only motorized two wheelers.	2	Motorized Two Wheeler
	Bicycle=Only bicycle.	3	Bicycle
	Public Transport(PT)=Only public transportation.	4	Public Transport
	Multiple Modes=Includes only combination of car, motorized two wheelers, bicycle, public transport.	5	Multiple Mode including PT
	Personal Modes=Includes only combination of car, motorized two wheelers, bicycle but excludes public transport.	6	Personal Modes excluding PT
	Effort Expectancy of using MaaS (EE)	1	Strongly Disagree
8	I think I understand the concept of MaaS very well.(EE1)	2	Disagree
9	I think it will be easy to use MaaS app.(EE2)	3	Agree
10	I think I can easily learn to use MaaS app.(EE3)	4	Strongly Agree
	Performance Expectancy of using MaaS (PE)	1	Strongly Disagree
11	I think using MaaS app will help me save money.(PE1)	2	Disagree
12	I think using MaaS app will help me save time.(PE2)	3	Agree
13	I think using MaaS app will help me travel around conveniently and easily.(PE3)	4	Strongly Agree
	Social Influence on using MaaS (SI)	1	Strongly Disagree
14	I think I will use MaaS app if my friends like it and use it too.(SI1)	2	Disagree
15	I think that the people important to me would like me to use MaaS app.(SI2)	3	Agree
16	I think I will use MaaS app if social media is positive about it.(SI3)	4	Strongly Agree
	Facilitating Condition of using MaaS (FC)	1	Strongly Disagree
17	I will be able to use MaaS app on my mobile device.(FC1)	2	Disagree
18	I have access to mobile internet to use MaaS app.(FC2)	3	Agree
19	I am able to use digital payment from my mobile device.(FC3)	4	Strongly Agree
	Hedonic Motivation (HM)	1	Strongly Disagree
20	I think it would be fun to use MaaS app.(HM1)	2	Disagree
21	I think it would be entertaining to use MaaS app.(HM2)	3	Agree
22	I think I would enjoy using MaaS app.(HM3)	4	Strongly Agree
	Price Value of using MaaS (PV)	1	Strongly Disagree
23	I think using MaaS app will be financially beneficial for me.(PV1)	2	Disagree
24	I think that the discounts offered in MaaS app are of fair value to me.(PV2)	3	Agree
		4	Strongly Agree
	Behavioral Intention to use MaaS (BI)	1	Strongly Disagree
25	I think I will use MaaS app when it is available in the future.(BI1)	2	Disagree
26	I think I will use MaaS app in my daily life.(BI2)	3	Agree
27	I think I will use MaaS app when needed.(BI3)	4	Strongly Agree
	New Construct (NC)	1	Strongly Disagree
28	I am aware of environmental impact of the vehicle(s) I use.(EA)	2	Disagree
29	I choose walking/Bicycling whenever possible.(HC)	3	Agree
30	I think I will start using electric vehicles such as e-cars,e-scooter, e-bikes in the future.(EVU)	4	Strongly Agree

4.5 Analysis Methods

For the purpose of analysis, the survey data was first prepared in MS Excel where Identification number (ID) was assigned to all the responses. Next, the variables of Gender

(Q1), Age(Q2), Income(Q3), Education(Q4), Experience(Q6) and Modes(Q7) were assigned values; also the responses of Q6 were reversed and the responses of Modes(Q7) were regrouped using MS Excel as shown in Table 4. MS Excel was also used to create descriptive graphical illustration of the data in chapters 5.1 and 5.2.

Then the same data was processed in IBM SPSS wherein Labels and Values were added to the data. Using the same software, reliability and validity of the data was established (see chapter 4.6). Similarly, convergent and discriminant validity of the data were analysed using SPSS AMOS. Then the data was used for structural equation modelling analysis which is reported in chapters 5 and 6.

Table 5: Regrouped Variables.

Variable	**Old Groups Value and Label**	**New Groups Value and Label**
Age	1. 18-30 2. 31-40	1. 18-40
	3. 41-50 4. More than 50	2. 40 plus
Income	1. 1000-25000 2. 25001-50000	1. <50K
	3. 50001-100000 4. More than 100000	2. >50K
Education	1. Higher Secondary 2. Bachelors	1. Bachelor and Below
	3. Masters 4. Higher	2. Above Bachelors
Mobility Modes	1. Car 2. Motorized Two Wheelers 3. Bicycle 4. Public Transportation 5. Multiple Modes including PT	1. Multiple modes
	6. Personal Modes excluding PT	2. Personal mode(s)
Familiarity	1. Never Used 2. Used Sometimes	1. Low Familiarity
	2. Used Frequently	2. High Familiarity

Next, in order to analyse the effect of moderating variables between the dependent variable and the independent variables, the moderating variables were regrouped into two groups by creating new variables using SPSS (Table 5). Furthermore, an interaction variable was created by multiplying the moderating variable with the mean centered independent variable. Lastly, the moderation analysis was conducted in SPSS AMOS by creating moderation models with the newly created interaction variable, moderating variable and independent variable in relation with the dependent variable (see Figure 20).

4.6 Reliability and Validity

In order to ascertain the reliability and validity of the sample data, Cronbach coefficient analysis was performed which measures the internal consistency of the scale used in data collection. The reliability is measured by the closeness of the alpha to absolute 1 which can be interpreted as 0.9 = Excellent, > 0.8= Good, > 0.7 = Acceptable, > 0.6 = Questionable, > 0.5 = Poor, and < 0.5 = Unacceptable. (Sekaran and Bougie 2020.)

4.6.1 Cronbach alpha analysis

Cronbach alpha analysis shows that internal validity of all constructs was reliable except the new construct (NC) which was omitted from further analysis.

Table 6: Cronbach's alpha Analysis.

Constructs and Items	**Cronbach's Alpha**	**Cronbach's Alpha if Item Deleted**	**Remarks**
Effort Expectancy (EE)	0.843		**Good**
I think I understand the concept of MaaS very well. EE1		0.75	
I think it will be easy to use MaaS app. EE2		0.765	
I think I can easily learn to use MaaS app. EE3		0.819	
Performance Expectancy (PE)	0.795		**Acceptable**
I think using MaaS app will help me save money. (PE1)		0.81	
I think using MaaS app will help me save time. (PE2)		0.655	
I think MaaS app will help me travel around conveniently and easily. (PE3)		0.698	

continued on next page…

Constructs and Items	**Cronbach's Alpha**	**Cronbach's Alpha if Item Deleted**	**Remarks**
Social Influence (SI)	0.811		**Good**
I think I will use MaaS app if my friends like it and use it too. (SI1)		0.715	
I think that the people important to me would like me to use MaaS app. (SI2)		0.792	
I think I will use MaaS app if social media is positive about it. (SI3)		0.703	
Facilitating Condition (FC)	0.765		**Acceptable**
I will be able to use MaaS app on my mobile device. (FC1)		0.665	
I have access to mobile internet to use MaaS app. (FC2)		0.621	
I am able to use digital payment from my mobile device. (FC3)		0.77	
Hedonic Motivation (HM)	0.925		**Excellent**
I think it would be fun to use MaaS app. (HM1)		0.892	
I think it would be entertaining to use MaaS app. (HM2)		0.886	
I think I would enjoy using MaaS app. (HM3)		0.897	
Price Value (PV)	0.782		**Acceptable**
Behavioural Intention (BI)	0.71		**Acceptable**
I think I will use MaaS app when it is available in the future. (BI1)		0.53	
I think I will use MaaS app in my daily life. (BI2)		0.707	
I think I will use MaaS app when needed. (BI3)		0.631	
New Construct (NC)	0.68		**Questionable**
I am aware of environmental impact of the vehicle(s) I use. (EA)		0.644	
I choose walking/Bicycling whenever possible. (HC)		0.497	
I think I will start using electric powered vehicles in the future. (EVU)		0.6	

4.6.2 Kaiser-Meyer-Olkin (KMO) test

For validity analysis, Kaiser-Meyer-Olkin (KMO) test was conducted. According to OnlineSPSS (2023), if KMO is equal or greater than 0.60, the sample used was adequate and if Bartlett’s test of sphericity is significant ($p < 0.05$), then the data can be considered valid.

Table 7: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.906
Bartlett's Test of Sphericity	Approx. Chi-Square	1470.140
	df	190
	Sig.	<.001

The analysis showed that KMO measure of sampling adequacy is 0.906 and Bartlett's test of sphericity was <.001 which proved that sample data was stable, valid and adequate for further analysis (Table 7).

4.6.3 Convergent Validity

Convergent validity measures the similarity of the items or the indicators of a particular construct. Composite Reliability (CR) and Maximum Reliability MaxR(H) should be greater than 0.7 in order to establish convergent validity but if the AVE is less than 0.5 while the CR is greater than 0.6, the convergent validity of the construct is still adequate (Fornell & Larcker, 1981).

Table 8: Convergent Validity Analysis

Construct	**CR**	**MaxR(H)**	**AVE**
EE	0.847	0.851	0.649
PE	0.746	0.755	0.496
SI	0.812	0.813	0.590
FC	0.754	0.879	0.521
HM	0.928	0.929	0.811
PV	0.791	0.826	0.656
BI	0.726	0.734	0.470

In this case, all the constructs have higher than required threshold except the PE and BI which was less than the required threshold of 0.5 AVE but CR as well as MaxR(H) both are greater than 0.7 as shown in Table 8.

4.6.4 Discriminant validity

Discriminant validity is the measurement of uniqueness or the distinction between the constructs. One of the techniques to measure discriminant validity is called Heterotrait-Monotrait (HTMT) analysis. According to Henseler et al. (2015), the threshold for discriminant validity in HTMT analysis is: <0.85 or <0.9. The HTMT analysis shows that all constructs are distinguished from each other except BI with PE, FC and PV. As most of the constructs consisted of three items per construct, except PV which had two, none of the items were deleted even though it would have slightly improved the reliability and validity of the data as suggested by Cronbach's alpha analysis. Nevertheless; the sample data, for this particular study, can be claimed as reliable and valid overall and fit for further analysis.

Table 9: HTMT Analysis

	EE	PE	SI	FC	HM	PV	BI
EE							
PE	0.812						
SI	0.607	0.761					
FC	0.784	0.868	0.708				
HM	0.571	0.814	0.528	0.709			
PV	0.711	0.877	0.706	0.774	0.792		
BI	0.807	0.998	0.750	0.910	0.828	0.963	

4.7 Research Overlay Matrix

The following table shows the theoretical framework, applied research method, measurement question and results of the research question and investigative questions, respectively.

Table 10. Research Overlay Matrix

Research Questions	Theoretical Framework	Research Methods	Measurement Questions	Results
RQ: What is the general perception of MaaS in Kathmandu from consumer context?	Chapters: 3	Survey & Data Analysis	8, 9, 10, 11, 12, 13, 14	Chapters: 5.2, 6.1
IQ1: What factors affect the adoption of MaaS app by potential users?	Chapters: 2.5, 2.6, 2.7, 3	Literature Review, Survey & Data Analysis	8, 9, 10, 11, 12, 13, 14, 15	Chapters: 5.3.3, 6.2
IQ 2. What factors moderate the intention to use MaaS app?	Chapters: 2.5, 2.6, 2.7, 3	Literature Review, Survey & Data Analysis	1, 2, 3, 4, 6, 7	Chapters: 5.4, 6.3

5 RESULTS

This chapter presents the results of the data analysis in text and graphics.

5.1 Demographics

The total number of respondents were 105 out of which 72 were male and 33 were female. Regarding the age of the respondents, 27 were between the age of 18-30, 52 were between 31-40, 23 were 41-50 and 3 were more than 50. Corresponding percentages as shown in Figure 11.

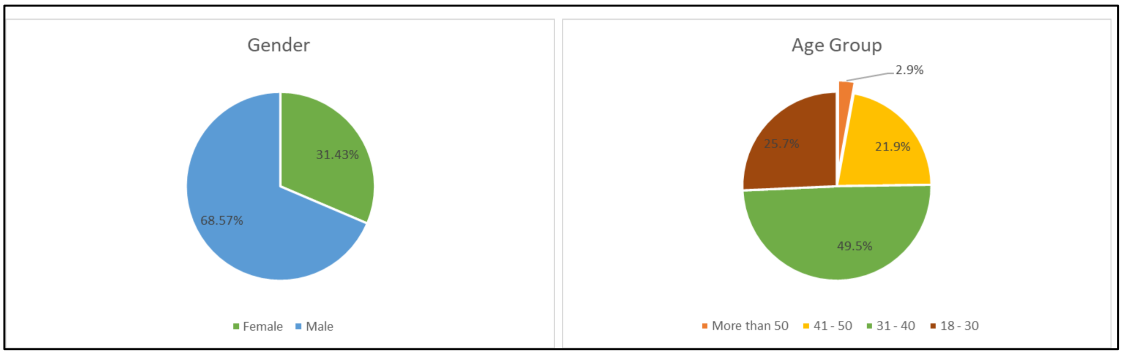

Figure 11: Gender and Age Descriptive statistics.

Regarding the income of the respondents, 37 earned 25001-50000 NRS, 29 earned more than 100000 NRS, 23 earned 1000-25000 NRS and 16 earned 50001-100000 NRS as shown in Figure 12.

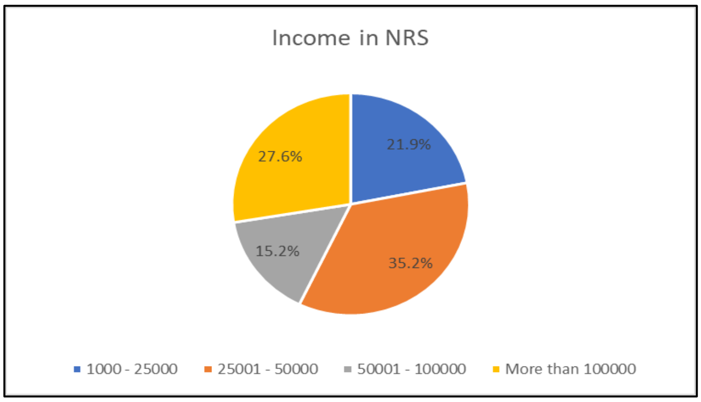

Figure 12: Income Distribution.

Most of the respondents had Bachelor (42) and Masters (38) level education, whereas 20 respondents had Higher secondary level education and 5 respondents had the highest level of education. Corresponding percentage of respondents' education level is described in Figure 13.

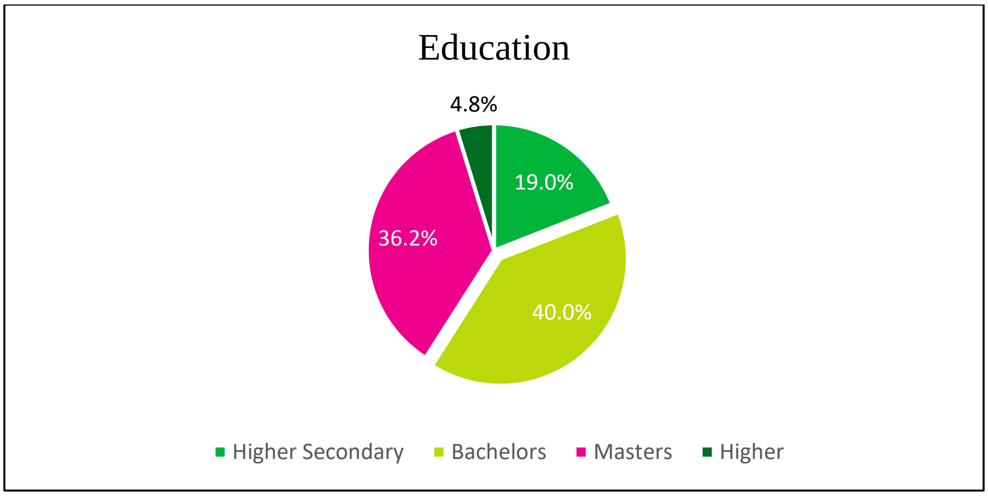

Figure 13: Education Distribution.

To study experience or usage of mobility services similar to MaaS, respondents were asked to answer the frequency of the usage of such services. Out of the total 105 respondents, 6.7% never used, 59% used sometimes while 34.3% used frequently (Figure 14).

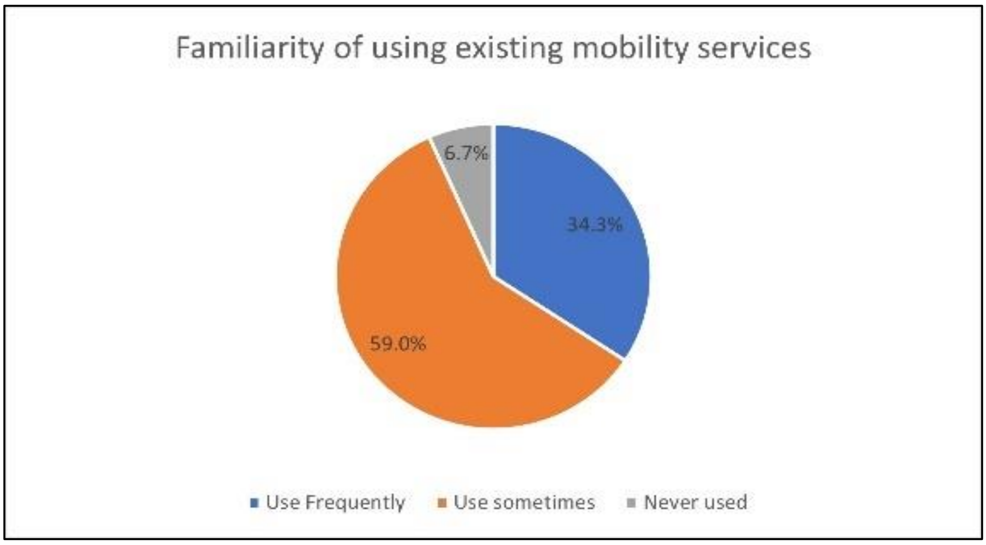

Figure 14: Usage frequency of mobility services.

And regarding the modes used by the respondents, 12 used car, 26 used motorcycle/scooter, 3 used bicycle, 15 used public transportation, 27 used multiple modes while 22 used personal modes. Corresponding percentage of the mobility modes used by the respondents are shown in Figure 15.

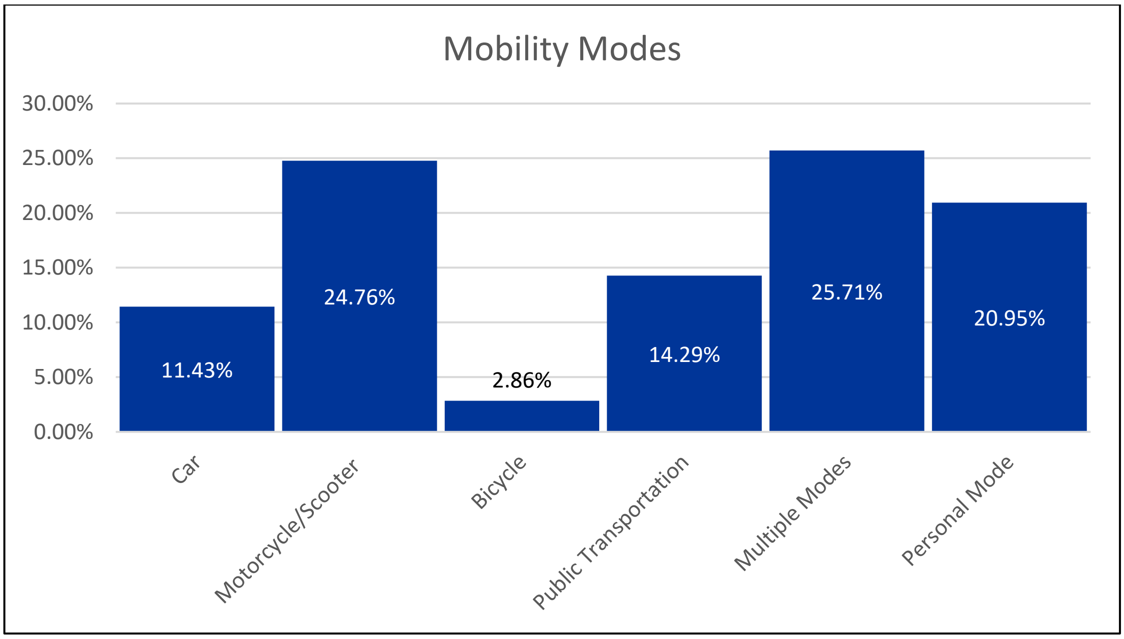

Figure 15: Mobility modes used by the respondents.

5.2 Descriptive Analysis of Constructs

Within the construct of Effort Expectancy (EE) of using MaaS; 1.9% strongly disagreed, 14.2% disagreed, 32.3% agreed and 51.4% strongly agreed with the statement EE1: 'I think I understand the concept of MaaS very well.' For EE2: 'I think it will be easy to use MaaS app'; 0% strongly disagreed, 14.2% disagreed, 41.9% agreed and 43.8% strongly disagreed. And for EE3: 'I think I can easily learn to use MaaS app'; 0% strongly disagreed, 7.6% disagreed, 37.1% agreed and 55.2% strongly agreed. (Figure 16)

Within the construct of Performance Expectancy (PE), for the statement PE1: 'I think using MaaS app will help me save money'; 3.8% strongly disagreed, 26.6% disagreed, 31.4% agreed and 38.1% strongly agreed. For PE2: 'I think using MaaS app will help me save time'; 1.9% strongly disagreed, 16.1% disagreed, 31.4% agreed and two 50.4%

strongly agreed. For PE3: ‘I think using MaaS app will help me travel around conveniently and easily’; 2.8% strongly disagreed, 16.1% disagreed, 33.3% agreed and 47.6% strongly agreed. (Figure 16)

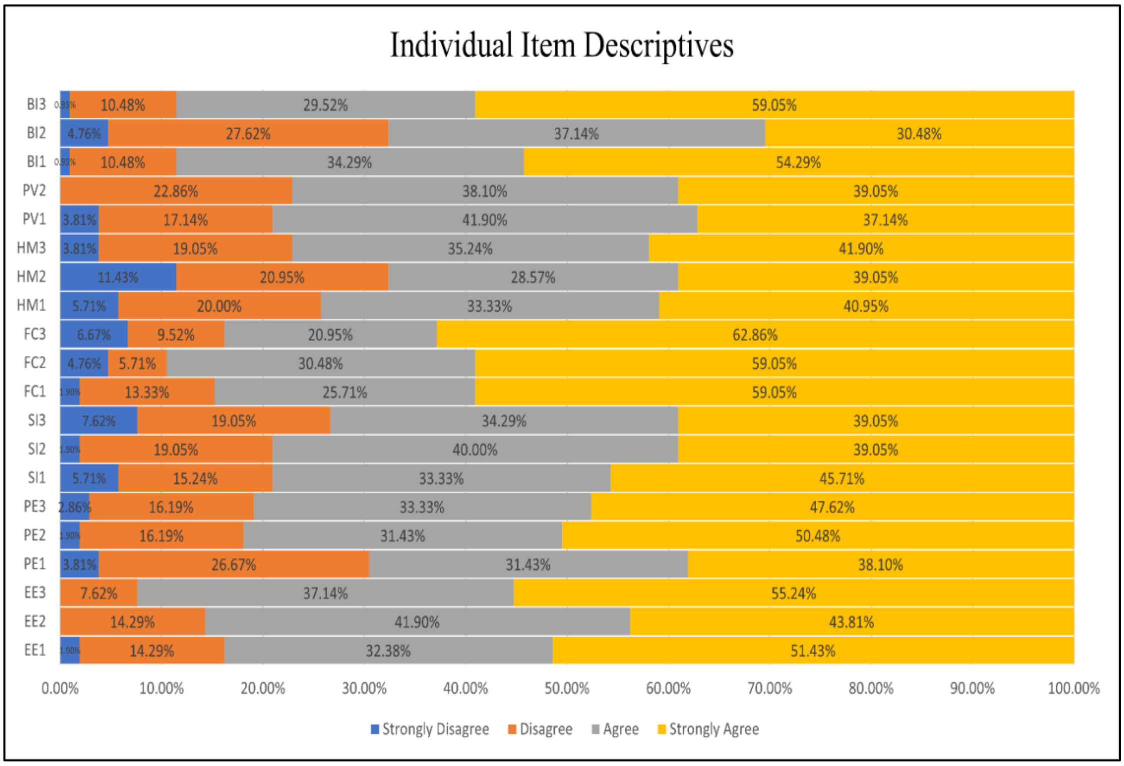

Figure 16: Descriptive analysis of all items.

Within the construct of Social Influence (SI) on using MaaS, for statement SI1: ‘I think I will use MaaS app if my friends like it and use it too’; 5.7% strongly disagreed, 15.2% disagreed, 33.3% agreed and 45.7% strongly agreed. For SI2: ‘I think that the people important to me would like me to use MaaS app’; 1.9% strongly disagreed, 19.05% disagreed, 40% agreed and 39% strongly agreed. For SI3: ‘I think I will use MaaS app if social media is positive about it’; 7.6% strongly disagreed, 19% disagreed, 34.2% agreed and 39% strongly agreed. (Figure 16)

Within the construct of Facilitating Condition (FC) of using MaaS, for statement FC1: ‘I will be able to use MaaS app on my mobile device’; 1.9% strongly disagreed, 13.3% disagreed, 25.7% agreed and 59% strongly agreed. For FC2: ‘I have access to mobile internet to use MaaS app'; 4.7% strongly disagreed, 5.7% disagreed, 30.4% agreed add 59% strongly agreed. For FC3: 'I am able to use digital payment from my mobile device'; 6.6% strongly disagreed, 9.5% disagreed, 20.9% agreed and 62.8% strongly agreed. (Figure 16)

Within the construct of Hedonic Motivation (HM), for HM1: 'I think it would be fun to use MaaS app'; 5.7% strongly, disagreed 20% disagreed, 33.3% agreed and 40.9% strongly agreed. For HM2: ' I think it would be entertaining to use MaaS app'; 11.4% strongly disagreed, 20.9% disagreed, 28.5% agreed and 39% strongly agreed. For HM3: 'I think I would enjoy using MaaS app'; 3.8% strongly disagreed, 19% disagreed, 35.2% agreed and 41.9% strongly agreed. (Figure 16)

Within the construct of Price Value of using MaaS (PV), statement PV1: 'I think using MaaS app will be financially beneficial for me'; 3.8% strongly disagreed, 17.1% disagreed, 41.9% agreed and 37.1% strongly agreed. For PV2: 'I think that the discounts offered in MaaS app are of fair value to me'; 0% strongly disagreed, 22.8% disagreed, 38.1% agreed and 39% strongly agreed. (Figure 16)

And within the construct of Behavioural Intention to use MaaS (BI), for BI1: 'I think I will use MaaS app when it is available in the future'; 1% strongly disagreed, 10.4% disagreed, 34.2% agreed and 54.2% strongly agreed. For BI2: 'I think I will use MaaS app in my daily life'; 4.7% strongly disagreed, 27.6% disagreed, to the 37.1% agreed 30.4% strongly agreed. For BI3: 'I think I will use MaaS app when needed'; 1% strongly disagreed, 10.4% disagreed, 29.5% agreed and 59% strongly agreed. (Figure 16)

Similarly, median or mode analysis of the responses for the items or the statements shows that 37.14% 'agree' and 52.38% 'strongly agree' while 10.48% 'disagree' but none 'strongly disagree' in effort expectancy category. Regarding the performance expectancy; 0.95% 'strongly disagree,' 20.95% 'disagree,' 35.24% 'agree' and 42.86% 'strongly agree'. About the social influence; 3.81% 'strongly disagree', 16.19% 'disagree', 38.10% 'agree' and 41.90% 'strongly agree'. Furthermore; 2.86% 'strongly disagree', 8.57%

‘disagree’, 24.76% ‘agree’ and 63.81% ‘strongly disagree’ to have the facilitating conditions to use MaaS. And about the hedonistic factor; 6.67% ‘strongly disagree’, 19.05% ‘disagree, 34.29% ‘agree’ and 40.00% ‘strongly agree’ as shown in Figure 17.

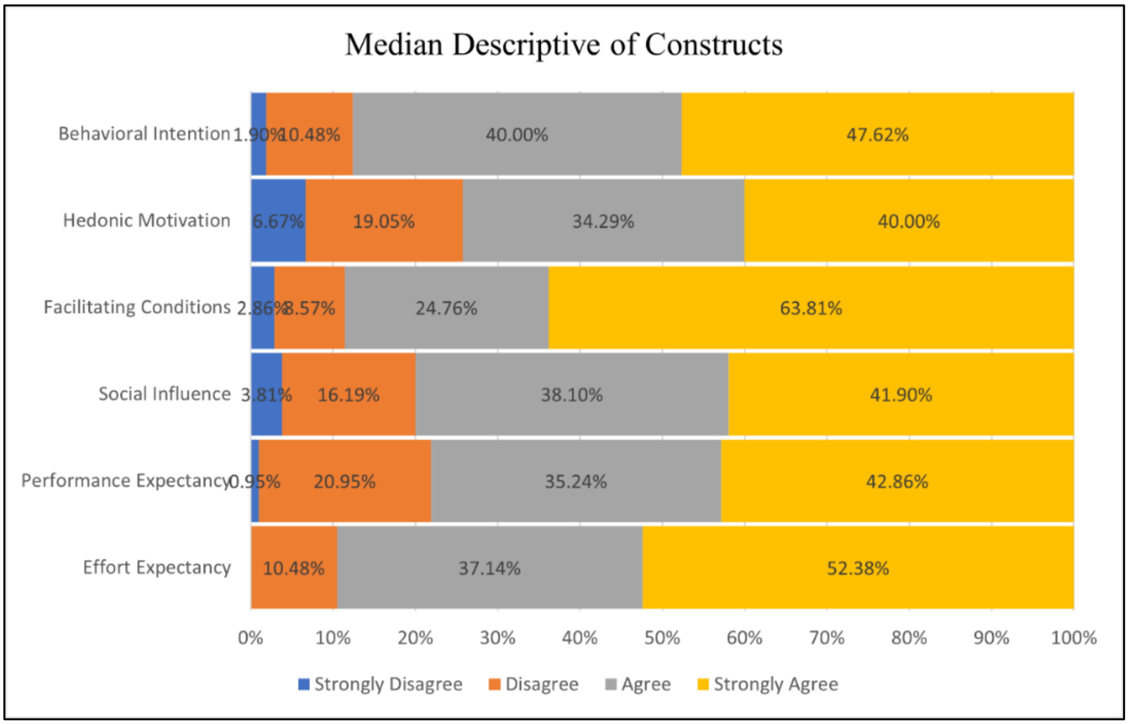

Figure 17: Median Analysis of Constructs.

5.3 Structural Equation Modelling

Structural equation modelling (SEM) is a type of statistical method which analyses the relationships between multiple exogenous (independent) and endogenous (dependent) variables. SEM is capable to perform multiple regression, path analysis, and factor analysis. It can be utilized to confirm or reject a predesigned theoretical model having relations among different constructs, on the basis of the available data. (Mancha and Leung 2010.)

5.3.1 Measurement Model Analysis

Measurement model analysis showed that all items or the indicators were greater than 0.5 as shown in Table 11. For the sample size of 100, factor loading should be >0.50 (Hair et al. 1998).

Table 11: Factor loading of each indicator.

Indicator			Factor
EE3	<---	EE	.756
EE2	<---	EE	.832
EE1	<---	EE	.826
PE3	<---	PE	.710
PE2	<---	PE	.733
PE1	<---	PE	.792
SI3	<---	SI	.747
SI2	<---	SI	.756
SI1	<---	SI	.797
FC3	<---	FC	.536
FC2	<---	FC	.683
FC1	<---	FC	.913
HM3	<---	HM	.897
HM2	<---	HM	.917
HM1	<---	HM	.889
PV2	<---	PV	.730
PV1	<---	PV	.882
BI3	<---	BI	.639
BI2	<---	BI	.660
BI1	<---	BI	.754

Also, in order to improve the measurement model, AMOS suggested to covariate some of the indicators out of which only two, which belonged to the same construct, were selected as shown in Table 12.

Table 12: Covariances Modification Indices

Path			M.I.
e10	<-->	e11	5.677
e4	<-->	e5	13.125

So the indicators PE2 (e5) and PE3 (e4) as well as FC2 (e11) and FC3 (e10) were covariated as suggested by AMOS in Table 12. After that, a new measurement model was created with the modified covariance as shown in Figure 18.

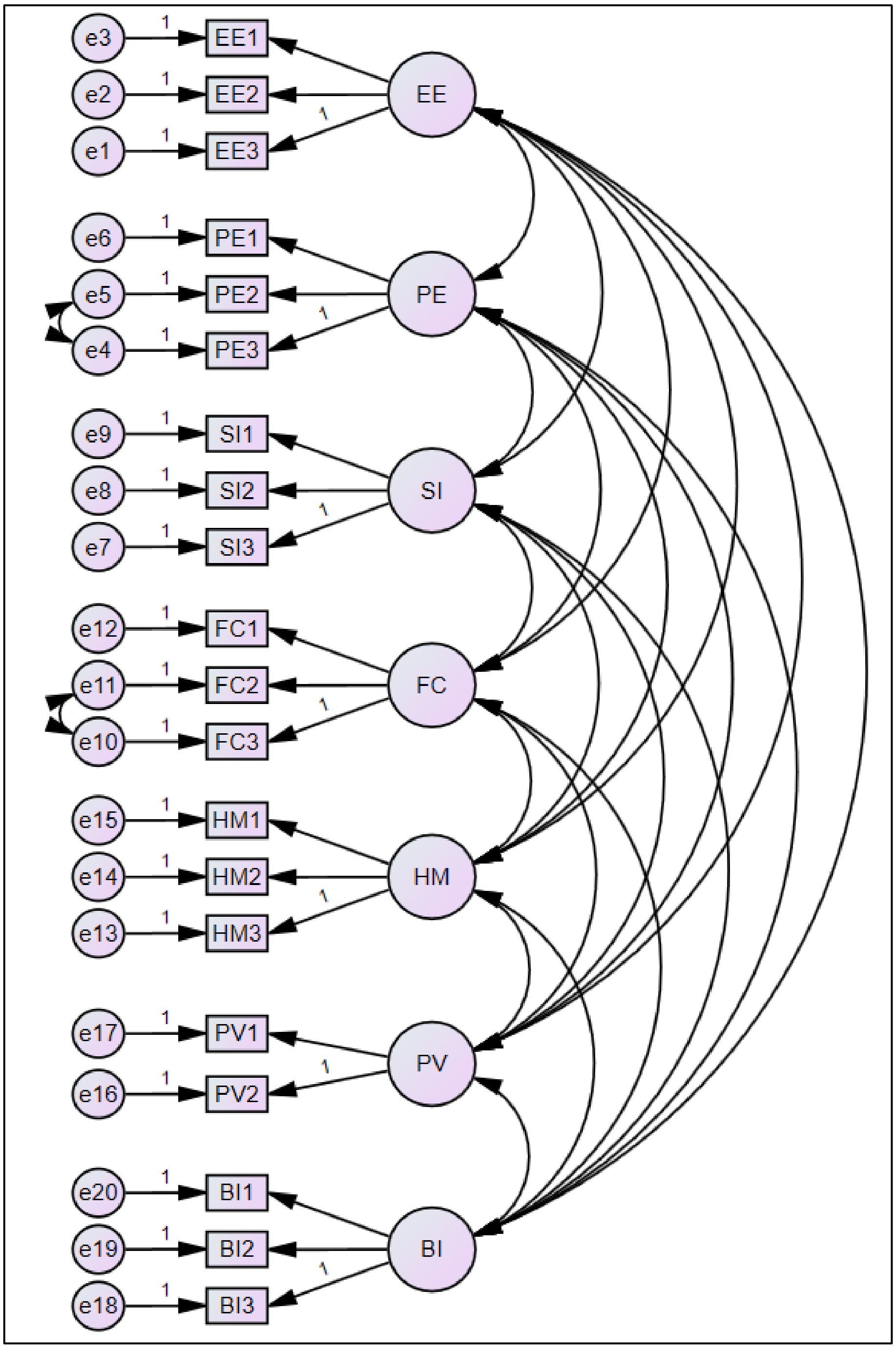

Figure 18: Measurement model with adjusted covariances.

5.3.2 Model Fit Assessment

According to Fan et al.; cited in Moss (2016), some fit indices are really sensitive to sample size which leads to the overestimation of the fit when the sample size is small or below 200 but on the other hand, RMSEA and CFI are less sensitive to sample size.

Table 13: Measurement Model Fit Analysis adapted from Uedufy (2022).

Acronym	Definition	Threshold	Reference	Result	Remarks
CMIN/DF	Chi-square divided by Degree of Freedom	≤ 3 = acceptable fit ≤ 5 = reasonable fit	Kline (1998); Marsh & Hocevar (1985);	1.773	ACCEPTABLE
GFI	Goodness of Fit Index	1 = perfect fit ≥ 0.95 = excellent fit ≥ 0.9 = Acceptable fit (0,7,0,9) =Acceptable	Kline (2005); Hu & Bentler (1998,1992);	.820	ACCEPTABLE
AGFI	Adjusted Goodness of Fit Index	≥ 0.90 = acceptable fit (0,7,0,9) =Acceptable	Tabachnick & Fidell (2007); (Bentler, 1992)	.743	ACCEPTABLE
CFI	Comparative Fit Index	1 = perfect fit ≥ 0.95 = excellent fit ≥ .90 = acceptable fit	West et al. (2012); Fan et al. (1999);	.919	ACCEPTABLE
RMSEA	Root Mean Square Error of Approximation	≤ 0.05 = reasonable fit <0.08=good fit; 0.08 to 1= moderate fit	MacCallum et al (1996); Meyers et al. (2005)	0.086	MODERATE FIT
RMR	Root Mean Squared Residual	≤ 0.05 = acceptable fit ≤ 0.07 = acceptable fit	Diamantopoulos & Siguaw (2000); Steiger (2007);	0.049	ACCEPTABLE
SRMR	Standardized Root Mean Squared Residual	≤ 0.05 = acceptable fit <0.09 = acceptable	Diamantopoulos & Siguaw (2000); Hair et al, 2009	.0687	ACCEPTABLE

In this case, the model fit assessment of the survey data with the sample size of 105 shows that RMSEA and CFI both acceptable even though the GFI and AGFI are below the acceptable threshold, which is normal in small sample size. Based on this analysis and the established Reliability and Validity of the data (chapter 4.6), the adjusted measurement model was used for structural model assessment presented in chapter 5.3.3.

5.3.3 Structural Model Assessment

According to structural model assessment result, Chi-square was 260.564, degrees of freedom (df) was 147 and probability level (p) was 0.000. The fit indices were similar to the measurement model fit described in Table 13. The squared multiple correlation(r^2) of Behavioural Intention was 0.961.

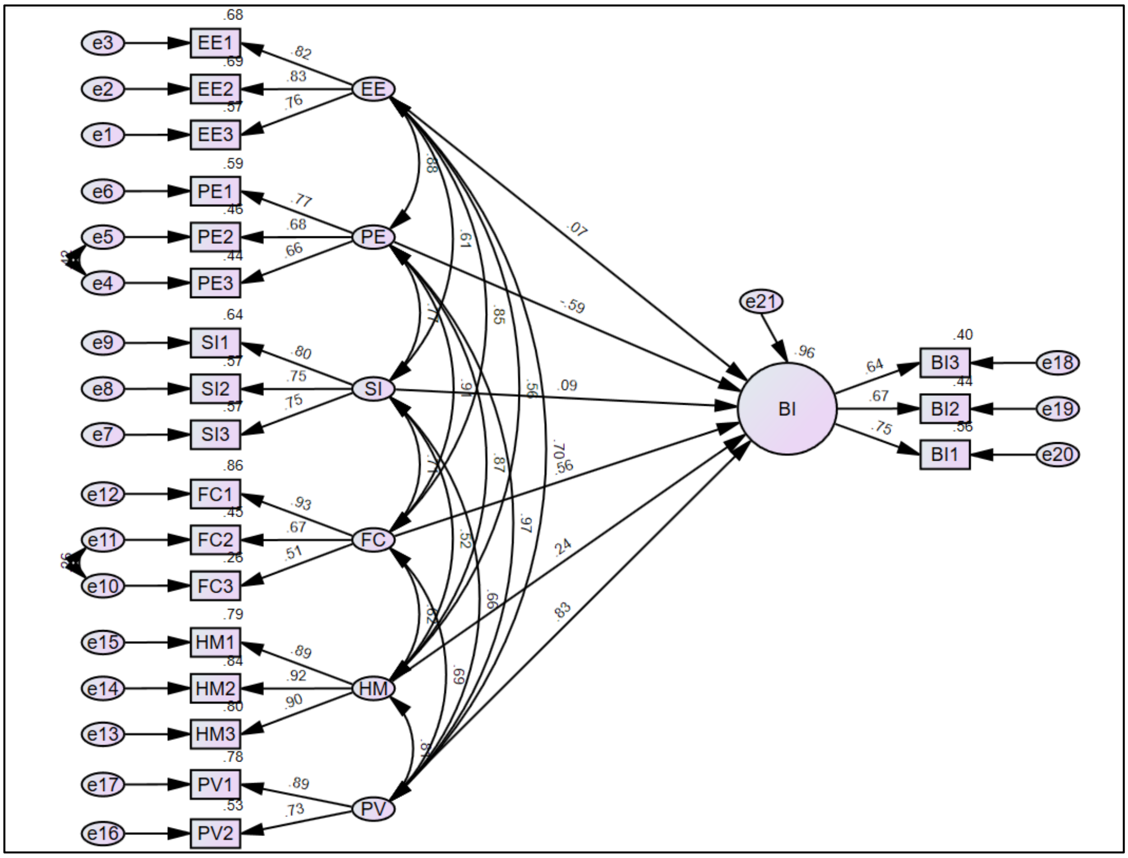

Figure 19: *Structural Model path diagram in AMOS graphical interface.*

From the structural model analysis, regression weights of all exogenous variables (EE, PE, SI, FC, HM, PV) with the endogenous variable (BI) were obtained and are shown in Table 14 which are further discussed in chapter 6.2.

Table 14: Regression Weights between the IVs and DV.

Path	Unstandardized Estimate	Standard Error (S.E.)	Critical Ratio (C.R.)	Standardized Estimate	P	Impact
BI<---EE	.064	.341	.187	.064	.852	Not significant
BI<---PE	-.491	.856	-.573	-.588	.567	Not significant
BI<---SI	.055	.131	.422	.086	.673	Not significant
BI<---FC	.559	.413	1.355	.564	.176	Not significant
BI<---HM	.142	.209	.677	.239	.498	Not significant
BI<---PV	.677	.381	1.776	.829	**.076**	**Almost significant**

5.4 Moderation Analysis

According to Fawad (2023), moderation is a term used for describing the effect of a third variable (moderator) on the relationship between an independent variable with the dependent variable. By interacting with the independent variable, moderator can influence the output of the dependent variable in either positive or negative direction and even neutralize the outcome.

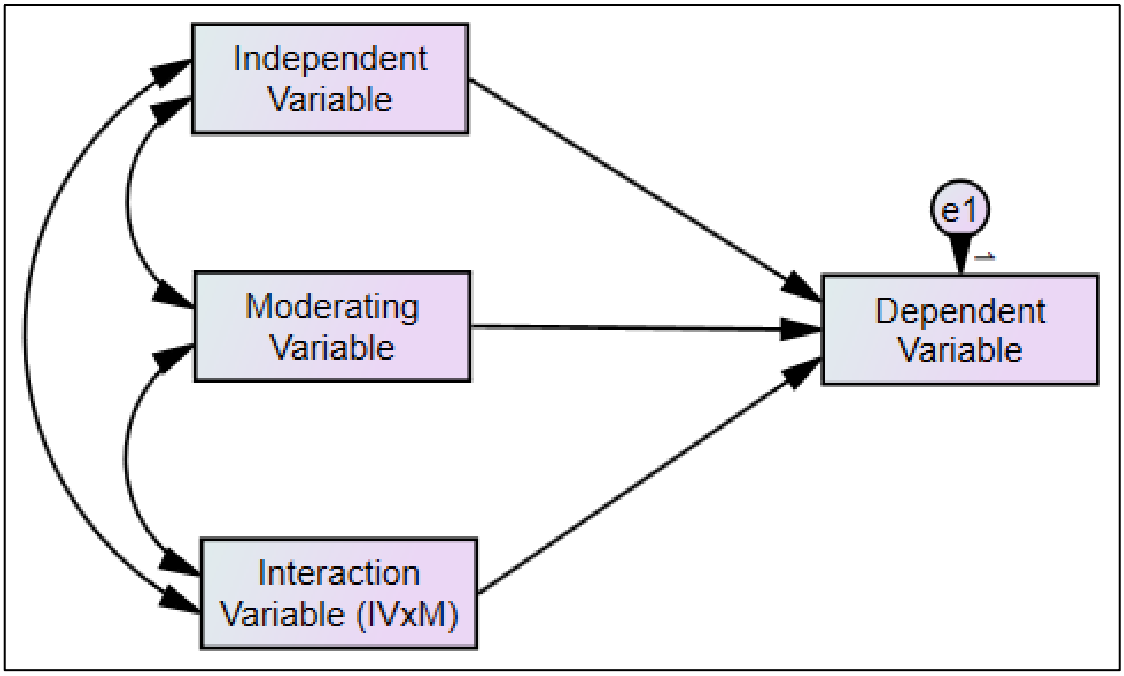

Figure 20: Moderation model.

For the purpose of moderation analysis, the independent variables were mean centered in SPSS. Mean centering can avoid multi collinearity issues and simplify the interpretation (Dawson 2014; cited in Fawad 2023). After that, a new variable was computed with the help of SPSS by multiplying each mean centered independent variable with each moderator which was named interaction variable.

As shown in Figure 20, the interaction variable was used to create a moderation model in AMOS including the moderating variable as well as the independent variable (not mean centered). Mean centered variables were used only to compute the interaction variable. After running the analysis, the resulting moderating variables' regression weights and their respective significance were analyzed in order to determine their impact on the relationship (path) of the independent variables with the dependent variable. Table 15 shows the impact and their significance in detail.

Table 15: Interaction of moderators on the relationship path between IVs and DV.

Moderator	**Path**	**Estimate**	**S.E.**	**C.R.**	**p**
Gender	BI <--- EExGEN	-.148	.163	-.906	.365
	BI <--- PExGEN	.101	.117	.865	.387
	BI <--- SIxGEN	.254	.157	1.620	.105
	BI <--- FCxGEN	-.200	.137	-1.455	.146
	BI <--- HMxGEN	-.053	.104	-.512	.608
	BI <--- PVxGEN	.171	.124	1.385	.166
Age	BI <--- EExAGE	-.122	.167	-.735	.462
	BI <--- PExAGE	.135	.122	1.109	.268
	BI <--- SIxAGE	.111	.151	.737	.461
	BI <--- FCxAGE	-.080	.143	-.555	.579
	BI <--- HMxAGE	-.135	.108	-1.241	.215
	BI <--- PVxAGE	.108	.131	.821	.412

continued on next page…

Moderator	Path	Estimate	S.E.	C.R.	p
Income	BI <--- EExINC	.091	.156	.580	.562
	BI <--- PExINC	.172	.116	1.479	.139
	BI <--- SIxINC	.192	.148	1.299	.194
	BI <--- FCxINC	**.237**	.140	1.701	**.089**
	BI <--- HMxINC	.141	.106	1.332	.183
	BI <--- PVxINC	.010	.119	.087	.931
Education	BI <--- EExEDU	.043	.157	.274	.784
	BI <--- PExEDU	**.224**	.108	2.076	**.038**
	BI <--- SIxEDU	.206	.135	1.528	.126
	BI <--- FCxEDU	-.049	.128	-.383	.702
	BI <--- HMxEDU	**.184**	.096	1.912	**.056**
	BI <--- PVxEDU	.086	.117	.738	.461
Familiarity	BI <--- EExFAM	-.059	.160	-.367	.714
	BI <--- PExFAM	.142	.127	1.118	.264
	BI <--- SIxFAM	-.024	.137	-.177	.860
	BI <--- FCxFAM	.048	.144	.338	.736
	BI <--- HMxFAM	**.231**	.125	1.844	**.065**
	BI <--- PVxFAM	.068	.125	.546	.585
Mobility Mode	BI <--- EExMOD	.142	.154	.920	.358
	BI <--- PExMOD	.146	.115	1.270	.204
	BI <--- SIxMOD	.095	.136	.696	.486
	BI <--- FCxMOD	.112	.134	.830	.407
	BI <--- HMxMOD	.100	.106	.944	.345
	BI <--- PVxMOD	-.056	.121	-.464	.643

From the moderation analysis, as shown in Table 15, it became evident that Education moderator had a positive impact (0.224) on the relationship between performance expectancy and behavioral intention which was statistically significant (0.038) at $p<0.05$ level. Furthermore, Education also had a positive impact (0.184) on the relationship between hedonic motivation and behavioral intention which was ‘almost’ statistically significant (0.056).

Familiarity moderator had an ‘almost’ significant (0.065) positive effect (0.231) on the relation between hedonic motivation and behavioral intention. And Income moderator (0.237) which also had an ‘almost’ significant relation (0.089) between facilitating conditions and the behavioral intention.

Table 16: Multi Group comparison of regression between moderators.

	Estimate		**Standard Error (S.E.)**		**Critical Ratio (C.R.)**		**p-value**		**Standardized Estimate**	
Education	**BB**	**AB**	**BB**	**AB**	**BB**	**AB**	**BB**	**AB**	**BB**	**AB**
BI<--- PE	.107	.467	.100	.141	1.078	3.313	.281	***	0.134	0.514
BI<--- HM	.066	.234	.070	.098	.937	2.375	.349	.018	0.100	.320
BI<--- FC	.202	-.015	.100	.098	2.029	-.156	.042	.876	0.230	-.018
BI<--- PV	.276	.046	.092	.114	2.995	.398	.003	.690	0.362	.048
Gender	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
BI<--- FC	.251	-.067	.099	.097	2.545	-.689	.011	.074	.226	.074
Age	**18-40**	**40+**	**18-40**	**40+**	**18-40**	**40+**	**18-40**	**40+**	**18-40**	**40+**
BI<--- PE	.115	.432	.118	.111	.973	3.882	.330	***	.137	.503
Income	**<50K**	**>50K**	**<50K**	**>50K**	**<50K**	**>50K**	**<50K**	**>50K**	**<50K**	**>50K**
BI<--- PE	.189	.427	.109	.129	1.740	3.314	.082	***	.226	0.426
BI<--- PV	.289	.068	.091	.111	3.169	.611	.002	.541	.353	0.073
Modes	**MM**	**PM**	**MM**	**PM**	**MM**	**PM**	**MM**	**PM**	**MM**	**PM**
BI<--- PV	.308	.057	.097	.119	3.177	.478	.001	.632	0.371	0.064
Familiarity	**LF**	**HF**	**LF**	**HF**	**LF**	**HF**	**LF**	**HF**	**LF**	**HF**
BI<--- PE	.181	.443	.104	.165	1.749	2.687	.080	.007	.214	.478
BI<--- PV	.210	.148	.089	.141	2.371	1.055	.018	.291	.252	.174

Notes: BB=Bachelor and Below, AB=Above Bachelor, M=Male, F= Female,
MM=Multiple Modes, PM= Private Mode(s),
LF= Low Familiarity, HF=High Familiarity,
p-value<0.05.

Similarly, multi-group analysis of the moderating variables was also performed in which differences in the regression weights between the assigned groups of each moderating variables along with their respective p values were used to determine the significance of impact of each group of moderators on the relationship (path) of the independent variables with the dependent variable as shown in Table 16.

The analysis showed that the ‘above bachelor’ group had statistically more significant positive impact on performance expectancy and intention to use than the group ‘bachelor and below’ in education as moderating variable. The ‘above bachelor’ group also had significantly more positive impact on hedonic motivation and intention to use than the ‘bachelor and below’ group. On the other hand, ‘bachelor and below’ group had more significant positive impact on facilitating condition and price value with the intention to use than the group ‘above bachelor.’

In gender as moderator, which was regrouped into male and female groups, male group had more significant positive moderating effect than the female group on facilitating condition and intention to use. In age as moderator which was regrouped into ‘40+’ and ‘below 40’ groups, the group 40+ had more significant and positive impact on performance expectancy and intention to use than the other group. In income as moderator which was regrouped into ‘>50K’ and ‘<50K’ earning groups, group earning more than 50k had more significant positive impact on performance expectancy and intention to use than the other group. But the group below 50k earnings had a more significant positive impact on price value and intention to use than the other group.

In mobility modes moderator which was regrouped into ‘multiple modes’ and ‘private mode(s)’ groups, the group using multiple modes had more significant positive impact on the relationship of price value with intention to use than the other group. In familiarity moderator, the group having high familiarity had more significantly positive impact on performance expectancy and intention to use than the group having low familiarity. But the group having low familiarity had more significant impact than the other group on the relationship between price value and the intention to use.

6 DISCUSSION

MaaS can be used as a tool to achieve societal goals such as sustainability, to increase accessibility of vital services, as well as to enhance safety and well-being. There is positive correlation between sustainability and MaaS whether partially or fully integrated (Kamargianni et al. 2016). The MaaS trials discussed in chapters 2.5 and 2.6 as well as findings from other trials and research, summarized in Table 2, have further strengthened the positive relation between sustainability and MaaS.

And during the field trial of UbiGo (Chapter 2.5.1), a notable change in travel behaviour among the participants was witnessed. Some participants gradually favoured alternative mobility modes like PT, car/bike sharing more than using personal cars over the trial period (Karlsson et al. 2016). Similar to the finding of UbiGo trial, usage of personal car declined significantly among the users of EC2B (Hensher et al. 2020). According to Hartikainen et al. (2019), data analysis of Whim (see chapter 2.5.2) users in Helsinki showed that users put PT as the major mobility mode while using other modes before and after using the PT mode. The same dataset also pointed towards MaaS as a solution for the first and last mile transportation problem as well as in reduced usage of own car while using rental car whenever needed.

Based upon the Sydney trial results of Tripi (Chapter 2.5.5), it has been proved that MaaS has potential in terms of creating larger market demand and also in terms of achieving societal goal if suitable incentives and carefully designed MaaS bundles are targeted to different market segments. During the trial, over half of the trial participants subscribed to one of the bundles offered whereas the rest opted for PAYG option. From the same trial, reduction of car usage was noted among the monthly subscribers while PAYG users maintained their travel behaviour as before. So, at least the bundle subscribers contributed towards achieving societal goals of reducing emission and traffic congestion.

Furthermore, Sydney trial has also highlighted the potential of commercializing MaaS platform in which subsidized public transportation play as major element of MaaS business model. But in order for the MaaS to be financially sustainable, a cross sectoral cooperation between public and private mobility service providers is imperative where public service provider fulfils societal objectives while private sector focus on commercial objective. (Hensher et al. 2020a p. 6-7.)

Integration of MaaS elements can also create positive impact to the society. Even a partial integration of the ticketing of different PT modes in the city of Tampere; Finland through a single physical card faster seamless mobility was achieved (Blythe and Holm 2002). Similarly, in Singapore, a significant increase in the use of PT became evident when different mobility service providers were partially integrated through a single card which combined payment system of different operators (Prakasam 2009).

And when all the MaaS elements were fully integrated with the mobility packages, personal car usage dropped drastically. According to Schad et al. 2005; cited in Kamargianni et al. (2016 p. 3297), almost 90% users of the integrated mobility packages in Swiss market managed without cars, and some even sold their car when they purchased the mobility package. However, unlike other MaaS trials, Reck et al. (2021) reported a substantial increase in the shared car usage among the subscribers of the Mobil-Flat (see chapter 2.5.4). Their report also pointed out that consumer saved a lot more in car sharing service by utilizing the flat rate subscription but on the other hand the report also showed low profit scenario for the car sharing service providers.

From the cases of MaaS in Asia (see chapter 2.6), it has become evident that MaaS has the ability to promote sustainability by increasing the usage of communal transportation. MaaS could influence the travel behaviour as well as increase safety awareness of its users. From the case of *Kochi One,* it has been observed that MaaS can induce socio-economic growth as well as increase operational efficiency while solving any dispute between different mobility operators.

The government of Nepal (GoN) levies 80% import duty and 80% excise duty for most type of automobiles including two-wheelers as well as four-wheelers (GoN 2022) and the end consumers end up paying almost three times the original price of the vehicle after adding Value Added Tax and Road Tax. The government justifies the high tax rate by claiming that it is being levied to reduce climate change, air pollution, traffic jams as well as to reduce the cost of importing fossil fuels but facts and figures points otherwise (see chapter 1.1, 3). Yadav (2023) even claims that high taxes are causing transportation service to be costly and at the same time indirectly causing road accidents because low-income population are buying cars with low taxes which are cheaper and affordable but do not meet the safety standards. Yadav (2023) further accuses the politicians of Nepal and the importers of the automobile for deliberately keeping the price high for their vested interests. Perhaps, using the already existing modes efficiently would be more sustainable option in KV rather than importing more.

Rapidly urbanizing cities, like Kathmandu, could benefit by implementing clean and shared mobility model. The Clean and Shared Model takes into use of EVs as well as encourages collaborative usage rather than ownership of the mobility means which can eventually address the problems of pollution as well as traffic congestion (Hannon et al. 2016). Similarly, Khaimook et al. (2019) suggests that MaaS could contribute to a safer, more efficient, and sustainable mobility by putting the right modes in the right places by using inter-modality and simultaneously increasing efficiency of PT. Singh (2020) suggests that cities which are emerging economically utilize MaaS to re-design sustainable and efficient urban mobility. And if the MaaS providers are successful in attracting and retaining the mobility users with attractive incentives and mobility bundles, societal goals are achievable (Smith & Hensher 2020).

Results obtained from this study were somewhat similar to findings from previous research. As mentioned in EC2B trial (see chapter 2.5.3), in which main factor of using the app was to reduce time and hassle, the result of this study also shows same as statements PE2 and PE3 were agreed by more than 80% (see figure 16). Also, the price value or the monetary benefits received from MaaS is a motivating factor in this study as was the case in Manilla (see chapter 2.6.1).

In this study, discounts and economical gains were important factors for some demographic groups as in the case of Tripi in Sydney (see chapters 2.5.5 and 2.7). The results of this study show that hedonic factor was also considered important similar to the case in Germany (see Table 2). Education was found to be an important moderator in this study which could mean that highly educated segment could be the early adopters as mentioned in the latent class cluster analysis of Netherlands (see Table 2).

Regarding the use of additional variables as mentioned in chapter 3, this study also used a new construct (see Table 4) but was omitted from further analysis as its reliability index was not strong enough (see Table 6). But the factors, which were assumed as moderators in this study (see Figure 9) were found to be somewhat moderating the relationship between the independent variables with the dependent variable which are discussed in chapter 6.3.

6.1 RQ: MaaS Perception from Consumer Context

As shown in Figure 16, most of the respondents exhibited some degree of agreement with all the statements as either ‘agree’ or ‘strongly agree’. Regarding the behavioural intention of using MaaS, result showed that the majority of the respondents intended to use MaaS as needed but not so much on daily basis when it is available in the future. From effort perspective, most of the respondents found MaaS easy to understand, to learn and to use but some found it difficult as well. From performance perspective, most respondents thought that MaaS would help in travelling around easily and save time but not money.

Regarding the social influence perspective, influence of friends and important people in the lives of the respondents had greater influence than the social media. From the perspective of facilitating conditions, most had a smart phone with internet and digital payment system in their mobile. From the hedonic perspective, majority of the respondents would enjoy using MaaS app whereas some respondents also thought that using MaaS would not be entertaining. And from the perspective of value, while majority agreed that

MaaS would be financially beneficial, some also thought that the discounts offered are not sufficient.

From the median analysis or the count of most common response among the items of the constructs (Figure 17), we can see that there is strong positive behavioural intention (BI) as 87% of combined responses were ‘agree’ and ‘strongly agree’. Similarly, more than 87% (agree+strongly agree) agreed of having the facilitating conditions favourable to use MaaS. More than 77% (agree+strongly agree) agreed that MaaS could be useful in some ways and more than 89% (agree+strongly agree) also jointly agreed that MaaS would not be difficult to use.

Majority of the respondents have exhibited a certain level of agreement by responding either ‘agree’ or ‘strongly agree’ for the factors that were investigated in the survey. Therefore, it would not be inappropriate to claim that MaaS is generally perceived positively by the respondents of KV, notwithstanding the negative responses. Negative responses could be considered as a part of technology adoption process.

6.2 IQ1: Factor and Correlation Assessment

The Structural Model Analysis (chapter 5.3.3) resulted into 0.961 squared multiple correlation (r^2) which means that more than 96% variance in behavioural intention to use MaaS app can be accounted by the factors; effort and performance expectancy, social influence, facilitating condition, hedonic motivation as well as price value.

As shown in Table 14, effort expectancy had positive impact on intention, social influence had positive impact on intention, facilitating condition had impact on intention, hedonic motivation had positive impact on intention to use MaaS app but none had any substantial statistical significance. Similarly, performance expectancy had negative impact (-0.491) on intention to use but the standard error (S.E.) was large (0.816) which could mean that sample data might not accurately represent the population (Bhandari 2022).

Nevertheless, price value had a positive as well as ‘almost’ statistically significant (0.076) impact on the behavioural intention to use MaaS App which is close to $p<0.05$ level. This means that the more value users perceive from the usage of MaaS app, in terms of subscription price as well as discounts offered in the app, the stronger is their intention to use it. So it can be said that the price value is the factor which had the biggest effect on the intention to use the MaaS app followed by facilitating condition, hedonic motivation, effort expectancy and social influence according to their respective regression weights shown in Table 14.

6.3 IQ2: Moderation Assessment

From the moderation assessment, it is evident that all factors assumed as moderators in this study had somewhat moderating impact on the relationships between the independent and the dependent variable. In gender as moderating factor, male group perceived that increase in facilitating condition increase their intention to use. In age moderator, respondents above the age of 40 perceived that better performance from the app can increase the intention to use.

In income moderator, group earning more than 50K NRS perceived performance of MaaS increase the intention to use while the group earning less than 50K NRS perceived that monetary benefits can increase the use intention. In education as moderator, highly educated group perceived that performance expectancy and fun can increase their intention to use MaaS app. For the group having education level of bachelor and below, increasing facilitating conditions could increase the intention to use.

In familiarity moderator, highly familiar group perceived performance is important for use than the lowly familiar group. On the other hand, lowly familiar group perceived price value of using MaaS could increase their intention to use. And in mobility modes as a moderator, respondents who use multiple modes considered that if using MaaS could provide more monetary value, then the intention to use it could also increase.

7 CONCLUSION, LIMITATION AND FURTHER RESEARCH

Mobility modes, in macro or micro forms, can be publicly or privately owned as well as shared among the users. We tend to use different modes or mobility services for different purposes and needs. Every mode has their own characteristics and each possess varying degrees of environmental impact. Also, some modes are much faster and time saving whereas some require more physical effort and relatively slower than others. Similarly, the prices of using these mobility services are different from each other. In general, factors such as affordability, availability, usability, convenience, distance, purpose, weather, safety and physical effort as well as the amount of carbon emission can influence the users' choice of mobility.

Mobility is an essential part of everyone's life. In the author's context, a personal car was used to travel to work as it was twenty-five kilometres away from his place of residence. The drive to work took less than thirty minutes by car and more than an hour by Public Transport (PT), so using a car saved time for the author. During the weekends and other free times, when the car was not being used, it was rented out to others in need through peer-to-peer (P2P) rental platform.

And when the workplace changed to a nearby location, which was easily accessible by public transportation, the author sold the car as there was no need for it every day but occasionally. In order to fulfil the occasional need, the author uses P2P car sharing platform like *'GoMore'* as well as B2C electric car renting platform such as *'Green Mobility'*. As the primary mode of mobility, the author also uses public transportation including metro, commuter trains, trams as well as ferries.

During the summer months, the author prefers to use station-based city bikes (SBBS) as well as other free-floating bikes. In addition, the author also uses micro mobility modes like e-scooter whenever needed which are quicker, effortless and not station based. In absence of all other modes, the author uses taxi as well as ride hailing services. If required, the author uses the combination of all mobility modes in order to fulfil the mobility needs to reach the destination. The fare for PT is paid in monthly occurring subscription basis as it is used frequently and is more economical than pay as you go (PAYG) option. And for modes other than PT, the author uses PAYG payment option because they are used only occasionally.

The availability of all kinds of mobility services whenever required without owning any mobility mode had motivated the author to use multi-modal mobility as a service and give up the car entirely. Instead, the author uses public transportation, pedal powered city bikes as well as low emission cars as and when needed, contributing to the sustainability as promised by MaaS. From this real-life example, the research idea was born to investigate the possibility of MaaS in Kathmandu Valley where it would yield more benefits, socially as well as environmentally.

Evidence from the trials, findings from the MaaS research as well as considering the suggestions made by MaaS experts, it has become evident that MaaS, actually, is beneficial for the society as it can be used as a tool to mitigate environmental hazard, reduce traffic congestion, improve accessibility, decrease social exclusion as well as induce economic growth and promote social harmony to some extent. These societal as well as environmental benefits could be reaped by Kathmandu if MaaS is implemented and used widely.

Owning a mobility means could be more economical in the long term but if mobility modes are made highly available and affordable than the ownership of mobility mode, MaaS would be widely popular. Utilizing the already existing mobility efficiently, the need for adding more of them will decrease as a result. When the quantity of mobility modes is reduced on the road, urban traffic congestion is also reduced, and greenhouse gas emissions is also limited consequently. And by including more eco-friendly mobility modes, MaaS can provide more sustainable mobility in an urban setting. So, MaaS could be used to mitigate the problem of environmental pollution and traffic congestion to some extent.

However, MaaS cannot displace the actual ‘need’ for owning a personal vehicle but might help users to overcome their ‘desire’ of owning one if MaaS can fulfil its promise of seamless, quick, efficient, economical mobility services to the mobility users on demand. And if MaaS can induce mobility related behavioural changes in the users of the developing countries as witnessed in the developed countries, sustainable mobility can be achieved. Furthermore, it will be very difficult, if not impossible, to disrupt private car ownership. So, the private cars must be included in the MaaS ecosystem in order to curb their number on the streets. Also, it might be very challenging to integrate all the elements discussed in chapter 2.3 as well as the mobility service providers into one platform.

And even though the idea of MaaS is gaining popularity and many users are adopting and utilizing the concept of MaaS worldwide, the profitability of MaaS as a business remains somewhat less. As MaaS is a new concept, it is recommended to assign the enlargement of customer base as the first priority and profitability as the second. When MaaS is able to attract and retain more customers, revenue will flow constantly making the business profitable as well as provide return on investment for the investors. A small scale MaaS platform can be designed by integrating some crucial elements and offering sustainable mobility modes to create a business model with low operational cost.

MaaS packages must include modes and packages suitable to the different user segments such as younger generations, older generation as well as families in order to enable adoption and usage by all segments of the market. Wrong packages offered to wrong users might become barrier to MaaS adoption. Rate of acceptance and adoption of technology varies between individuals but could be positively influenced by disseminating information about the benefits of using MaaS, and by offering attractive incentives, creating suitable packages and applying right marketing mixture.

However, MaaS may also produce some unintentional effects, pose risks as well as exhibit limitations. According to Pangbourne et al. (2018), if the mobility services are completely digitalized, MaaS could exclude the population who don’t have access to a bank for digital payment required for MaaS and also those who lack overall digital skills. Also, there is a possibility of MaaS standstill if the MaaS platform which controls all the mobility modes and services is disrupted for some reasons like power failure, ICT failure, or in case of cyber-attack such as Deliberate Denial of Service as well as Global Positioning System disruption (Pangbourne et al. 2018 p. 5).

As MaaS providers like Uber and Lyft make mobility so much flexible and instantly available that it reduces the use of PT which is deemed as backbone of MaaS. Use of such small capacity mobility services actually produce negative effects on the environment which is opposite to the claim of MaaS being sustainable mobility option which is also able to reduce traffic congestion. MaaS can also negatively affect the health and well-being of the user if they choose to use non-active door to door mobility modes instead of active modes like bicycles and walking. (Kate et al. 2020 p.43-44.)

According to Kate et al. (2020), as MaaS is a noble phenomenon, there is lack of clear policies, regulations and undefined delegation of responsibilities within the stakeholders as well absence of security framework which can undermine the positive implications of MaaS. And although MaaS can provide unlimited mobility opportunity for those who can afford it, on the other hand mobility can become less accessible to those with lower income creating inequality in the society.

As far as the limitation of MaaS is concerned, mobility modes or supplier side have finite capacity due to which Pangbourne et al. (2018) claim that MaaS may not always be able to fulfil the core criteria of MaaS as the ‘on demand mobility’ defined by Heikkilä and Hietanen (2014) and as the concept of ‘Demand Responsive MaaS’ defined by Kamau et al. (2016). Also, MaaS is based on providing mobility ‘services’ rather than manufacturing mobility ‘products’ which could lead to decline in manufacturing products such as cars. From macro-economic perspective, when manufacturing declines and services become costlier, it can negatively impact national as well as world economy (IBM 2020).

And from the perspective of Van Doorn 2017; cited in Hamal (2019), platform-based businesses, including ride sharing MaaS platforms, are not advantageous for the workforce involved as platforms-based businesses utilizes the strategy of legal immunity, algorithmic control, and superfluity by hiring excess workforce. From a qualitative research of the ride hailing/sharing MaaS platforms operating in KV, Hamal (2019) claims that MaaS platforms operating in KV have created negative implications in terms of gender and social class bias, misuse of customer data leading to sexual harassment as well as intrusion of privacy, and labour force exploitation even though such platforms have solved mobility related problems of KV as well as given economic advantage for low to middle-class riders in the valley, to some extent.

A limitation of this study is the lack of a real comprehensive and multi-modal MaaS app in the Kathmandu Valley. Nevertheless, the author had tried to overcome this limitation by utilizing the respondents' familiarity of already existing mobility service platforms similar to the MaaS app discussed in this study. Furthermore, the concept of MaaS was presented to all the survey participants in words, pictures as well as in video format in order to facilitate the understanding of MaaS before answering the survey questions.

Also, the sample data collected for this research, which is 105 in total, might not accurately represent the entire five million population of KV. As such, a comparative analysis of MaaS user's behaviour changes before and after the use of a real MaaS app could be researched in the future with larger sample size. Also, perceived social status as a moderating factor could be investigated which was not included in this study. Lastly, suppliers side or the service provider's perspective on MaaS could also be researched further.

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APPENDICES

Appendix 1: Survey Questionnaire.

Kathmandu MaaS Survey

(यस सव णलाई गूगल ोममा नेपाली अनुवाद गन सिक छ।)

Dear Respondents,

This survey is being conducted to study user perceptions of a potential Mobility-as-a-Service (MaaS) digital platform in Kathmandu Valley. Please read the definition of MaaS, see demo pictures of MaaS packages with indicative prices and also watch the video to know the concept of MaaS before answering the survey questions.

The purpose of the research is to investigate the feasibility of deploying a MaaS platform in the valley. The survey is part of the thesis work of the MBA program. The survey is for educational purposes and is not motivated by financial incentives.

The survey will take approximately 10-15 minutes to complete. Responses are anonymous.

Surveyor,

Dipesh Shakya, MBA Candidate, Arcada University of Applied Sciences, Helsinki, Finland.
dipesh.shakya@arcada.fi, dps.sakya@gmail.com

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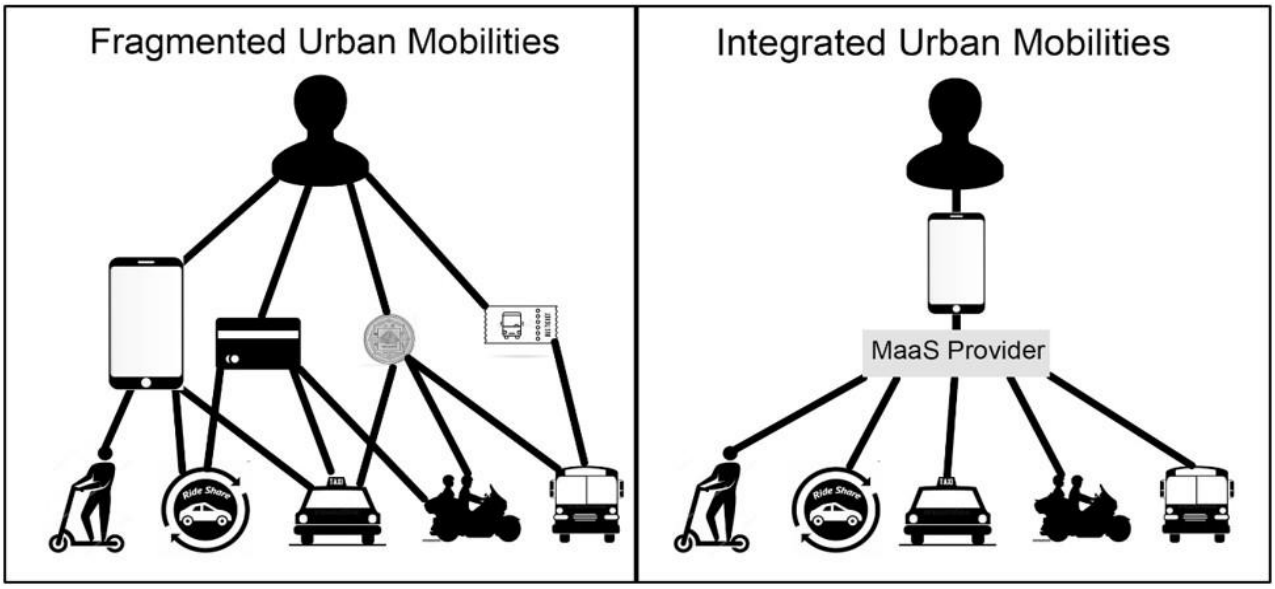
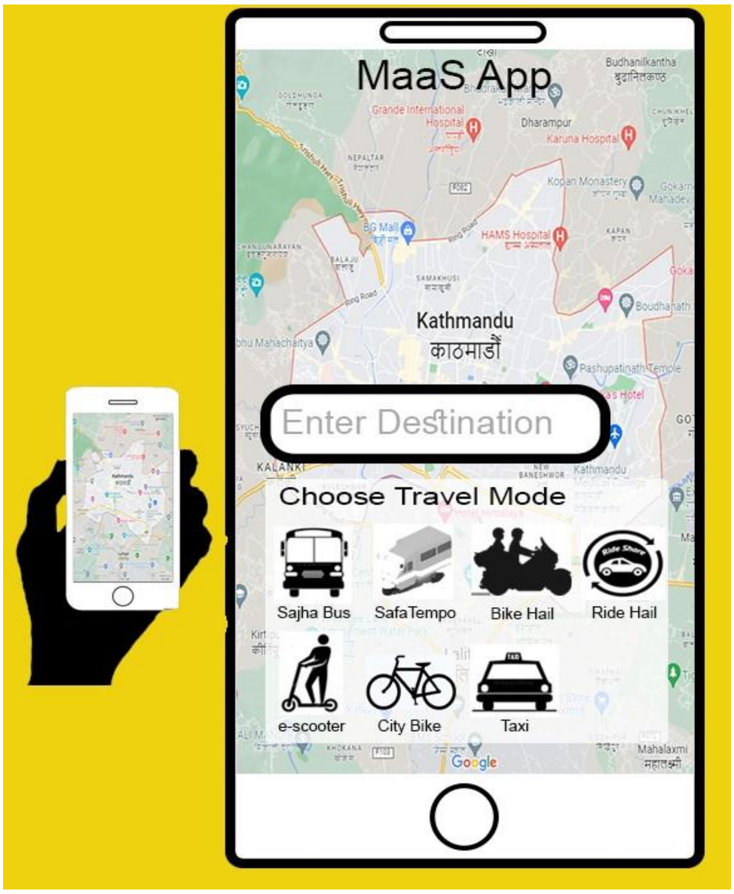
*Required

Definition of MaaS

Mobility-as-a-Service or MaaS is a digital platform in the form of an android/IoS app or a website which is used as a tool to travel to a desired destination using several types of vehicles integrated into the platform. MaaS provides users with many travel options using single or combination of transportation modes such as public transport, ride hailing/sharing, rental car, shared car, city bicycles, e-scooters as well as walking. MaaS can potentially decrease the need for own vehicles leading to less traffic congestion and reduction of vehicular emission subsequently. MaaS users can subscribe to different packages of mobility services offered in the platform through monthly recurring fixed payment or choose to pay per use through the embedded payment system in the app. (Heikkilä 2014; Hietanen 2014; Kamargianni et al. 2016.)

MaaS Integration concept

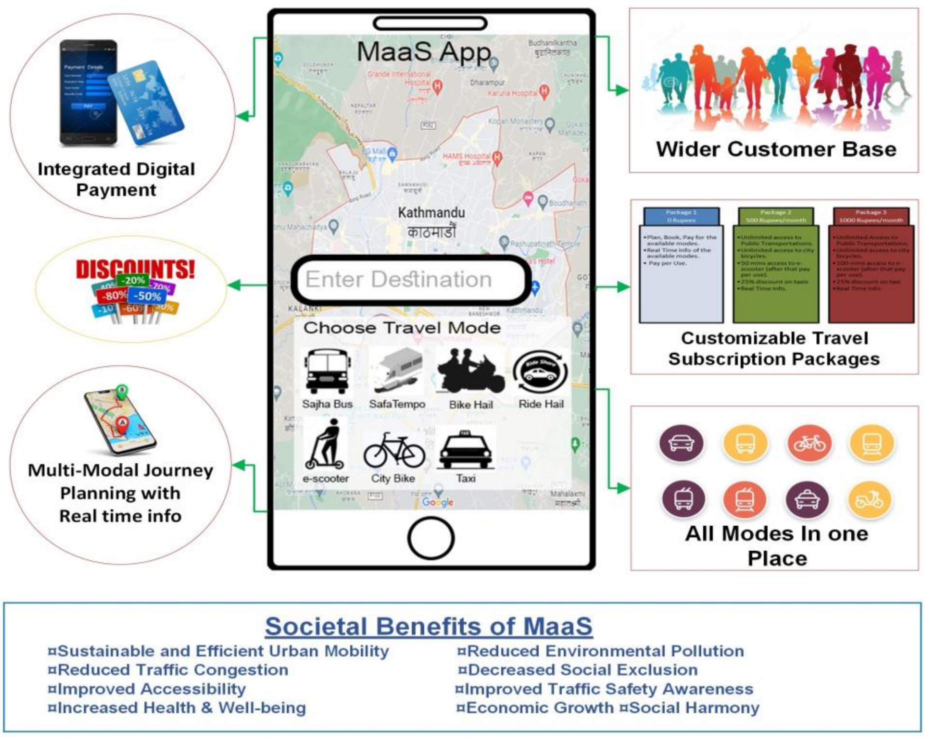




Examples of MaaS Packages with indicative prices. Possible Discounts on rental cars, discount on long distance buses. Discount on travel packages, Discount on Hotels/Restaurants etc.

- Whim: A MaaS app: http://youtube.com/watch?v=iDlbj9xcZ58
- Omnecal App Demo | OSM Hackfest 2022 winne: http://youtube.com/watch?v=idMJdfUuF9I

MaaS Effect



1. **Gender** **Tick all that apply.*

- [ ] Male
- [ ] Female
- [ ] Other: ____________________

2. **Age** **Mark only one oval.*

( ) 18 - 30
( ) 31 - 40
( ) 41 - 50
( ) More than 50

3. **Income (NRS)** **Mark only one oval.*

( ) 1000 - 25000
( ) 25001 - 50000
( ) 50001 - 100000
( ) More than 100000

4. **Education** **Mark only one oval.*

( ) Higher Secondary
( ) Bachelors
( ) Mas-
ter's
( ) Higher

5. **Occupation** *

____

6. Experience of using mobility services like Pathao, Tootle, My Sajha, Indriver, Google Maps etc. *Mark only one oval.* *

( ) Use Frequently
( ) Use sometimes
( ) Never used

7. What kind of mobility mode or modes do you use to travel around? **Tick all that apply.*

- [ ] Car
- [ ] Motorcycle/Scooter
- [ ] Bicycle
- [ ] Public Transport
- [ ] Multiple Modes

8. I think I understand the concept of MaaS very well. * *Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

9. I think it will be easy to use MaaS app. * *Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

10. I think I can easily learn to use MaaS app. * *Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

11. I think using MaaS app will help me save money. *Mark only one oval.

	1	2	3	4	
Strongly Disagree					Strongly Agree

12. I think using MaaS app will help me save time. *Mark only one oval.

	1	2	3	4	
Strongly Disagree					Strongly Agree

13. I think using MaaS app will help me travel around conveniently and easily. *Mark only one oval.

	1	2	3	4	
Strongly Disagree					Strongly Agree

14. I think I will use MaaS app if my friends like it and use it too. *Mark only one oval.

	1	2	3	4	
Strongly Disagree					Strongly Agree

15. I think that the people important to me would like me to use MaaS app. *Mark only one oval.

	1	2	3	4	

Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

16. I think I will use MaaS app if social media is positive about it. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

17. I will be able to use MaaS app on my mobile device. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

18. I have access to mobile internet to use MaaS app. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

19. I am able to use digital payment from my mobile device. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

20. I think it would be fun to use MaaS app. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

21. I think it would be entertaining to use MaaS app. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

22. I think I would enjoy using MaaS app. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

23. I think using MaaS app will be financially beneficial for me. *Mark only one oval.

	1	2	3	4	
Strongly Disagree	⬭	⬭	⬭	⬭	Strongly Agree

24. I think that the discounts offered in MaaS app are of fair value to me. (See the * example of possible discounts with Mobility Packages) Mark only one oval.

	1	2	3	4	
Strongly Disagree					Strongly Agree

25. I think I will use MaaS app when it is available in the future. **Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

26. I think I will use MaaS app in my daily life. **Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

27. I think I will use MaaS app when needed. **Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

28. I am aware of environmental impact of the vehicle(s) I use. **Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

29. I choose walking/Bicycling whenever possible. **Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

30. I think I will start using electric vehicles such as e-cars, e-scooter, e-bikes in the future *. *Mark only one oval.*

	1	2	3	4	
Strongly Disagree					Strongly Agree

Thank you for your response. Please be assured that the data will be used for the intended purpose only. Comments are welcome: