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Do Security and Privacy Attitudes and Concerns Affect Travellers' Willingness to Use Mobility-as-a-Service (MaaS) Systems? †

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Abstract

Mobility-as-a-Service (MaaS) represents a transformative shift in transportation, enabling users to plan, book, and pay for diverse mobility services via a unified digital platform. While previous research has explored factors influencing MaaS adoption, few studies have addressed users' perspectives, particularly concerning data privacy and cyber security. To address this gap, we conducted an online survey with 320 UK-based participants recruited via Prolific. This study examined psychological, demographic, and perceptual factors influencing individuals' willingness to adopt MaaS, focusing on cyber security and privacy attitudes, as well as perceived benefits and costs. The results of a hierarchical linear regression model revealed that trust in how commercial websites manage personal data positively influenced willingness to use MaaS, highlighting the indirect role of privacy and security concerns. However, when additional predictors were included, this effect diminished, and perceptions of benefits and costs emerged as the primary drivers of MaaS adoption, with the model explaining 54.5% of variance. These findings suggest that privacy concerns are outweighed by users' cost–benefit evaluations. The minimal role of trust and security concerns underscores the need for MaaS providers to proactively promote cyber security awareness, build user trust, and collaborate with researchers and policymakers to ensure ethical and secure MaaS deployment.

Keywords: mobility-as-a-service; MaaS; cyber security; privacy; privacy attitude; privacy concern; trust; perceived incentives; perceived costs

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1. Introduction

As the global population continues to rise and urbanisation increases, the transport sector faces significant challenges and opportunities. With growing environmental concerns, there is a pressing need for modern, sustainable, and efficient transportation solutions. The transportation sector is a major contributor to greenhouse gas emissions globally [1]. By implementing greener and more efficient mobility options in urban, suburban, and rural areas, both personal benefits for individuals (e.g., long-term reduced costs as a result of not owning any personal vehicles, more travel choices, and a healthier lifestyle) and broader advantages for society and the planet can be achieved (e.g., reduced traffic congestion, and greenhouse gas emissions with a consequent lower impact on global warming). The body of research supporting green transport is rapidly increasing, aiming to foster more sustainable communities, enhance quality of life, and develop more effective travel solutions.

Mobility-as-a-Service (MaaS) is a multimodal transport solution that provides passengers with seamless, end-to-end mobility options, marking a substantial step toward more efficient and environmentally friendly transportation. MaaS allows travellers to plan, book, and pay for both traditional public transport and on-demand or shared services, such as ride-sharing, bike-sharing, and car-sharing, via a single integrated platform [2,3]. The growth and adoption of MaaS are expected to reduce private vehicle use, offering positive impacts on reducing traffic congestion and acoustic pollution [4].

For effective operation, MaaS relies on a complex infrastructure and an efficient digital network of stakeholders [5]. However, even with these in place, successful implementation is not automatically assured. The potential success of MaaS largely depends on travellers' willingness to adopt these technologies and alter their travel behaviours and habits accordingly. To implement MaaS successfully, understanding travellers' attitudes, concerns, and needs is essential [6,7]. Previous studies identified privacy and the security of personal data as potential barriers to the MaaS adoption and implementation; however, these have been discussed primarily from the perspective of system security [5,8,9] or regulatory and policy frameworks [3,10,11]. To the best of our knowledge, evidence remains limited and inconclusive on how travellers' privacy and security attitudes and concerns may affect their willingness to use MaaS platforms [6,12,13].

In addition, perceived benefits and perceived costs are worth taking into consideration, as existing studies reported that acceptance of new technologies largely depends on what individuals perceive to be the benefits that derive from their usage (e.g., aspects of perceived increased flexibility, sustainability, innovativeness, and practical convenience of the service) as well as the perceived costs they would incur (e.g., monetary and time-related costs) [14,15]. More relevantly, previous research has explored several related factors that potential MaaS travellers might view as benefits for adopting MaaS, as well as perceived costs that could impede the implementation of MaaS [14]. Nevertheless, there is currently no agreement on which factors serve as barriers or incentives for travellers' MaaS adoption. Despite various suggestions, a unified understanding remains elusive [7,12,16].

Having these in mind, we aim to fill the research gaps by focusing on two aspects: (1) the role of cyber security and privacy attitudes and concerns about personal data on the intention to adopt MaaS systems, and (2) the significance of the perceived benefits and costs that users associate with MaaS, and whether these factors outweigh users' concerns over security and privacy of their personal data. For the first aspect, we adopted several existing scales on internet privacy and security attitudes and concerns [17,18]. In addition, we included factors (i.e., indicators of personal experiences of internet misuse and familiarity with news about the misuse of personal data, trust belief in both commercial and governmental websites [19]) that are indirectly related to security and privacy; however, we hypothesised that they would have a greater impact than security and privacy attitudes and concerns. For the second aspect, we compiled a list of indicators of costs and benefits that could impact the adoption of MaaS. The list was informed by the literature that has investigated the costs and benefits of MaaS implementation [6,7,20], as well as by the literature that identifies differences in the intentions to adopt MaaS between private vehicle and public transportation users [13,21,22].

To the best of our knowledge, this represents a pioneering effort in the MaaS literature to incorporate such a wide range of factors. By investigating the factors mentioned above, we aim to answer the following research questions (RQs):

- **RQ1**: Do cyber security and privacy attitudes and concerns affect travellers' decisions to use MaaS systems, and if so, to what extent?
- **RQ2**: Does trust in how websites handle users' personal data affect their decisions to use MaaS systems, and if so, to what extent?
- **RQ3**: Does the frequency of being a victim of perceived improper invasion of privacy have an impact on travellers' decisions to use MaaS systems?
- **RQ4**: Does the frequency with which a traveller has come across news of potential misuse of personal data affect their decisions to use MaaS systems?
- **RQ5**: Do the perceived benefits and costs associated with MaaS usage outweigh other cyber security and privacy-related factors, in shaping traveller's decisions to use MaaS systems?

To answer these research questions, we conducted a large-scale online survey and applied correlation analysis, followed by hierarchical linear regression modelling and by structural equation modelling to analyse and interpret the survey responses. In summary, this research work contributes to the literature by concluding the following:

- Travellers' cyber security and privacy concerns do not appear to have a direct impact on their willingness to use MaaS systems except the following two effects: (1) cyber security and privacy attitudes and concerns are operationalised as 'trust in the provider', and (2) the frequency with which a traveller has encountered reports and news regarding the misuse of personal data in the past.
- When perceived benefits (i.e., the flexibility, sustainability, convenience, and innovativeness of the service) that come with the usage of MaaS systems are considered, trust in the provider's data handling practices and the frequency of encountering reports of personal data misuse are no longer predictive of the travellers' intentions to use MaaS, as the perceived benefits take precedence.

This article is a revised and expanded version of a paper presented at the 2023 IEEE 26th International Conference on Intelligent Transportation Systems (ITSC 2023) and published in its proceedings [23], which reported the results of applying a multiple linear regression model to partially address RQ1 through RQ4. In this work, we extend our research by introducing additional variables, such as perceived benefits and costs, aiming to offer more insights for RQ1 to RQ4 and to address RQ5. This would allow us to gain a more comprehensive understanding of the key factors influencing MaaS development and adoption from the user perspective.

The rest of this paper is organised as follows. Related work is discussed in Section 2. It is followed by details of our methodology in terms of the survey design, variables used, main hypotheses, and data analysis methods as shown in Section 3. Results of our analysis of data collected are presented in Section 4. The last section concludes the paper with further discussions and recommendations.

2. Related Work

2.1. Privacy and Security Concerns for MaaS Development and Adoption

Privacy and security concerns and risks associated with MaaS systems are closely related to the types of personal data collected, as well as how the data is used and shared. Several studies examine how MaaS data can be used to infer user behaviour and mobility patterns [24,25]. For instance, analysis of movement data can infer health conditions [25], while location data with timestamps can be monetised, raising potential privacy and ethical concerns [26]. Additionally, driver performance data and GPS coordinates can expose sensitive information, leading to violations of their identity and location privacy [9,27]. Privacy concerns in MaaS systems extend beyond profiling and inference risks to include third-party access to personal data and the over-sharing of personal data between multiple parties. Examining third-party processors, including payment processors and hosting providers, is essential for addressing privacy considerations and implications [28]. It is also critical to understand what data are necessary for what operations and what data are requested unnecessarily by stakeholders [29]. Similarly, some research recommended that users should have a certain degree of privacy control when their personal data are shared on open data platforms, with the consensus that personal data types and formats can be shared to facilitate the smooth operation of mobility platforms [30]. To overcome these obstacles, a previous study highlighted that privacy regulations should be carefully considered to support the development of MaaS and enhance the trust of both users and providers [14]. Although privacy and security risks are recognised as critical factors in MaaS development and deployment, past research on how travellers' attitudes toward these risks affect their willingness to use MaaS systems remains inconclusive. While some studies concluded that privacy and security concerns could negatively affect travellers' decisions to adopt MaaS [7,16], some found that these concerns had no impact [6,13] and others reported mixed results [12,13]. To this end, our aim is to address key research gaps by validating previous findings and exploring the underlying reasons for these inconsistencies.

2.2. Research in Trust for MaaS

Trust has been widely recognised as a key prerequisite for successful e-commerce and e-service. This is because online transactions inherently involve high levels of uncertainty, often greater than face-to-face exchanges, due to their anonymous, cross-border, and non-instantaneous characteristics, where online users need to trust the sellers and providers that they will fulfil their obligations and meet their commitments without engaging in harmful practices [31,32]. This has been validated by a multitude of studies indicating that trust plays an essential role in online transactions, both directly and indirectly through the reduction in consumers' perceived risk [31–34].

Although travellers' trust is frequently viewed as critical for implementing and deploying MaaS systems [14,35], its influence on travellers' willingness to adopt these systems remains under-explored. We consider that the limited research on how trust in MaaS providers influences travellers' intention to use MaaS represents another research gap in the literature. More specifically, trust could be considered a useful proxy for privacy and security concerns to some extent, as it is potentially more familiar and relatable for most non-expert users with less knowledge of privacy and security matters. Additionally, social–environment cues, such as media stories of hacking and loss of credit card details, can affect people's trust in a service provider as well as its reputation [36]. However, to the best of our knowledge, no previous studies have investigated the impact of such factors on MaaS providers and people's willingness to adopt MaaS.

2.3. Perceived Benefits and Costs of Using MaaS from Users' Perspectives

The research literature on MaaS has looked at various factors that could act as benefits or costs to travellers' intentions to try out MaaS systems. According to a study [22], the convenience derived by being able to do everything via a single app (i.e., plan, book, and pay) was found to be an important selling point for participants considering switching to MaaS, as was the flexibility of the service. Other studies [7,37] also indicated that potential MaaS users are primarily attracted by the service's innovative features, while considerations of its sustainability as a motivator for adoption are more controversial [22,38]. Additionally, several costs, that could work as barriers to the adoption of MaaS, have been associated with MaaS usage. These encompass economic factors, such as the cost of the service and travellers' willingness to pay [15,22], as well as practical considerations, including the average distance of the services (i.e., the average distance a traveller needs to travel to access: bus stops, tube stations, e-bike stations, nearby e-scooters) or the overall travel time [22,38]. Moreover, a specific set of costs that could act as potential barriers to users' adoption of MaaS are users' concerns over the privacy and security of their personal data [14,16]. In fact, the complex and integrated system required for MaaS to coordinate multimodal solutions relies on the integration of diverse transport service providers and related stakeholders (e.g., payment processors), who acquire, exchange and process operational data, mostly in a decentralised manner. The decentralisation and flexibility of this approach introduce numerous security and privacy risks as highlighted in previous studies [5,8]. The complex, integrated system required for MaaS relies on diverse transport service providers and stakeholders (e.g., payment processors) who acquire, exchange, and process data in a decentralised manner. This decentralisation and flexibility introduce numerous security and privacy risks as highlighted in previous studies [5,8]. Although research on MaaS adoption is growing, what motivates or demotivates travellers remains unclear. Studies generally focus on two main factors influencing adoption: (1) practical advantages and disadvantages related to performance expectations and (2) emotional or intrinsic motivations. Practical advantages identified include service flexibility, cost–benefit evaluations, the convenience of an all-in-one app, sustainability through reduced private vehicle use, and the customised nature of service bundles [37,39–41]. However, at the time of this writing, there is no clear consensus as to which should be considered the main incentives or barriers to travellers' intentions to adopt MaaS systems. In addition, whether these benefits and costs could outweigh the influence of other factors, such as privacy and security concerns, remains unclear.

3. Methodology

To address the research gaps identified in Section 2 and answer the research questions outlined in Section 1, we conducted a large-scale online survey, aiming to comprehensively learn about the influencing factors that affect people's willingness to use MaaS systems. The rest of this section presents more details of our methodology in terms of survey design, the selection of variables, development of hypotheses, and data analysis.

3.1. Survey Design

To fill the research gaps identified in Section 2.2, the online survey incorporated several existing scales on internet privacy and security attitudes and concerns to evaluate their influence on travellers' willingness to adopt MaaS. Different factors of trust in commercial and governmental websites were also introduced in this online survey. In addition, a set of factors related to the perceived benefits and costs of MaaS usage as well as a variety of socio-psychological and travel-behaviour-related variables were added to the survey, aiming to capture a broader spectrum of factors and gain more insights into the determining factors of MaaS adoption. The online survey (the full survey can be accessed from https://cyber.kent.ac.uk/research/MACRO/survey.html, accessed on 5 August 2025) was designed to consist of the following six parts.

Part 1 aims to learn the basic *socio-demographic*, such as age, gender, ethnicity, and family composition, about participants. This could help establish some baseline understanding about our participants' recruitment.

Part 2 focuses on *transport and travel route information behaviour*. Participants were asked about their behaviour related to transport and travel route information. This included questions about their habits, such as which trip and route-planning apps they used and the frequency of their usage.

Part 3 focuses on *perception about data sharing and trust of data consumers*. In this part, we used data sharing and trust as proxies for capturing privacy and security attitudes and concerns, which have been widely used in privacy and security research communities. We adopted two existing scales. The first scale is the Internet Users' Information Privacy Concerns (IUIPC) [17], which includes several factors focusing on online privacy concerns in terms of collection, control and awareness. In this survey, we adopted a version of IUIPC used in the study [18] that investigated privacy and security attitudes and concerns about location privacy, which can also be applied to the context of MaaS systems. The second scale concerns how much participants trust or are concerned about how commercial and governmental websites dispose of users' personal data. This is borrowed from a previous study [19], which focused on measuring users' perception of personal data collection, secondary usage, errors, improper access, control, and awareness of commercial and governmental websites.

Part 4 primarily investigates *perceptions about MaaS systems*. Participants were given a brief overview of MaaS and were then asked about their perceptions of the MaaS service, specifically regarding its perceived usefulness and their intention to use it if it were available. In addition, based on the existing literature about perceived benefits [4,13,14,22,37–39,42] and perceived costs [13–15,21,22] associated with the use of MaaS, we hand-picked an array of factors to be included in this part of the survey.

Part 5 looks at *transportation habits and evaluations*. Participants were asked questions about their personal transport habits, as well as their experiences and opinions of local public transport systems (e.g., their primary mode of transportation and their satisfaction with local bus services).

Part 6 focuses on the influence of *social–environment cues*. Inspired by the work [36] that reported that the trust in and reputation of a provider can be affected by social–environment cues like media stories of hacking and loss of credit card details, we aimed to understand how frequently participants had experienced (1) being victims of improper invasion of privacy online and (2) encountering news regarding the misuse of personal data.

Following the completion of the above six parts, participants were invited to give any additional comments. They were then thanked and debriefed.

We conducted a power analysis using G*Power [43] to determine the required sample size, indicating that at least 274 participants would be needed to detect a small-to-medium effect size of $f = 0.07$ with 80% power ($\alpha = 0.05$). To ensure robustness, we opted to recruit 320 participants.

3.2. Selection of Variables and Hypotheses

A number of past studies have investigated the impact of cyber security and privacy attitudes and concerns on people's willingness to use MaaS systems. However, such studies are often fragmented and do not systematically consider different aspects of MaaS systems from end-users' perspectives. Here, we introduced an array of variables in the survey, attempting to gain a more comprehensive understanding of the main driving forces that affect people's intention to use MaaS. The selection of all variables was derived based on the existing literature and our own knowledge. The rest of this section provides more details about all variables.

3.2.1. Selection of the Dependant Variable

In this survey, the **behavioural intention to use MaaS (BIUM)** was measured by asking participants to indicate how much they disagreed or agreed with the following statements using a 7-point Likert scale (1 = 'Strongly disagree', 7 = 'Strongly agree'; $\alpha = 0.97$) [6], and the average score was taken for the further analysis. BIUM was treated as the sole dependent variable for further analysis.

- *Assuming I would have access to the MaaS offering, I intend to use it.*
- *Given that I would have access to the MaaS offering, I predict using it.*

3.2.2. Independent Variable About Privacy and Security Attitudes and Corresponding Hypothesis

Participants were tasked with expressing their level of agreement or disagreement with seven distinct statements using a 7-point Likert scale (1 = 'Strongly disagree', 7 = 'Strongly agree'; $\alpha = 0.84$). The statements were adopted from a previous study [18], which investigated people's **attitudes towards personal identifying information collection (APII)**. Examples of statements are the following:

- *It is important to me that I am aware and knowledgeable about how my personal information will be used*
- *I am unconcerned when a website uses my PII to customise my browsing experience (R)*
- *I mind when my PII is traded with or sold to third parties*

The inclusion of this independent variable can partially address **RQ1**, and we propose the following hypothesis:

Hypothesis 1 (**H1**)**.** *Privacy and security attitudes will impact travellers' intentions to adopt MaaS systems.*

3.2.3. Independent Variables About Privacy and Security Concerns and Corresponding Hypothesis

Participants' internet privacy concerns were assessed by asking their level of agreement with 18 different statements adapted from a previous study [19]. These statements refer to six different domains (Collection, Secondary Usage, Errors, Improper Access, Control and Awareness). Each statement is considered separately for both *commercial* and *governmental* websites, producing two different scales: one for **internet privacy concerns for commercial websites (IPCC)**, and the other for **internet privacy concerns for governmental websites (IPCG)**. Reliability of the scales was very high, with respectively $\alpha = 0.96$ for commercial websites and $\alpha = 0.97$ for governmental websites. Here, IPCC and IPCG can help further address **RQ1**. Consequently, we made the following hypothesis.

Hypothesis 2 (**H2**)**.** *Privacy and security concerns will impact travellers' intentions to adopt MaaS systems.*

3.2.4. Independent Variable About Trust and Corresponding Hypotheses

We included variables that measure **trusting beliefs for commercial websites (TRUSTcom)** and **trusting beliefs for governmental websites (TRUSTgov)** abilities to handle personal data. We asked participants to indicate their level of agreement with four different statements borrowed from a previous study [19]. All these questions are measured using a 7-point Likert scale (1 = Strongly disagree, 7 = Strongly agree; $\alpha = 0.93$ for trust related to commercial websites and $\alpha = 0.95$ for trust related to governmental websites). The respective average scores were used for subsequent statistical analyses. Two example statements are as follows:

- *Commercial/Government websites would keep my best interest in mind when dealing with my personal information.*
- *Commercial/Government websites would fulfil their promises related to my personal information.*

The inclusion of TRUSTcom and TRUSTgov can help gain insights for **RQ2**. To further facilitate this, two hypotheses are made accordingly as follows.

Hypothesis 3 (H3). *Trust in commercial websites will positively predict travellers' intentions to adopt MaaS.*

Hypothesis 4 (H4). *Trust in the governmental websites will positively predict travellers' intentions to adopt MaaS.*

3.2.5. Independent Variables About Social Environment Cue and Corresponding Hypotheses

To answer **RQ3** and **RQ4**, we intended to learn how social environment cues impact travellers' decision to use MaaS systems. To be more specific, we measured travellers' self-reported frequency of being victims of **improper invasion of privacy (IIP)** and the frequency of hearing/reading about **news of information misuse (NIM)** and treated them as two variables for this study. The relevant questions used in the survey are listed below:

- *How frequently have you personally been the victim of what you felt was an improper invasion of privacy?'* (1 = 'Never', 2 = 'Infrequently', 3 = 'Rarely', 4 = 'Sometimes', 5 = 'A moderate amount', 6 = 'Frequently').
- *How much have you heard or read during the last year about the use and potential misuse of the information collected from the Internet?'* (1 = 'Not at all', 7 = 'Very much').

Based on the previous literature, we expected familiarity with information misuse to negatively affect the willingness to use MaaS [36]. Furthermore, we also anticipated that personal experiences of information misuse could exhibit the same effect. Hence, the following hypotheses were proposed.

Hypothesis 5 (H5). *Familiarity with information misuse will negatively predict travellers' willingness to use MaaS.*

Hypothesis 6 (H6). *Personal experiences of information misuse will negatively predict travellers' willingness to use MaaS.*

3.2.6. Independent Variables About Perceived Benefits and Corresponding Hypotheses

Guided by the related work and our own judgement, we compiled a list of perceived benefits that could be associated with the adoption of MaaS systems. To answer **RQ5**, we assessed whether these would be perceived as potential benefits and favourably or negatively impact travellers' decisions to use MaaS systems. It is worth acknowledging that this list of perceived benefit variables is selective rather than exhaustive due to the abundance of costs–benefits that the literature has proposed. Specifically, we looked at **the sustainable quality of the service (SUS)**, as there is evidence suggesting that those who care about environmental sustainability are more likely to hold favourable attitudes towards MaaS [4,37,38], **the innovativeness of the service (INNOV)**, as multiple research works suggest that travellers that are interested in using Maas are more likely to be tech savvy [20,38,44], and generally interested in trying out new things [16,20,44]. We also looked at an array of more practical attributes: **cost–benefit evaluations (COSTBEN)**—defined as the participant's overall assessment of whether the advantages of using MaaS outweigh any perceived disadvantages, a subjective, high-level judgment of value-for-cost—as MaaS anticipated value expectations have been found to be predictors of travellers' intentions to use MaaS [13,14,22,42]; **the practical convenience of the service (CONV)** all in a single app because studies have shown that the convenience of having everything in one app is positively valued by travellers [22,39]; and **the flexibility of the**

service (FLEX), a characteristic of MaaS derived by the possibility of using a variety of different transport modes, which appeared to be highly valued by potential MaaS subscribers [22,39].

In the survey, participants were asked to indicate their level of agreement for each perceived benefit variable (through a 7-point Likert scale ranging from 1 = 'Strongly disagree', to 7 = 'Strongly agree') for the statement '*The MaaS offering is interesting to me because of:*'. Based on the literature, we expected the perceived benefits to positively affect the willingness to use MaaS. To this end, a set of five hypotheses is made as follows:

Hypothesis 7 (H7a–e). *Sustainability (H7a), flexibility (H7b), cost–benefit evaluation (H7c), practical convenience (H7d), and innovativeness (H7e) will positively predict travellers' willingness to use MaaS.*

3.2.7. Independent Variable About Perceived Cost and Corresponding Hypotheses

Inspired by existing work, we also compiled a list of variables for perceived costs that could be associated with the adoption of MaaS. To address **RQ6**, we further investigated the impact of these potential barriers on the travellers' decisions to use MaaS systems. First of all, we considered the **cost of the service (COST)**, as several studies suggest that the cost of MaaS is one of the main concerns of potential users and a crucial barrier to the implementation of MaaS [13–15,22]. Then, we looked at a number of costs that are often cited by car users as reasons not to switch to MaaS usage [13,21,22], hypothesising that they could act as disincentives to the adoption of MaaS: the **time needed to transfer from one transportation mean to another (TT)**, the **discomfort in having to transfer from one transportation mean to another (DISC)**, the **overall transfer times (OTT)**, and the **average distance of the services (DIST) (i.e., bus stop, tube stations, nearby e-scooters)**.

To measure them, we asked participants to answer the question '*Regarding the MaaS service, how concerned are you about the following*' to indicate how concerned they were with several aspects related to the service. Concern was measured with a 5-point Likert scale ranging from 1 = 'Not at all concerned' to 5 = 'Extremely concerned'. Based on the previous literature, we expected perceived costs to have a negative effect on people's willingness to use MaaS. To this end, another set of four hypotheses is made.

Hypothesis 8 (H8a–d). *Cost of the service (H8a), time needed to transfer from one transportation mean to another (H8b), overall transfer time (H8c), and average distance of the services (H8d) will negatively predict travellers' willingness to use MaaS.*

3.3. Ethics Consideration

This study received a favourable ethical opinion from the Central Research Ethics Advisory Group of the University of Kent (Reference Number: CREAG109-09-22). We used the Jisc Online Surveys system (https://www.onlinesurveys.ac.uk/, accessed on 5 August 2025) to host the online survey and the crowdsourcing platform Prolific (https://www.prolific.co/, accessed on 5 August 2025) to recruit participants. All participants gave their consent electronically as part of the online survey before taking it. The participants were compensated financially at a rate of GBP 9 per hour, and the survey took an average of 17 min to complete.

3.4. Data Analysis

To address all the research questions and test the hypotheses outlined earlier, data analysis was conducted in four stages. In the first stage, we computed bivariate correlations to identify which variables were significantly associated with the behavioural intention to use MaaS (BIUM). Variables showing strong associations with BIUM were then selected for further analysis. In the second stage, we performed exploratory factor analysis (EFA) to validate the construct structure of the selected variables; this was then followed by hierarchical linear regression (stage three). In this regression model, BIUM served as the primary dependent variable (DV), and the aim was to determine which of the selected variables emerged as significant predictors (independent variables, IVs). Finally, in the fourth stage, we tested a latent structural equation model (SEM) to assess the relationships among the constructs simultaneously, examine potential mediating effects, and evaluate the overall model fit. This allowed us to gain a more nuanced understanding of the key factors influencing MaaS adoption from the users' perspectives. The data presented in this study are openly available in the Open Science Framework, at https://doi.org/10.17605/OSF.IO/5G8H7.

4. Results

In total, 327 individuals participated in the survey. Of these, 7 participants were excluded, as they discontinued after answering only a few initial questions, resulting in a final sample of 320 participants (133 females, 183 males, 3 preferred not to say, and 1 other). The mean age was 39.71 (SD = 11.79), and the median was 38. The majority of the participants reported to be White (85.9%), followed by Asian or Asian British (10%), Black/Black British/African or Caribbean (2.2%), and (0.9%) from mixed or other ethnicities.

4.1. Analysis of Correlations

First, we performed a correlation analysis to investigate the relationships between independent and dependent variables. The mean values and standard deviations for all measures are reported in Table 1, and the correlation results are presented in Table 2. The rest of this section presents more analysis of our interpretation of the results to address the different RQs outlined in Section 1.

Table 1. The maximum (Max), minimum (Min), median (Md), means (M), and standard deviation (SD) of all variables across all participants.

Measures	Max	Min	Md	M	SD
BIUM	7	1	5	4.67	1.52
APII	7	1	5.77	5.44	1.05
IPCC	7	1	5.61	5.48	1.02
IPCG	7	1	4.27	4.25	1.37
TRUSTcom	7	1	4	3.79	1.37
TRUSTgov	7	1	5	4.77	1.38
IIP	6	1	2	2.31	1.08
NIM	7	1	4	4.26	1.51
SUS	7	1	4	4.18	1.43
FLEX	7	1	5	5.19	1.33
AV	7	1	4	4.50	1.35
CONV	7	1	6	5.70	1.30
INNOV	7	1	5	4.89	1.40
COST	5	1	3	2.78	1.16
TT	5	1	2	2.07	1.01
DISC	5	1	2	2.05	1.07
OTT	5	1	2	2.24	1.05
DIST	5	1	2	2.18	1.07

Table 2. Correlations among variables (* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$).

	BIUM	APII	IPCC	IPCG	TRUSTcom	TRUSTgov	IIP	NIM	SUS	FLEX	COSTBEN	CONV	INNO	COST	TT	DISC	OTT	DIST
BIUM	–	−0.06	−0.03	−0.07	0.24 ***	0.18 ***	0.04	0.15 **	0.52 ***	0.65 ***	0.52 ***	0.65 ***	0.65 ***	0.02	0.10	−0.01	0.09	0.12 *
APII		–	0.77 ***	0.48 ***	−0.34 ***	−0.24 ***	0.33 ***	0.27 ***	0.06	−0.07	−0.01	−0.02	−0.07	0.04	−0.02	0.03	0.04	−0.01
IPCC			–	0.56 ***	−0.36 ***	−0.22 ***	0.35 ***	0.30 ***	0.12 *	−0.05	0.04	−0.03	−0.05	0.08	0.13 *	0.15 **	0.17 **	0.13 *
IPCG				–	−0.29 ***	−0.55 ***	0.33 ***	0.31 ***	0.01	0.12 *	−0.06	−0.16 **	−0.10	0.08	0.24 ***	0.26 ***	0.22 ***	0.15 **
TRUSTcom					–	0.52 ***	−0.25 ***	−0.12 *	0.25 ***	0.26 ***	0.25 ***	0.23 ***	0.33 ***	−0.08	−0.04	−0.07	−0.06	−0.03
TRUSTgov						–	0.17 ***	−0.14 *	0.19 ***	0.25 ***	0.25 ***	0.27 ***	0.25 ***	−0.09	−0.14 **	−0.16 **	−0.05	−0.02
IIP							–	0.25 ***	0.04	−0.02	0.02	−0.01	−0.02	0.13 *	0.22 ***	0.17 ***	0.22 ***	0.23 ***
NIM								–	0.18 ***	0.17 ***	0.09	0.09	0.11	0.09	0.15 ***	0.12 *	0.19 ***	0.14 **
SUS									–	0.56 ***	0.59 ***	0.38 ***	0.58 ***	0.03	0.18 **	0.11 *	0.18 ***	0.17 **
FLEX										–	0.66 ***	0.70 ***	0.62 ***	0.04	0.07	−0.01	0.07	0.04
COSTBEN											–	0.53 ***	0.55 ***	0.07	0.20 ***	0.16 **	0.20 ***	0.20 ***
CONV												–	0.67 ***	−0.03	−0.02	−0.07	0.02	0.04
INNO													–	−0.02	0.05	0.01	0.08	0.09
COST														–	0.40 ***	0.39 ***	0.43 ***	0.48 ***
TT															–	0.78 ***	0.77 ***	0.68 ***
DISC																–	0.76 ***	0.66 ***
OTT																	–	0.75 ***
DIST																		–

4.1.1. RQ1 and RQ2: Influence of Cyber Security and Privacy Attitudes and Concerns and Trust Belief

To answer **RQ1**, we looked at the correlations between the indices for data privacy and data security attitudes and concerns (i.e., APII, IPCC, IPCG), and 'behavioural intentions to use MaaS' (i.e., BIUM). As suggested by the authors who developed the Internet Privacy Concerns scales [19], we calculated separate indices for commercial (IPCC) and government (IPCG) websites. As reported in our previous ITSC conference paper [23], our results showed that participants exhibited moderate to high levels of concern regarding the privacy and security of their personal data. However, interestingly and somewhat unexpectedly given the inconclusive evidence in the literature, we found that neither of these indices showed a significant correlation with the participants' intentions to use MaaS (see Table 2). Hence, **H1 and H2 are rejected**. This mismatch between the degree of concern and the lack of a connection between that concern and the intention to use MaaS aligns with the existing literature on the 'privacy paradox', which suggests that while individuals often consider privacy as a primary concern, they still disclose personal information for relatively minor incentives [45].

To answer **RQ2**, we examined the correlations between BIUM and TRUSTcom and between BIUM and TRUSTgov. The results show positive and significant (although weak) correlations, suggesting that trust in commercial and government websites managing personal data influences participants' intention to use MaaS. This was also reported in our previous conference paper [23]. To further test **H3** and **H4**, TRUSTcom and TRUSTgov were selected as IVs for the hierarchical follow-up regression model.

4.1.2. RQ3 and RQ4: Influence of Social Environment Cues

Additionally, to answer **RQ3** and **RQ4**, we examined the correlations between BIUM and NIM and between BIUM and IIP. This part of the results is also reported in our previous work [23]. The positive correlation between BIUM and NIM suggests that participants' intention to use MaaS is linked to how often they encounter news or reports about information misuse online. However, unexpectedly, this relationship was positive rather than negative, indicating that the more individuals had heard about information misuse, the more likely they were to be willing to adopt MaaS. In other words, those participants who were more likely to adopt MaaS were also the ones who had more frequently come across news of information misuse. Additionally, no correlation was found between BIUM and IIP, which reveals that participants' past experiences of personal invasion of privacy do not seem to affect their willingness to use MaaS.

This result might be unanticipated, as one might assume that past experiences of privacy invasion would discourage individuals from using similar apps in the future. A possible explanation relates to the data distribution, which shows that participants rarely viewed themselves as victims of online information misuse ($M = 2.31$, SD = 1.08). This limited perception could make it challenging to identify a significant relationship. Finally, aligning with the notion that greater trust correlates with lower user concerns, we found negative and statistically significant correlations between the three indicators of privacy and security attitudes/concerns (APII, IPCC, and IPCG) and trust in both commercial and government websites (TRUSTcom and TRUSTgov) as shown in Table 2).

4.1.3. Construct Validation: Exploratory Factor Analysis of MaaS Perceptions

Before examining how perceived benefits and barriers influence behavioural intention, it was important to assess whether these service characteristics were meaningfully grouped in participants' perceptions. To this end, we performed exploratory factor analysis (EFA) using principal axis factoring with Varimax rotation (see Table 3). All items related to perceived benefits (e.g., flexibility, convenience, and innovativeness) and costs or burdens (e.g., transfer time, discomfort, service cost, and service distance) were included. The number of factors to retain was determined based on Kaiser's criterion (eigenvalues $p \leq 1$) and visual inspection of the scree plot.

The EFA yielded a two-factor solution that accounted for 61.6% of the total variance in item responses.

- **The first factor reflected perceptions of logistical or infrastructural burdens and included the following:**
  The time needed to transfer between transportation modes (0.873).
  The overall transfer time (0.818).
  The discomfort of transfers (0.850).
  The average distance of available services (DIST; 0.732).
  The cost of the service (0.480).
- **The second factor represented perceived service incentives and benefits, including the following:**
  Flexibility (0.848).
  Practical convenience (0.757).
  Innovativeness (0.786).
  Sustainable quality (0.666).
  Cost–benefits (0.746).

Table 3. Results of exploratory factor analysis with Varimax rotation.

Factor Matrix			
Factor 1 (34.43%)		**Factor 2 (27.15%)**	
TT	0.873	TT	0.071
OTT	0.818	OTT	0.081
DISC	0.850	DISC	0.004
DIST	0.732	DIST	−0.375
COST	0.480	COST	−0.020
SUS	0.129	SUS	0.666
FLEX	−0.008	FLEX	0.848
COSTBEN	0.163	COSTBEN	0.746
INNOV	−0.012	INNOV	0.786
CONV	−0.083	CONV	0.757

These findings support a clear empirical distinction between the perceived barriers and perceived benefits in users' cognitive representations of MaaS.

This two-factor solution provided the basis for subsequent analyses, examining how perceived barriers and benefits influenced the participants' behavioural intentions to adopt MaaS.

4.1.4. RQ5: Influence of Perceived Benefits and Costs

To answer **RQ5** and **RQ6**, we then looked at the correlations between BIUM and the various indicators of perceived costs and perceived benefits associated with the usage of MaaS. In terms of perceived costs, we found that only the average distance with the services (i.e., bus stop, tube station, e-bike stations, and nearby e-scooters) was significantly (and positively) related to the behavioural intentions to use MaaS as indicated by a significant correlation between BIUM and DIST ($r = 0.12$, $p = 0.037$), suggesting that higher concern corresponded to higher intentions to use MaaS. This relationship appears to be counterintuitive, as one would expect higher concerns to be associated with lower intentions to use MaaS. First of all, we need to acknowledge that correlations do not inform us about the direction of the relationship; thereby, we could interpret this correlation as, the more individuals were inclined to use MaaS, the more they were concerned with the distance. This would make sense from a logical perspective, as the average distance with the services would be more concerning for those who intend to use them than for those who do not. Secondly, participants may have rated their concerns over the average distance with the services in general but not specifically in relation to MaaS. Because MaaS allows for multimodal and integrated transport allowing to fill the gaps between one transport mode to another, individuals who are concerned about the distance of services in general may be more willing to use MaaS. This interpretation is further supported by the results of our exploratory factor analysis, which clarified the role of DIST in the participants' perceptions. DIST loaded strongly onto the cost/barrier factor, alongside transfer time, discomfort, and service cost, indicating that participants conceptualised it as a logistical burden. However, rather than acting as a deterrent, this perceived burden may motivate MaaS adoption. Individuals who experience service access as limited or fragmented could be more inclined to adopt MaaS precisely because it promises to resolve such structural challenges. This perspective aligns with behavioural intention models [46], which highlight that recognising a problem often precedes the formation of adoption intentions. In this context, perceived barriers such as DIST may not inhibit engagement with MaaS but instead stimulate interest in integrated mobility solutions designed to address these exact issues.

Contrastingly, all other variables about perceived costs (COST, OTT, TT, DISC) are not significantly associated with BIUM. In terms of perceived benefits, we found that behavioural intentions to use MaaS were strongly and positively associated with all the indicators of perceived benefits as indicated by significant correlations between BIUM and SUS ($r = 0.52$, $p \leq 0.001$), BIUM and FLEX ($r = 0.65$, $p \leq 0.001$), BIUM and CB ($r = 0.52$, $p \leq 0.001$), BIUM and CONV ($r = 0.65$, $p \leq 0.001$), BIUM and INNOV ($r = 0.65$, $p \leq 0.001$). To validate the **H7** set and **H8** set, DIST, SUS, FLEX, AV, CONV, and INNOV are included as IVs in the follow-up hierarchical linear regression model presented in the next section.

4.2. Testing Model Assumptions of Linear Regression

Prior to conducting the regression analysis, we examined diagnostic plots to assess the assumptions of ordinary least squares (OLS) regression. Normal probability plots (P–P plots) and histograms of standardised residuals suggested the approximate normality of residuals. However, the residuals-versus-fitted scatter plot indicated a potential concern for heteroscedasticity, as the variance of residuals appeared to increase at higher predicted values.

To further investigate this, we performed a Breusch–Pagan test by regressing the squared residuals on all predictors in the model. The test revealed a small but significant relationship between predictors and residual variance, $F(9, 306) = 1.923$, $p = 0.048$, suggesting a potential violation of the homoscedasticity assumption.

To address this, we re-estimated both hierarchical models using Huber–White heteroscedasticity-consistent standard errors (HC3) computed in R. This approach adjusts the standard errors without altering the OLS coefficients, providing robust inference even in the presence of heteroscedasticity. The results of these robust models were highly consistent with the original OLS estimates, with all significant predictors retaining their significance and effect sizes remaining stable. These diagnostic checks reinforced confidence in the validity of our findings and informed our decision to report robust results in the main text.

4.3. Hierarchical Linear Regression Analysis with Robust Standard Errors

A hierarchical linear regression was conducted to examine predictors of intention to use MaaS. Based on the diagnostic checks outlined above, the results presented here are from OLS regression models estimated with Huber–White robust standard errors. This approach ensures the robustness of our findings in the presence of any potential heteroscedasticity. For transparency, the results from the original OLS models without robust standard errors are included in Table A2 in Appendix B.

Variance inflation factors (VIFs) were computed for each predictor to assess multicollinearity. All VIF values were below 3, indicating minimal concern for collinearity. Two hierarchical models were tested: Model 1 included only cyber security and privacy-related variables (TRUSTcom, TRUSTgov, and NIM), whereas Model 2 added cost–benefit-related predictors (SUS, FLEX, AV, CONV, INNOV, and DIST).

This hierarchical two-steps approach allowed us to systematically assess the contribution of privacy/security- and cost–benefit-related factors to the behavioural intention to use MaaS while ensuring methodological rigour and robust inference. Table 4 shows the p-values of all variables for both Model 1 and Model 2. The rest of this section provides more details about the analysis for both models.

Table 4. Results of the hierarchical linear regression model: predictors of intentions to adopt MaaS (with robust standard errors).

Model 1			
$F(3,316) = 11.09$, $p \leq 0.001$, $R^2 = 0.095$, $R^2_{Adj} = 0.087$ (from OLS)			
Predictors	β (p-value)	**Predictors**	β (p-value)
TRUSTcom	0.21 (***)	NIM	0.19 (***)
TRUSTgov	0.10 (ns)		
Model 2			
$F(9,306) = 42.87$, $p \leq 0.001$, $R^2 = 0.558$, $R^2_{Adj} = 0.545$ (from OLS)			
Predictors	β (p-value)	**Predictors**	β (p-value)
TRUSTcom	0.03 (ns)	CONV	0.28 (***)
TRUSTgov	−0.05 (ns)	INNOV	0.22 (**)
NIM	0.02 (ns)	DIST	0.04 (ns)
SUS	0.13 (*)	COSTBEN	0.02 (ns)
FLEX	0.22 (**)		

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p \leq 0.001$, ns = non-significant ($p > 0.05$). Robust standard errors reported. R^2 and F from the original OLS model.*

4.3.1. Model 1 with a Focus on Privacy and Security

Model 1 was statistically significant ($R = 0.308$, $F(3,316) = 11.09$, $p \leq 0.001$, $R^2 = 0.095$, R^2 Adjusted $= 0.087$), and its fitted regression model is

$$\text{BIUM} = 0.00 + 0.208 \times \text{TRUSTcom} + 0.099 \times \text{TRUSTgov} + 0.188 \times \text{NIM} \quad (1)$$

In Model 1, we considered TRUSTcom, TRUSTgov, and NIM as the predictors. We found that both TRUSTcom ($\beta = 0.21$, $p \leq 0.001$) and NIM ($\beta = 0.19$, $p \leq 0.01$) significantly predict BIUM, whereas TRUSTgov ($\beta = 0.10$, $p = 0.16$) does not. This suggests that while people's trust in commercial websites (i.e., TRUSTcom) and how frequently they receive news of information misuse (i.e., NIM) can influence their decisions and behaviour of adopting MaaS systems, trust in governmental websites does not. Hence, **H3, can be accepted** under Model 1. **H4 on the other hand, needs to be rejected,** as the relationships between TRUSTgov and BIUM is not significant. Additionally, also **H5 needs to be rejected,** as the relationship we found is significant but in the opposite direction to the one expected. However, due to the relatively low R^2 Adjusted value, Model 1 exhibits limited predictive power, accounting for only a small amount of the variance in the value of intentions to use MaaS (9.5%). Therefore, it is necessary to look at other competing factors to have a more comprehensive understanding.

4.3.2. Model 2 with Both Sets of Predictors

Model 2 with both sets of predictors is statistically significant ($R = 0.75$, $F(9, 306) = 42.87$, $p \leq 0.001$, $R^2 = 0.558$, R^2 Adjusted $= 0.545$), and the fitted regression model is

$$\begin{aligned} \text{BIUM} = -0.01 + 0.03 \times \text{TRUSTcom} - 0.05 \times \text{TRUSTgov} + 0.02 \times \text{NIM} \\ +0.13 \times \text{SUS} + 0.22 \times \text{FLEX} + 0.02 \times \text{COSTBEN} \\ +0.28 \times \text{CONV} + 0.23 \times \text{INNOV} + 0.04 \times \text{DIST} \end{aligned} \quad (2)$$

In Model 2, we include both the privacy/security-related variables (TRUSTcom, TRUSTgov, NIM) and the service-related variables (SUS, FLEX, COSTBEN, CONV, INNOV, DIST). As shown in Table 4, once the perceived benefits and costs associated with MaaS usage were added to the model, the effects of TRUSTcom ($\beta = 0.03$, $p = 0.59$) and NIM ($\beta = 0.02$, $p = 0.54$) became non-significant. While these two variables exhibited small but significant impacts on travellers' intentions in Model 1, their non-significant influence in Model 2 suggests that service-related factors account for the variance previously attributed to privacy and security concerns. Consequently, **H3, H4, and H5 are rejected** in the context of this combined model, while **H6 is rejected** on the basis of insignificant correlations found between frequency of experiences of improper invasion of privacy (IIP) and BIUM.

Among the five perceived benefits variables, four emerged as significant predictors of behavioural intentions to use MaaS. Practical convenience (CONV) was the strongest predictor ($\beta = 0.28$, $p \leq 0.001$), followed by innovation (INNOV) ($\beta = 0.22$, $p \leq 0.01$), flexibility (FLEX) ($\beta = 0.22$, $p \leq 0.01$) and sustainable quality (SUS) ($\beta = 0.13$, $p = 0.019$), cost–benefit evaluations (COSTBEN), on the other hand, were not predictive ($\beta = 0.02$, $p = 0.70$). These findings provide robust support for **H7a, H7b, H7d, and H7e**, while **H7c is rejected**. In contrast, the only cost-related variable included, the average distance of services (DIST), was not significantly predictive ($\beta = 0.04$, $p = 0.36$), leading to the rejection of all hypotheses under **H8**.

To test the stability of these results, a third linear regression analysis was conducted that introduced socio-demographic variables (e.g., age, gender, education, and employment status). The inclusion of these variables did not materially alter the significance or strength of the key predictors identified in Model 2 (see Appendix A for more details).

Overall, the results from Model 2 indicate that users' adoption intentions are more strongly influenced by the perceived benefits of MaaS service features than by trust or privacy concerns. With $R^2 = 0.558$, Model 2 accounts for over half of the variance in adoption intentions, representing a substantial increase in predictive power compared to Model 1 ($R^2 = 0.095$). This underscores the importance of service-related factors as primary drivers of behavioural intention within the MaaS context.

While the variance explained by Model 1 is modest (R^2 Adjusted $= 0.087$), the model serves a theory-driven purpose: to assess the standalone influence of privacy and trust-related factors prior to the inclusion of service-level predictors. This provides a meaningful point of comparison for evaluating the incremental predictive value of practical MaaS features in Model 2.

Comparing Model 1 with Model 2, TRUSTcom and NIM became insignificant predictors in Model 2. This change in the significance of the predictors could be due to two possible reasons. The first reason is that there could be a confounding effect of predictors. When we add a new predictor that is related to an existing predictor in the model, the newly added predictor may "absorb" the effect of the previously significant predictor, changing it into an insignificant one. However, in the current analysis, the VIFs for the predictors were less than 3, indicating low concern of correlation between the predictors in the two models. Hence, the explanation related to the confounding effect is unlikely. The second, and more reasonable explanation could be that the newly added benefits and cost factors were more meaningful predictors of travellers' intentions to use MaaS. This is further supported by the considerably improved predictive ability of Model 2 in comparison to Model 1. As shown in Table 4, the privacy and security factors (more specifically 'trust in commercial websites' and 'frequency of receiving news of internet misuse') alone explained little variance (i.e., R^2Adjusted $= 0.087$ in Model 1) in travellers' intentions to use MaaS. Conversely, Model 2 is highly predictive (i.e., R^2 Adjusted $= 0.545$), explaining a large amount of the variance in the value of intentions to use MaaS (54.5%). The benefits–costs factors greatly improve the predictive ability of the model, demonstrating how important they are while exploring travellers' intentions to use MaaS.

For robustness, results from the original OLS regression are reported in Table A2 in Appendix B. The OLS Model 2 explained 54.5% of variance in BIUM (R^2 Adjusted $= 0.545$), with the same key perceived benefit predictors (flexibility, convenience, innovativeness, and sustainability) reaching significance. Privacy/security variables and cost-related factors were also not significant in the OLS model.

To assess the robustness of our findings, we additionally conducted a stepwise regression analysis, which retained SUS, FLEX, CONV, and INNOV as significant predictors. Results were highly consistent with Model 2, reinforcing the robustness of our findings. Full results of this streamlined model are reported in Appendix C.

4.4. Structural Equation Model

To complement the hierarchical regression analysis and evaluate the robustness of findings, we estimated a mixed structural equation model (SEM). In this model, *PerceivedBenefits*, *PerceivedCosts*, and *WebsitesTrust* were specified as latent constructs, based on theoretical relevance and strong factor loadings. Specifically, *PerceivedBenefits* was measured through items assessing flexibility, cost advantages, convenience, innovation, and sustainability. *PerceivedCosts* captured concerns about travel time, service unreliability, discrimination, and monetary cost. *WebsitesTrust* reflected websites trust in both governmental and commercial MaaS providers. Conversely, the only privacy-related indicator—*Misuse News*, reflecting the frequency of exposure to news about information misuse—was retained as an observed variable. This hybrid approach allowed us to test all key conceptual predictors while maintaining model parsimony.

The final model showed good overall fit statistics (CFI $= 0.92$, TLI $= 0.91$, RMSEA $= 0.066$, SRMR $= 0.070$). As summarised in Table 5 and illustrated in Figure 1, *PerceivedBenefits* exhibited a strong positive effect on behavioural intention to use MaaS ($\beta = 0.808$, $p \leq 0.001$), explaining 63.5% of the variance. No direct effects were found for *PerceivedCosts* ($\beta = -0.007$, $p = 0.851$), *WebsitesTrust* ($\beta = -0.088$, $p = 0.172$), or exposure to news about privacy-related misuse ($\beta = 0.029$, $p = 0.502$).

Table 5. Structural equation model results predicting intention to use MaaS.

Path	Estimate	Std. Error	Std. β (p-Value)
Latent Variable Loadings			
PerceivedBenefits → FLEX	1.000 (fixed)	–	0.827 (***)
PerceivedBenefits → COSTBEN	0.869	0.060	0.709 (***)
PerceivedBenefits → INNOV	0.933	0.065	0.774 (***)
PerceivedBenefits → CONV	0.921	0.073	0.768 (***)
PerceivedBenefits → SUST	0.786	0.064	0.644 (***)
PerceivedCosts → OTT	1.000 (fixed)	–	0.876 (***)
PerceivedCosts → TT	1.023	0.050	0.900 (***)
PerceivedCosts → DISC	0.975	0.057	0.856 (***)
PerceivedCosts → DIST	0.905	0.055	0.804 (***)
PerceivedCosts → COST	0.512	0.062	0.454 (***)
WebsitesTrust → TRUSTcom	1.000 (fixed)	–	0.675 (***)
WebsitesTrust → TRUSTgov	1.155	0.247	0.766 (***)
Structural Paths			
PerceivedBenefits → BIUM	0.977	0.076	0.808 (***)
PerceivedCosts → BIUM	−0.008	0.044	−0.007 (ns)
WebsitesTrust → BIUM	−0.131	0.096	−0.088 (ns)
MisuseNEWs → BIUM	0.028	0.042	0.029 (ns)
Predictors of PerceivedBenefits			
WebsitesTrust → PerceivedBenefits	0.528	0.124	0.427 (***)
MisuseNEWs → PerceivedBenefits	0.167	0.051	0.208 (**)
Predictors of PerceivedCosts			
WebsitesTrust → PerceivedCosts	−0.134	0.122	−0.100 (ns)
MisuseNEWs → PerceivedCosts	0.130	0.053	0.149 (*)
Covariates			
Age → BIUM	−0.116	0.041	−0.121 (**)
Gender → BIUM	−0.085	0.079	−0.043 (ns)
Education → BIUM	−0.017	0.041	−0.017 (ns)
Place of living → BIUM	−0.074	0.038	−0.075 ($p = 0.054$)
Income → BIUM	0.095	0.043	0.099 (*)

Note: BIUM = Behavioural Intention to Use MaaS. Standardised betas shown. * $p < 0.05$, ** $p < 0.01$, *** $p \leq 0.001$, *ns = non-significant.*

WebsitesTrust significantly predicted *PerceivedBenefits* ($\beta = 0.427$, $p \leq 0.001$). Exposure to news about misuse (NIM) was also positively associated with both *PerceivedBenefits* ($\beta = 0.208$, $p \leq 0.001$) and *PerceivedCosts* ($\beta = 0.149$, $p = 0.014$). Although somewhat counterintuitive, these associations may reflect increased cognitive elaboration of MaaS systems among users exposed to critical information, who simultaneously recognise both the potential advantages and the risks of such services.

These findings reinforce that perceived service benefits are the strongest and most consistent drivers of intention to adopt MaaS. Conversely, perceived costs and website trust appear to play an indirect or limited role once perceived benefits are taken into account. Hypotheses **H5** and **H6**, concerning direct privacy-related effects on intention, are therefore not supported by the data.

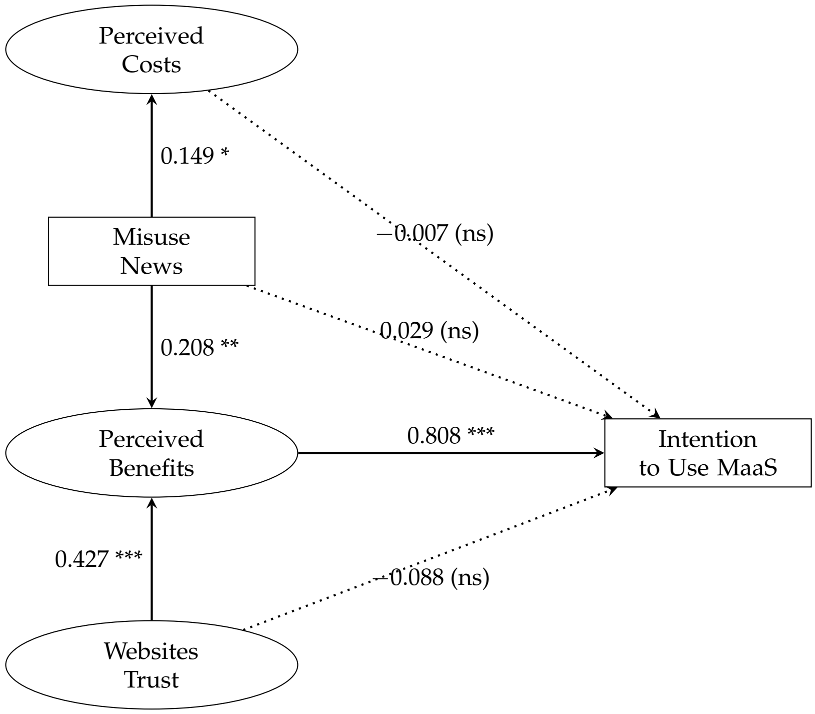

Figure 1. The path diagram of the SEM model showing significant (solid) and non-significant (dotted) paths. * $p < 0.05$, ** $p < 0.01$, *** $p \leq 0.001$, ns = non-significant.

4.5. Testing the Privacy Calculus Model

To address theoretical concerns related to the Privacy Calculus and Privacy Paradox frameworks, we tested a moderated regression model in which perceived benefits and perceived barriers were entered as predictors of behavioural intention to use MaaS, along with their interaction term (Benefits × Barriers). The predictors were mean-centred prior to computing the interaction. The overall model was significant, $F(3, 316) = 121.58$, $p \leq 0.001$, with an adjusted R^2 of 0.531, indicating substantial explanatory power. Perceived benefits emerged as a strong positive predictor of behavioural intention ($\beta = 0.732$, $p \leq 0.001$), whereas perceived barriers had no significant effect ($\beta = -0.006$, $p = 0.874$). Importantly, the interaction term was also non-significant ($\beta = 0.047$, $p = 0.845$), suggesting that the effect of barriers on intention does not depend on the level of perceived benefits. These findings indicate that while users clearly distinguish between benefits and burdens (as shown in the EFA), their intention to adopt MaaS is primarily driven by perceived utility. Even when participants perceive logistical barriers, they appear willing to adopt if the system is perceived as beneficial. This lends partial support to privacy paradox dynamics, in which users adopt digital services despite concerns—but does not support a full privacy calculus interaction effect.

5. Further Discussions and Conclusions

Although MaaS has received increasing interest since it was first presented at ITS Europe Congress held in Helsinki, Finland, in June 2014 [47], there is no clear account of which aspects work as benefits/incentives or costs/barriers to travellers' adoption of such systems. For example, relative to the barriers to the adoption of MaaS, a number of research studies have been investigating the effects of privacy and security concerns on the intentions to use MaaS by travellers. However, the number of studies on this topic remains limited, with mixed and inconclusive findings. Our goal was to provide greater clarity by simultaneously evaluating the role played by (1) cyber security and privacy attitudes and concerns; (2) trust in the providers; (3) social environment cues; and (4) the perceived benefits and perceived costs of using the MaaS system.

5.1. Cyber Security and Privacy Attitudes, Concerns, and Trust

In this study, we did not find any direct relationships between cyber security and privacy attitudes/concerns and people's intention to use MaaS systems, suggesting that people may underestimate cyber security and privacy risks or lack general awareness of such matters. Conversely, trust (more specifically, trust in commercial websites' ability and practice to handle users' personal data) is found to be able to positively predict participants' intentions to use MaaS. This result is in line with previous research on MaaS (i.e., trust in the provider as relevant and a positive predictor of willingness to adopt MaaS [2,35,40]). This is also consistent with the findings from research that identifies trust in websites as a core positive predictor of people's intentions to use or buy from online service providers [31–33]. Nonetheless, it is crucial to acknowledge that such trust is intimately linked to privacy and security measures. One could argue that this partially mirrors individuals' perceptions of privacy and security. However, while incorporating more competing variables into the regression model presented in this paper, no significant impact from privacy and security-related variables was found, with trust in commercial providers and frequency of having read or heard news of information misuse both losing their predictive power. Therefore, we can summarise as follows.

- In comparison with privacy and cyber security concerns, trust could be a more relatable concept for potential MaaS users and a clearer predictor.
- Considering trust as a proxy for representing people's privacy and security perception, there is indirect evidence supporting the interplay between cyber security and privacy attitudes and concerns, and the intention to use MaaS.
- Compared with other competing factors, the predictive power of trust in providers is not substantial.

5.2. Social Environment Cues

Surprisingly, we found that having heard or read about internet data misuse (NIM) had a positive and significant effect on intentions to use MaaS systems (BIUM). This counterintuitive finding runs opposite to our initial expectation that exposure to such news would heighten privacy concerns and discourage adoption. One plausible explanation is that individuals who are more digitally literate and tech savvy are both more likely to encounter news about data misuse and more inclined to adopt innovative digital services such as MaaS. Prior studies have identified tech savviness and digital literacy as important positive predictors of MaaS adoption intentions, suggesting that frequent exposure to digital content—including reports of data misuse—may reflect higher levels of digital engagement rather than heightened privacy sensitivity.

To explore this unexpected association further, we reversed the regression direction and tested whether the behavioural intention to use MaaS (BIUM) predicted exposure to news about internet misuse (NIM). This analysis revealed that BIUM significantly predicted NIM ($\beta = 0.15$, $p \leq 0.01$), supporting the idea of a shared underlying factor, such as digital engagement or tech savviness, influencing both variables.

Consistent with this interpretation, when we regressed NIM alone on BIUM ($\beta = 0.15$, $p \leq 0.01$; $R = 0.15$, $F(1, 318) = 7.15$, $p \leq 0.001$, $R^2 = 0.22$, R^2Adjusted $= 0.20$), NIM was a significant positive predictor. However, when we added perceived service innovativeness (INNOV)–our closest proxy for technological interest—to the model, the effect of NIM was no longer significant (NIM: $\beta = 0.08$, $p \leq 0.06$), while INNOV emerged as a strong positive predictor ($\beta = 0.64$, $p \leq 0.001$). The full model $R = 0.65$, $F(2, 316) = 116.89$,

$p \leq 0.001$, $R^2 = 0.42$, R^2 Adjusted $= 0.42$ suggests that the initial association between NIM and BIUM may have been driven by an underlying interest in innovative technologies. However, we emphasise that this remains a tentative and post hoc interpretation, as the current dataset does not include direct measures of digital literacy or tech savviness. Future research should explicitly test this hypothesis by incorporating digital literacy indicators and exploring potential moderated mediation effects (e.g., using PROCESS or latent SEM).

5.3. Perceived Benefits and Costs

Due to the limited predictability of variables related to trust in providers and social environment cues, we added perceived benefits and perceived costs variables, aiming to obtain a more comprehensive view of the determining factors on the adoption of MaaS. The responses from participants led to the following findings.

- Participants cognitively differentiate between cost-related burdens and benefit-related incentives (as shown by our Exploratory Factor Analysis).
- Perceived benefits, including the practical convenience of the service, the innovativeness of the service, the flexibility of the service, and the sustainable quality of the service, strongly influenced their intention to embrace MaaS systems.
- Users' concerns over functional and practical aspects of MaaS including the cost of the service, the distance of the services, the time to transfer from one mode to another, and the discomfort in having to transfer from one transportation mean to another were not found to be associated with intention to adopt MaaS systems.
- Specifically, perceived benefits outweighed other factors (such as privacy and security attitudes and concerns, trust, etc.) to be the main factors to predict travellers' willingness to adopt MaaS systems.

These findings imply a heightened focus on the potential benefits of MaaS rather than its potential costs. They also emphasise that the perceived benefits possibly overshadow other factors such as cyber security, privacy, and concerns. The preference for potential benefits in the decision-making process indicates a common trend in the privacy–benefits trade-off and suggests a shift in evaluative criteria: participants may acknowledge burdens such as cost or logistical friction but view them as manageable within a system perceived to offer strong overall value. In other words, these practical concerns may not act as decisive deterrents in contexts where integration, innovation, and user convenience are prominent. This interpretation aligns with emerging findings in MaaS research (e.g., [6,7,48]), which suggest that adoption decisions are shaped more by holistic perceptions of system utility than by isolated cost evaluations. However, our results provide only partial support for the Privacy Calculus model: although participants acknowledged both benefits and barriers, their intention to adopt MaaS was driven almost entirely by the former. Moreover, the absence of a significant interaction effect indicates that participants may not have evaluated risks and benefits as a deliberate trade-off. Instead, they seem to disregard privacy and security concerns when the perceived utility is high. This pattern aligns more closely with the Privacy Paradox, where strong perceptions of utility tend to override data protection or effort-related concerns [45]. Future research could investigate whether this dynamic varies across user subgroups or in real-world adoption contexts.

5.4. Limitations

One limitation of this study is that we measured trust as trust in how general commercial or governmental websites handle users' personal information, rather than as trust specifically in how a MaaS system would do so. However, given that we did not employ a stated preference approach (where participants evaluate hypothetical scenarios), but instead provided a generic definition of MaaS, it would have appeared contrived to ask participants to evaluate their trust in a system they had not experienced. Moreover, since MaaS systems will necessarily be operated by either commercial or governmental actors (or hybrids thereof), the trust measures we used remain relevant to the evaluation of MaaS. Additionally, at the time of data collection, MaaS platforms were not widely used or recognised by the general public in the UK. Asking participants to report trust in an unfamiliar, hypothetical system risked introducing interpretive variability and measurement error due to low familiarity [32,49]. To address this, we adopted established trust measures anchored in more familiar online contexts, such as commercial websites, which participants were more likely to have experienced. This approach is further supported by trust transfer theory, which posits that trust in known digital platforms or service providers can shape perceptions of newer, related services [50,51]. Accordingly, while our trust items are not MaaS-specific, they reflect baseline trust orientations in online environments that are likely to influence openness to MaaS adoption. Nevertheless, future research should consider developing MaaS-specific trust items once baseline familiarity with such platforms is more widespread, potentially using stated preference scenarios or video prototypes to support contextual understanding.

Secondly, continuing with measurement considerations, our assessment of perceived privacy invasion relied on a single-item, self-reported frequency question. While this provides useful insight into participants' general exposure to privacy concerns, it does not capture the subjective severity or psychological impact of individual privacy breaches–factors that could meaningfully influence trust in digital services. To address this, future studies should adopt multi-item scales capable of differentiating between isolated versus repeated privacy harms and examining their distinct effects on trust and MaaS adoption behaviour. Similarly, the COSTBEN variable may integrate multiple evaluative dimensions (e.g., cost, functionality, and convenience) and could have been interpreted differently across respondents. Future studies should consider disaggregating this construct into validated subcomponents (e.g., perceived affordability, cost-benefit ratio, or value-for-money) for greater clarity and construct precision.

A third limitation of this study is that we did not consider the differential impact that concerns and benefits of MaaS would have depending on users' travel habits and primary transportation mode. This would be relevant, as research has shown, for example, that the sustainable quality of MaaS could be an important incentive to use MaaS for people who mostly travel by public transport but not for people who are avid car users [42]. However, because the purpose of this study was to assess the effect of privacy and security concerns specifically and the effects of perceived benefits and costs on the overall propensity to adopt MaaS, we believe that a comparison between users with different travel habits would have been beyond the scope of this study. However, because we consider differences in what different modes of travellers perceive as benefits or costs to MaaS use, a promising and interesting area of study, we aim to explore this aspect in a follow-up paper.

Last but not least, we acknowledge that another limitation is its sole focus on perceived incentives and concerns (including users' privacy and security attitudes) without directly measuring users' perceptions of the potential shift in travel behaviours towards the car-free mobility service that MaaS promotes. While this is out of the scope of this study, travel behaviour and lifestyle changes play a critical role in shaping users' willingness to use MaaS. Future research could explore how individuals perceive and adapt to these behavioural shifts and how such perceptions interact with the factors here investigated. The integration of these dimensions would offer a more comprehensive understanding of barriers and concerns of deploying and adopting MaaS.

5.5. Recommendations

The limited influence of privacy/security attitudes and concerns, and trust-related factors on individuals' willingness to update MaaS systems necessitates further collaboration among multiple parties of the MaaS ecosystem. Derived from the observations presented in this paper, we provide the following recommendations for MaaS operators.

- As potential MaaS users appear to underestimate the cyber security and privacy risks that are connected with the use of MaaS systems, this highlights **the ethical responsibility of MaaS operators to inform and foster better cyber security and privacy awareness**.
- To decrease users' perceived privacy and security risks, MaaS systems could assure that they comply with a privacy policy that indicates what personal data will be collected and how such collected personal data will be used and shared [31]. We recommend that **MaaS providers try to cultivate a stronger sense of trust and reliability among the public to expand their customer base and reduce users' perceived risks**.
- As individuals place significant value on a variety of benefits that are associated with the use of MaaS, these benefits are found to have a significant impact on people's decisions to adopt MaaS. We thus encourage **MaaS providers to implement and promote the potential benefits with the purpose of increasing the uptake of MaaS**.

Moreover, on the research side, we envisage the following research directions.

- Cyber security and privacy of MaaS should not be overlooked; there is the call for **the multidisciplinary approach to ensuring the considerations of cyber security and privacy in the development of MaaS systems/applications**.
- Researchers and practitioners from different disciplines need to work collaboratively to research how to **nudge/educate the general public to be more aware of potential cyber security and privacy risks related to MaaS systems**.
- Researchers and policy makers need to work together to develop **comprehensive guidance for the development and deployment of MaaS systems to ensure a more informed and secure MaaS landscape for all stakeholders**.

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Appendix A. Results of a Third Linear Regression Model

To test if the results would largely stay unvaried while introducing the predicting role of several socio-demographics, we tested a third linear regression model with robust standard errors, Model 3. It considers both data privacy and security related variables (i.e., TBC, TBG, and NIM), perceived cost–benefits related variables (i.e., SUS, FLEX, AV, CONV, INNOV, and DIST) as well as several indicators for socio-demographics (i.e., gender (GN), age (AGE), education level, area of living (AL), and household income (IN)). All VIF values were computed and found to be lower than three, indicating low concern of collinearity. Table A1 shows the p-values of all variables for Model 3. As predictors of BIUM, we included several socio-demographic factors, which the existing literature has linked to intentions to adopt MaaS. These factors were measured as follows:

- **Gender**: Participants were asked to indicate their gender with the following response options: male, female, other, and prefer not to say. Because the percentage of people who replied other and prefer not say was equivalent to only 1.3 per cent, we re-coded the variable into 1 = Female (41.6%) and 2 = Male (57.2%).
- **Age**: Participants were asked to answer question 'How old are you?' The mean age is 39.7 with a standard deviation of 11.8.
- **Education level**: Participants were asked to indicate the highest level of education completed, available options were categorised as follows: 0 = No qualifications (0%); 1 = GCSE's (10.9%); 2 = A levels/ BTEC (17.2%); 3 = Higher education experience without degree (10%); 4 = First degree (37.5%); 5 = Master's degree (18.4%); 6 = Doctoral degree or above (3.4%).
- **Residing area**: Participants were asked about their place to live with the question 'Which of the following best describes the place where you live? (a town is a compactly settled area, usually larger than a village but smaller than a city, surrounded by rural territory)'. The following options were available for participants to choose from: 1 = Village (15.6%), 2 = Town (46.6%), 3 = City (37.8%).
- **Household income**: Participants were asked about their income with the question 'What is your total household annual income?' The following options were available for them to choose from: 1 = Less than GBP 15,000 (10.5%); 2 = GBP 15,000 to GBP 30,000 (23.9%); 3 = GBP 30,000 to GBP 40,000 (16.3%); 4 = GBP 40,000 to GBP 60,000 (24.8%); 5 = GBP 60,000 to GBP 100,000 (19.6%); 6 = More than GBP 100,000 (4.9%); and prefer not say (treated as missing) (4.4%).

Model 3 was statistically significant and accounted for 56.8% of the variance in behavioural intentions to use MaaS ($R = 0.754$, $F(14, 285) = 26.78$, $p \leq 0.001$, $R^2 = 0.568$, $R^2_{\text{Adjusted}} = 0.547$). The full model specification is shown in Equation (A1), and detailed coefficients are reported in Table A1:

$$\begin{aligned} \text{BIUM} = 0.46 - 0.04 \times \text{GN} - 0.12 \times \text{AGE} - 0.01 \times \text{EDU} - \\ 0.09 \times \text{AL} + 0.09 \times \text{IN} + 0.01 \times \text{TBC} - 0.03 \times \text{TBG} + \\ 0.05 \times \text{NIM} + 0.04 \times \text{DIST} + 0.12 \times \text{SUS} + 0.21 \times \text{FLEX} + \\ 0.05 \times \text{COSTBEN} + 0.25 \times \text{CONV} + 0.23 \times \text{INNOV} \end{aligned} \tag{A1}$$

As shown in Equation (A1), among the socio-demographic predictors, only age significantly predicted intention to use MaaS ($\beta = -0.10$, $p = 0.009$), suggesting that older individuals are slightly less inclined to adopt such systems. Trust-related predictors (TBC and TBG) and exposure to news about data misuse (NIM) remained non-significant, providing no support for Hypotheses **H3** through **H6**.

In contrast, perceived benefits emerged as the strongest predictors of behavioural intentions. Four out of five benefit-related variables significantly contributed to the model:

perceived convenience ($\beta = 0.25$, $p \leq 0.001$), innovativeness ($\beta = 0.23$, $p \leq 0.001$), flexibility ($\beta = 0.21$, $p = 0.003$), and sustainability ($\beta = 0.12$, $p = 0.037$). Only perceived availability did not reach significance. Therefore, Hypotheses **H7a**, **H7b**, **H7d**, and **H7e** are supported, while **H7c** is not. The perceived cost indicator (DIST) was also non-significant ($\beta = 0.02$, $p = 0.69$), leading to the rejection of Hypothesis **H8**.

Table A1. Results of the hierarchical linear regression model: predictors of intentions to adopt MaaS.

Model 3			
F(14, 287) = 26.80, $p \leq 0.001$, R^2 = 0.57, R^2 Adjusted = 0.55			
Predictors	**β (p-Value)**	**Predictors**	**β (p-Value)**
GN	−0.01 (ns)	NIM	0.05 (ns)
AGE	−0.10 (*)	SUS	0.12 (*)
EDU	−0.01 (ns)	FLEX	0.21 (**)
AL	−0.06 (ns)	COSTBEN	0.05 (ns)
IN	0.08 (ns)	CONV	0.25 (***)
TBC	0.01 (ns)	INNOV	0.23 (***)
TBG	−0.03 (ns)	DIST	0.02 (ns)

Note: * $p < 0.05$, ** $p < 0.01$, *** $p \leq 0.001$, *ns represents non significant where* $p > 0.05$.

Overall, Model 3 closely replicates the results of Model 2, with nearly identical patterns of significance and similar explanatory power (adjusted R^2 of 0.547 vs. 0.545 in Model 2). This suggests that the inclusion of socio-demographic controls does not substantially improve model performance and further reinforces the central role of perceived service benefits in shaping MaaS adoption intentions.

Appendix B. Original OLS Regression Results

For transparency, we report the original ordinary least squares (OLS) regression results without robust standard errors in Table A2. These results were included to allow comparison with the main analyses, which were re-estimated using Huber-White robust standard errors following initial diagnostic checks (see Section 4.2). As noted in the main text, the robust models produced results that were highly consistent with the original OLS estimates, reinforcing confidence in the robustness of our findings.

Here we applied a hierarchical linear regression model to further investigate the effects of those variables (i.e., TRUSTcom, TRUSTgov, NIM, DIST, SUS, FLEX, COSTBEN, CONV, and INNOV) that have significant correlations with BIUM. The variance inflation factor (VIF) was computed for each variable. All VIF values were lower than 3, indicating a low concern for collinearity. Then, a hierarchical linear regression was performed to compare the two models, each containing different types of predictors. Model 1 consists of only cyber security and privacy-related variables, including TRUSTcom, TRUSTgov, and NIM. Model 2 considers both cyber security and privacy-related variables and cost/benefit-related variables, including SUS, FLEX, COSTBEN, CONV, INNOV, and DIST. Table A2 shows the p-values of all variables for both Model 1 and Model 2. The rest of this section provides more details about the analysis for both models.

Appendix B.1. Model 1 with a Focus on Privacy and Security

Model 1 is statistically significant ($R = 0.30$, $F(3, 312) = 10.3$, $p \leq 0.001$, $R^2 = 0.09$, R^2 Adjusted $= 0.08$), and its fitted regression model is:

$$\text{BIUM} = 2.51 + 0.20 \times \text{TRUSTcom} + 0.09 \times \text{TRUSTgov} + 0.18 \times \text{NIM} \quad \text{(A2)}$$

In Model 1, we considered TRUSTcom, TRUSTgov, and NIM as the predictors. We found that both TRUSTcom ($\beta = 0.20$, $p \leq 0.001$) and NIM ($\beta = 0.18$, $p \leq 0.001$) significantly predict BIUM, whereas TRUSTgov does not ($\beta = 0.10$, $p = 0.11$), suggesting that people's trust in commercial websites (i.e., TRUSTcom) and how frequently they receive news of information misuse (i.e., NIM) can influence their decision and behaviour of adopting MaaS systems. Hence, **H3, H4, and H5 can be accepted** under Model 1. **H6 on the other hand, needs to be rejected** as the relationship we found was significant but in the opposite direction to the one expected. However, due to the relatively low R^2 Adjusted value, Model 1 exhibits limited predictive power, accounting for only a small amount of the variance in the value of the intentions to use MaaS (8.1%). Therefore, it is necessary to look at other competing factors to have a more comprehensive understanding.

Appendix B.2. Model 2 with a More Holistic Approach

Model 2 with both sets of predictors is statistically significant ($R = 0.75$, $F(9, 306) = 42.87$, $p \leq 0.001$, $R^2 = 0.56$, R^2 Adjusted $= 0.54$), and the fitted regression model is:

$$\begin{aligned} \text{BIUM} = -0.49 + 0.02 \times \text{TRUSTcom} - 0.05 \times \text{TRUSTgov} + 0.02 \times \text{NIM} \\ +0.04 \times \text{DIST} + 0.13 \times \text{SUS} + 0.22 \times \text{FLEX} \\ +0.02 \times \text{COSTBEN} + 0.28 \times \text{CONV} + 0.23 \times \text{INNOV} \end{aligned} \tag{A3}$$

In Model 2, we added variables for perceived benefits and costs (i.e., DIST, SUS, FLEX, CB, CONV and INNOV) as predictors of BIUM. As shown in Table A2, once the perceived benefits and costs associated with MaaS usage were added to the model, both TRUSTcom ($\beta = 0.02$, $p = 0.63$) and NIM lose their predictive power ($\beta = 0.02$, $p = 0.54$). Although both TRUSTcom and NIM exhibited significant (however small) impacts on travellers' intentions to adopt MaaS in Model 1, considering their insignificant predictive power in Model 2, **H3, H4, H5, and H6 are rejected** under such circumstances. Out of the five perceived benefits variables considered (i.e., SUS, FLEX, COSTBEN, CONV and INNOV), four are significantly predictive of behavioural intentions to use MaaS, with the strongest predictor being the practical convenience of the service (i.e., CONV) ($\beta = 0.28$, $p \leq 0.001$), followed by the innovativeness of the service (i.e., INNOV) ($\beta = 0.23$, $p \leq 0.001$), the flexibility of the service (i.e., FLEX) ($\beta = 0.22$, $p \leq 0.001$) and the sustainable quality of the service (i.e., SUS) ($\beta = 0.13$, $p = 0.015$). Based on the evidence presented, it can be concluded that **H7a, H7b, H7d, and H7e are validated**, while **H7c is rejected**. As for the only variable for costs considered in the model, the average distance of services (DIST), the model indicates that it is not significantly predictive of behavioural intentions to use MaaS ($\beta = 0.04$, $p = 0.36$), thereby **all hypotheses in the H8 set are rejected**. To further validate the results, we conducted a third linear regression analysis introducing socio-demographic variables including age, gender, education, employment status, etc., and the results remained largely unvaried (see Appendix A for more details).

Appendix B.3. Original Linear Regression Results

Comparing Model 1 with Model 2, TRUSTcom and NIM became insignificant predictors in Model 2. This change in the significance of the predictors could be due to two possible reasons. The first reason is that there could be a confounding effect of predictors. When we add a new predictor that is related to an existing predictor in the model, the newly added predictor may "absorb" the effect of the previously significant predictor, changing it into an insignificant one. However, in the current analysis, the VIFs for the predictors were less than 3, indicating low concern of correlation between the predictors in the two models. Hence, the explanation related to the confounding effect is unlikely. The second, and more reasonable explanation could be that the newly added benefits and cost factors were more meaningful predictors of travellers' intentions to use MaaS. This is further supported by the considerably improved predictive ability of Model 2 in comparison to Model 1. As shown in Table A2, privacy and security factors (more specifically 'trust in commercial websites' and 'frequency of receiving news of internet misuse') alone explained little variance (i.e., R^2Adjusted $= 0.08$ in Model 1) in travellers' intentions to use MaaS. Whereas Model 2 is highly predictive (i.e., R^2 Adjusted $= 0.54$), explaining a large amount of the variance in the value of intentions to use MaaS (54.5%). The benefits/costs factors greatly improved the predictive ability of the model, demonstrating how important they are while exploring travellers' intentions to use MaaS.

Table A2. Results of the hierarchical linear regression model: predictors of intentions to adopt MaaS.

Model 1			
$F(3, 312) = 10.3$, $p \leq 0.001$, $R^2 = 0.09$, R^2 Adjusted $= 0.08$			
Predictors	β (p-value)	**Predictors**	β (p-value)
TRUSTcom	0.20 (***)	NIM	0.18 (***)
TRUSTgov	0.09 (ns)		
Model 2			
$F(9, 306) = 42.87$, $p \leq 0.001$, $R^2 = 0.56$, R^2 Adjusted $= 0.54$			
Predictors	β (p-value)	**Predictors**	β (p-value)
TRUSTcom	0.02 (ns)	COSTBEN	0.02 (ns)
TRUSTgov	−0.05 (ns)	CONV	0.28 (***)
NIM	0.02 (ns)	INNOV	0.23 (***)
SUS	0.13 (*)	DIST	0.04 (ns)
FLEX	0.22 (***)		

Note: * $p < 0.05$, *** $p \leq 0.001$, *ns represents non significant where* $p > 0.05$.

Appendix C. Stepwise Regression Predicting Intention to Use MaaS

Appendix C.1. Stepwise Linear Regression Model

A stepwise linear regression analysis was conducted to identify the strongest predictors of the intention to use MaaS. Variables were entered sequentially using SPSS's default stepwise method based on statistical significance.

The final model (Model 5) retained four predictors: practical convenience (all-in-one app) ($\beta = 0.287$, $p \leq 0.001$), sustainable quality of the service ($\beta = 0.144$, $p = 0.005$), innovativeness of the service ($\beta = 0.233$, $p \leq 0.001$), and flexibility of the service ($\beta = 0.225$, $p \leq 0.001$). This model explained 55.6% of the variance in intention to use MaaS ($R^2 = 0.556$, $F(5, 308) = 55.091$, $p \leq 0.001$).

Earlier steps showed that practical convenience alone accounted for 44.0% of the variance ($R^2 = 0.440$, $F(1, 314) = 248.74$, $p \leq 0.001$). Adding sustainable quality increased the explained variance to 50.9% ($\Delta R^2 = 0.069$), and the inclusion of innovativeness and flexibility further improved the model fit to 55.6% ($\Delta R^2 = 0.047$ across both steps).

Appendix C.2. Stepwise Linear Regression Results

Table A3. Stepwise Linear Regression Predicting Intention to Use MaaS.

Predictors	**B**	**SE**	β **(p-Value)**
Model 1			
Practical convenience (all-in-one app)	0.621	0.043	0.624 (***)

Table A3. *Cont.*

Predictors	B	SE	β (p-Value)
Model 2			
Practical convenience (all-in-one app)	0.525	0.044	0.528 (***)
Sustainable quality of the service	0.297	0.045	0.295 (***)
Model 3			
Practical convenience (all-in-one app)	0.400	0.052	0.402 (***)
Sustainable quality of the service	0.208	0.049	0.206 (***)
Innovativeness of the service	0.252	0.060	0.253 (***)
Model 4			
Practical convenience (all-in-one app)	0.285	0.060	0.287 (***)
Sustainable quality of the service	0.145	0.051	0.144 (**)
Innovativeness of the service	0.232	0.059	0.233 (***)
Model 5			
Practical convenience (all-in-one app)	0.285	0.060	0.287 (***)
Sustainable quality of the service	0.145	0.051	0.144 (**)
Innovativeness of the service	0.232	0.059	0.233 (***)
Flexibility of the service	0.225	0.060	0.225 (***)

Note: Dependent variable = Intention to use MaaS. Model 1: $R^2 = 0.440$, $F(1,314) = 248.74$, $p \leq 0.001$. *Model 2:* $R^2 = 0.509$, $\Delta R^2 = 0.069$, $F(2,313) = 161.04$, $p \leq 0.001$. *Model 3:* $R^2 = 0.536$, $\Delta R^2 = 0.027$, $F(3,312) = 120.01$, $p \leq 0.001$. *Model 4:* $R^2 = 0.556$, $\Delta R^2 = 0.020$, $F(4,311) = 96.27$, $p \leq 0.001$. *Model 5:* $R^2 = 0.556$, $\Delta R^2 = 0.000$, $F(5,308) = 55.091$, $p \leq 0.001$. ** $p < 0.01$, *** $p \leq 0.001$.

The stepwise procedure retained four key service-related predictors: practical convenience, sustainable quality, innovativeness, and flexibility of the service. This streamlined model explained 55.6% of the variance in intention to use MaaS ($R^2 = 0.556$), with all retained predictors showing significant positive associations ($p < 0.01$).

By comparison, our theory-driven OLS model with Huber-White robust standard errors explained a nearly identical proportion of variance ($R^2 = 0.558$) and included these same four service-related predictors, as well as additional trust and privacy-related variables that were non-significant in the stepwise model.

The consistency of the key predictors and R^2 across the models supports the robustness of our findings. Retaining all theory-driven predictors in the main analysis helps ensure alignment with the prior literature and guards against potential omitted variable bias. The stepwise model is presented here for transparency as an exploratory alternative.

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