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Intelligent Transport Systems
Original Scientific Paper
Submitted: 7 Mar. 2022
Accepted: 8 June 2022

CORRELATION ANALYSIS METHOD OF CUSTOMISATION AND SEMI-PERSONALISATION IN MOBILITY AS A SERVICE

ABSTRACT

Mobility as a Service (MaaS) has been proposed as a user-centric, data-driven and personalised service. However, full personalisation is not available yet. Customisation settings are developed in mobile applications, and several semi-personalised functionalities are also involved. The quantitative analysis of relation between these two could be the reference for further development tendency of interface functions in mobile applications. Thus, the research objective is identified as: the quantitative correlation analysis between semi-personalisation functionalities and customisation settings. Accordingly, the multi-criteria qualitative analysis method is applied to identify the assessment aspects regarding mobile applications. The scoring method is also introduced. Then the correlation quantitative analysis method is applied to calculate the correlation coefficient. We have assessed 25 MaaS applications regarding determined aspects. The correlation coefficients for each application together with the overall coefficient are calculated, the assessment results are summarised, and the correlation tendency is interpreted. According to assessment results, the correlation between customisation settings and semi-personalisation is not strong at current stage. Selected MaaS mobile applications are customisation setting oriented applications. Fewer manual selections are expected in further personalised services. Our results facilitate development of further personalised functions in MaaS mobile applications.

KEYWORDS

Mobility as a Service; mobile application; customisation; semi-personalisation; correlation analysis.

1. INTRODUCTION

The definition of a smart city is based on a digitalised liveable environment. It provides cyber-physical systems and subsystems. These systems and sub-systems are available to be interconnected and interacted with each other, via physical connection and virtual information flow [1]. Smart mobility or transportation is considered as a subsystem, and it also has the property of a cyber-physical system [2]. Mobility as a Service (MaaS) is one of the representatives of digitalised mobility service provided by the smart mobility system. Its aim is to "deliver" the integrated service via a single platform.

The use of smartphones has changed people's lifestyle a lot, e.g. mobile payment, online social life, fragmented reading. Various aspects of daily life have been influenced by or depended on smartphones, as well as affecting mobility and travel behaviour [3]. Travellers interact with connected environment via smartphones. Thus, travellers not only participate in the physical movement of vehicles, but they are also involved actively in information flow exchange via mobile applications (MA), e.g. online announcement of service request, real-time network condition sharing. Citizens can be regarded as "sensors" because of their smartphone use.

MaaS is promoted as a MA-based and new integrated mobility service [4]. The development of interface functions is a challenging issue, not only for software developers, but for mobility service researchers as well. Smartphone MAs are expected to serve as major intelligent travel assistants, especially considering the future autonomous vehicle-based mobility services [5]. Mobile phone data have been used and analysed extensively in recent research papers [6].

MaaS is also considered to decrease private car use. How could private vehicles be replaced? Customisation and personalisation of provided services are the key: to provide the mobility service for users that is equally convenient and cheap as using their own cars. Considering service management processes, only smartphone MAs can provide such quick real-time information exchange and interaction opportunities.

Customisation and personalisation of services are discussed in customer relationship management focusing on big data [7]. These two terms are presented as the information customisation and personalisation [8]. However, the exact definitions of customisation and personalisation are not presented. The authors of [7] have concluded that big data could facilitate services to be more customised and personalised, but how and from which aspects a service is "customised or personalised" are not defined or summarised. Customisation and personalisation as setting options are discussed in a systematic analysis of MaaS services [9], but the differences between them have not been provided [10]. The results of these two may appear similar: to optimise provided solutions, but different input data require different design purpose of functionalities. In most papers, these two terms are used in a mixed way, but they are different. They do not contradict with each other; they overlap with each other in several aspects. Thus, to define the customisation, semi-personalisation and personalisation, and to identify the correlation intensity between customisation and semi-personalisation in a MaaS MA is the research niche of our paper.

Accordingly, the research questions are as follows:

- What are the aspects to be assessed regarding customisation and semi-personalisation in a MaaS MA?
- How to obtain the correlation coefficient?
- What is the applicability of the method?

To answer the research questions, the remainder of the paper is structured as follows. Literature review is summarised in Section 2. In Section 3, the proposed evaluation aspects and the applied coefficient calculation method are described as the research methodology. In Section 4, the assessment results are presented and discussed. We have accessed 25 MAs according to the introduced method, the coefficients as results are obtained and interpreted. The paper is completed by the concluding remarks including future research directions.

2. LITERATURE REVIEW

The literature is reviewed in the following streams:

- scientific results of MaaS trials focusing on the MAs,
- the MA in a MaaS service,
- applications of the correlation analysis.

MaaS has been implemented since 2015 [11, 12], but it is not enough for a technology-enabled service to assess its impacts. The trial studies of real MaaS implementations are still very limited. Only the Ubigo from Sweden and the MaaS trial in Australia have provided research results that MaaS has the potential to decrease private car use [13, 14]. The change of travel behaviour requires a long time period and a wider user acceptance [15]. The Whim is regarded as a successful MaaS mobile application, but there are no scientific papers about the impact analysis of the Whim smartphone application. MA was not developed in the Ubigo trial, but a modified MA was provided in the Australian trial. The Ubigo is the earliest trial focusing on combination of mobility modes in monthly packages. To a certain extent, the Australian trial is a more complete trial in comparison with the Ubigo. The Smile project from Austria was also based on a MA, but no scientific papers were published about results of the project [16].

The mobile Internet and mobile cloud are the two most significant technologies that facilitate the MA-based mobility services [17]. Travel planning is still one of the important functions in MaaS MAs [18]; however, the notification of service, the information about transfers [19], the travel tracking function etc., which are tightly related with real-time information are to be put in the focus. Especially when the cybersecurity of autonomous vehicle based MaaS services is taken into consideration [20]. The mobility-information system and its interconnected network interact with the MA in travellers' hands, via intensive information flows.

Correlation coefficient is used to describe the statistical characteristics of two random variables. Typically, the scatter diagram is presented first to observe the tendency of data, then the coefficient r is calculated to show the correlation intensity in numerical values. In case of strong linear correlation, mostly the regression model is applied for further demonstration purposes [21]. Correlation analysis has been widely applied in various science and technology-related fields; especially, the regression model is preferred [22, 23]. A literature overview and evaluation has been presented to summarise the correlation between the analytical measurement and the operability in real world regarding winter qualities of diesel. The conclusion of this descriptive study is that the correlation between theoretical and practical values is getting weaker [24]. The correlation coefficients are also used in one fuzzy set study to measure the similarity instead of distance functions [25]. In order to find a substitution parameter to represent the transportation economy, the coefficients between several parameters are calculated and presented in scatter diagrams [26]. The authors of [26] found that the introduced parameter "the order of the settlement" represents the correlation between public transportation lines and transportation economy better, within their research limitations.

MaaS is still in fast development stage. Increasing attention has been paid to the MAs. As customisation and personalisation are used in publications in a mixed way, we defined these two terms and quantified their relations.

3. METHODOLOGY

The correlation analysis in this work is not limited to statistical analysis, as the "customisation" and "semi-personalisation" cannot be regarded as strict random variables. Similar to [27], correlation exists between "land use" and "urban public transport"; the relation between these two terms is analysed. We quantified the correlation intensity between customisation and semi-personalisation as two variables, regarding same evaluation aspects of the MA.

Steps of the method are summarised in *Figure 1*.

Accordingly, evaluation aspects and scoring scales are determined. Then, scores regarding the selected MAs are obtained as input data set to calculate coefficient. Then, the results are visualised in the chord diagram. Finally, the results are explained. The core of the method is to use numerical values to "describe" the qualitative aspects, in order to use values to indicate the correlation intensity. The following definitions are identified first.

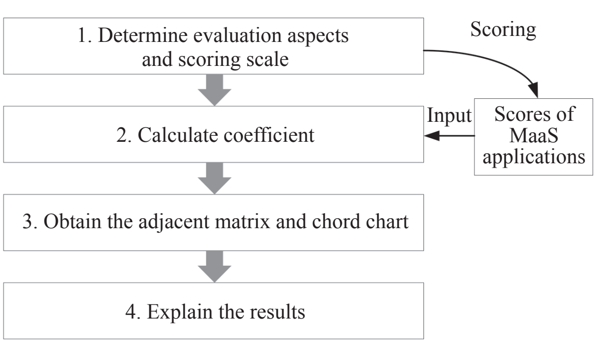

Figure 1 – Steps of the method

The common objective of customisation, semi-personalisation and personalisation in mobile applications is to provide additional input data to functions considering traveller's expectations and/or behaviour. Travellers provide filter conditions to help the system to "narrow" the range of provided solutions. Accordingly,

- *Customisation* is achieved by manual selection from lists of options according to travellers' preferences. The traveller provides data.
- *Personalisation* is achieved automatically by system cognitive capability and advanced data processes, by using passively collected, historical personal travel related data.
- *Semi-personalisation* is achieved by less manual input and more automatic, simple data processes, by using historical data from other database if needed (e.g. the crowdsourced travellers: Waze application). No passively collected personal travel related data are used at the current stage.

To our knowledge, a fully personalised mobility MA does not exist yet. Related to personalisation, data privacy is one significant concern. Another drawback is that the volume of individual mobility related data is already quite large, but the optimisation ability of a MA is still rather limited. Thus, the correlation between customisation and semi-personalisation is analysed in our work.

The Person coefficient and Spearman rank coefficient are both widely used in correlation analysis. Instead of the exact values or sample data, the ranks of sample data are applied in the Spearman method. The base formula is the same as in [28] and presented in *Equation 1*.

$$r_{XY} = \frac{cov(X,Y)}{\sigma_X \cdot \sigma_Y} \tag{1}$$

Regarding the sample data, the equation is expressed in *Equations 2 and 3*. The upper "-" stands for the average values.

$$r_{XY} = \frac{Cov(X,Y)}{\sqrt{Var(X) \cdot Var(Y)}} = \frac{\dfrac{\sum_{i=1}^{n}(X_i - \bar{X}) \cdot (Y_i - \bar{Y})}{n-1}}{\sqrt{\dfrac{\sum (X_i - \bar{X})^2}{n-1}} \cdot \sqrt{\dfrac{\sum (Y_i - \bar{Y})^2}{n-1}}} \tag{2}$$

$$r_{XY}=\frac{\sum_{i=1}^{n}(X_i-\bar{X})\cdot(Y_i-\bar{Y})}{\sqrt{\sum(X_i-\bar{X})^2}\cdot\sqrt{\sum(Y_i-\bar{Y})^2}} \tag{3}$$

From the statistics point of view, the coefficient r reflects the differences between sample data and average values. The *Equation 3* is applied in further calculation. Considering the main functions such as route planning, booking, ticketing and payment, i.e. functions I-VII, the assessment aspects of a MA regarding customisation (X) and semi-personalisation (Y) are summarised in *Table 1* as Step 1.

The scoring method is objective: except additional scale "0.5" is applied for aspects A9-A14 and A17, other aspects A*i* are scaled "1" for each when checking the availability of functions in a specific MA (Step 1).

Then, the selected applications are evaluated to obtain input data. The scores are presented in the scatter diagram first and then, the coefficients are calculated if the correlation exists (Step 2). The adjacent matrix R is obtained, and the chord diagram is presented to visualise values of R (Step 3). Finally, the results are explained (Step 4).

$$R=\begin{bmatrix} r_1 & 0 & 0 & \cdots & 0 \\ 0 & r_2 & 0 & \cdots & 0 \\ 0 & 0 & r_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & r_{25} \end{bmatrix} \tag{4}$$

We introduce *Figure 2* to support the distinction of three terms in using a MA. Regarding the input and processing, each aspect (A*i*) has three situations:

Table 1 – Aspects

Aspects (A*i*)		Customisation (X)	Semi-personalisation (Y)
I. Base			
A1	Service usage area	Manual selection	Automatic detection based on GPS location
A2	Message notification	Manual selection	Automatic message sending, e.g. delay, alters.
II. Route Planning			
A3	Favourite location saving	Manual selection	Frequently used ones are automatically saved
A4	Preferred mode choice	Selectable. e.g. bus, tram	Providing multimodal route planning options
A5	Preferred route choice	Selectable. e.g. best/fast/without transfer	Optimal one based on current network condition
A6	Mobility-impaired information	Manual selection	Providing wheelchair or relevant information
A7	Preferred walking speed	Setting is available	Applying average speed of travellers
A8	Preferred waiting time	Setting is available	Applying average acceptance time window
III. Booking Availability			
A9	Public transport service	Separate booking is available in the same app (1); separate booking turns to specific app (0.5)	Needed modes in a travel chain are booked by one button push
A10	Taxi		
A11	Car-sharing/rental		
A12	Bike-sharing		
A13	Scooter-sharing		
A14	Ride-sourcing		
IV. Ticketing			
A15	Electronic ticket	Separate tickets for different modes	One ticket is available for a travel chain, e.g. QR code
A16	Monthly package	Selectable	Discussion with operator, tailored package is available based on individual real needs.
V. Payment			
A17	Pay per trip in a travel chain	In the same application (1); not the same (0.5)	Credit card automatic payment
A18	Monthly subscription	Pay per month manually	
VI. Feedback			
A19	Feedback opportunity	Manual selection and input	Automatic question before each payment
A20	Statistics report	Manual selection to display	Automatic relevant reports sending (e.g. weekly/monthly mobility data, CO_2 footprints)
VII. Added value			
A21	Navigation opportunity	Selectable for different modes	Automatic update according to involved modes in a travel chain (e.g. finding booked vehicles)
A22	Incentive mechanism	Manual adding and management	Automatic mechanism. e.g. Bonus: green modes use, walking more.

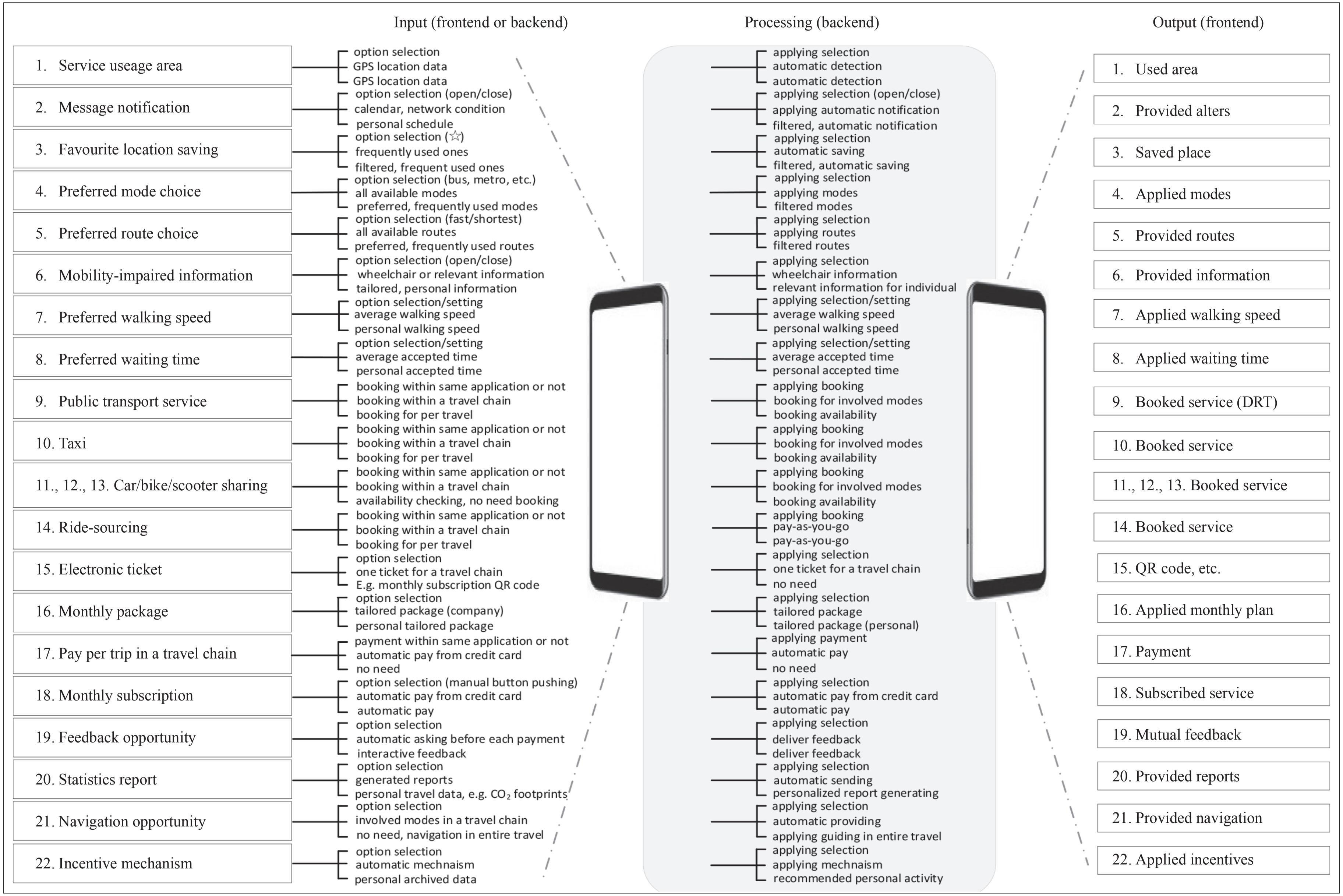

Figure 2 – Customisation, semi-personalisation and personalisation aspects in a MA

customisation, semi-personalisation and personalisation. The main differences among these three terms are distinguished regarding the input and processing procedure.

4. RESULT AND DISCUSSION

The applicability of the method is demonstrated in this section. The assessment results of 25 MaaS MAs are summarised and discussed.

4.1 Selected MaaS applications and scoring

The major application developers of selected MaaS MAs are located in Europe (18). Mostly, worldwide operated ones (7) are found in America. The relevant information is summarised in *Table 2*. As the public transportation is the backbone of MaaS, the city which has an integrated public transportation service has a bigger opportunity to launch the MaaS.

The selected MAs had been downloaded from Google Play. They were tested and scored by the authors according to the aspects table (*Table 1*) and scoring method, to obtain the input data of Step 2. Namely, regarding aspect A*i*, for specific MA*j*, the scores of $X_{i,j}$, $Y_{i,j}$ are assigned, respectively. Values are 0, 0.5 or 1. The structure of scoring data set is presented in *Figure 3*.

Scores of the selected MAs regarding customisation X and semi-personalisation Y are presented in *Table 3*.

The scores of X_j and Y_j are calculated as *Equation 5*.

$$X_j = \sum_{i=1}^{22} X_{i,j}, \quad Y_j = \sum_{i=1}^{22} Y_{i,j} \tag{5}$$

Table 2 – Information of selected MAs

j	Name	Main operational area	Website link
1	Combitrip	Netherlands	https://www.combitrip.com/en
2	DiDi	worldwide	https://www.didiglobal.com/
3	Hely	Netherlands	https://hely.com/
4	HVV	Germany	https://www.hvv.de/
5	Jelbi	Germany	https://www.jelbi.de/
6	Kyyti	Finland	https://www.kyyti.com/
7	Leipzig Move	Germany	https://leipzig-move.de/
8	MyCicero	Italy	http://www.mycicero.eu/
9	Mobility Stuttgart	Germany	https://www.s-bahn-stuttgart.de/
10	Mozio	worldwide	https://www.mozio.com/en-us/
11	Moovit	worldwide	https://moovit.com/
12	Mein GVH	Germany	https://www.gvh.de/home/
13	MVG	Germany	https://www.mvg.de/
14	Optymo	France	https://www.optymo.fr/
15	Omio	worldwide	https://www.omio.com/
16	PubliCar	Swiss	https://www.postauto.ch/
17	ReachNow	Germany	https://www.reach-now.com/
18	Transit	worldwide	https://transitapp.com/
19	Trip	worldwide	https://www.trip.com/
20	TripGo	worldwide	https://skedgo.com/tripgo/
21	UbiGo	Sweden	https://www.ubigo.me/en/home
22	Urbi	Europe	https://en.urbi.co/
23	Whim App	Finland	https://whimapp.com/
24	Wegfinder	Austria	https://wegfinder.at/
25	Wien Mobil	Austria	https://www.wienerlinien.at/

MA \ Aspect	A1	A2	...	Ai	...	A22
1	$(X_{1,1}, Y_{1,1})$	$(X_{2,1}, Y_{2,1})$	(…)	$(X_{i,1}, Y_{i,1})$	(…)	$(X_{22,1}, Y_{22,1})$
2	$(X_{1,2}, Y_{1,2})$	$(X_{2,2}, Y_{2,2})$	(…)	$(X_{i,2}, Y_{i,2})$	(…)	$(X_{22,2}, Y_{22,2})$
...	(…)	(…)	(…)	(…)	(…)	(…)
j	$(X_{1,j}, Y_{1,j})$	$(X_{2,j}, Y_{2,j})$	(…)	$(X_{i,j}, Y_{i,j})$	(…)	$(X_{22,j}, Y_{22,j})$
...	(…)	(…)	(…)	(…)	(…)	(…)
25	$(X_{1,25}, Y_{1,25})$	$(X_{2,25}, Y_{2,25})$	(…)	$(X_{i,25}, Y_{i,25})$	(…)	$(X_{22,25}, Y_{22,25})$

Figure 3 – Structure of the scoring table

Table 3 – Obtained scores of the MAs

MA, j	1	2	3	4	5	6	7	8	9	10	11	12	13
X_j	5.5	9	9	11.5	14	17	11	9	11	7	14	9.5	9
Y_j	2	5	1	5	4	10	6	4	5	4	3	3	6
MA, j	14	15	16	17	18	19	20	21	22	23	24	25	
X_j	11	7	10	9.5	8	8	7	6	8	14	14	11.5	
Y_j	2	1	3	5	6	3	4	3	3	8	6	6	

The scores of customisations (X_j) and semi-personalisation (Y_j) of each MA indicated by j as (X_j,Y_j) are presented in the scatter diagram (*Figure 4*). Typically, the scatter diagram is used for data visualisation, to determine whether the correlation exists, and whether the further analysis is needed.

Two dashed lines on the diagram: X=10.02 and Y=4.32 are there to indicate the average value of X_j and Y_j, respectively. The overall tendency shown by the trendline is almost a positive linear correlation, but both the correlation and linear tendency are not strong, as MAs are scattered on both sides of the trendline. According to the diagram, the correlation exists between X and Y. The coefficients r_j between X_j and Y_j can be calculated to continue the analysis, to determine what kind of correlation (positive or negative) exists, and what the intensity of a correlation (strong or weak) is.

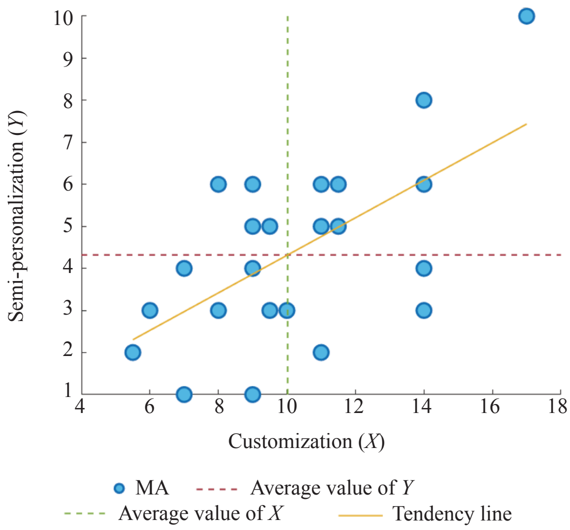

Figure 4 – Scatter diagram

4.2 Correlation coefficient

The correlation coefficient is the ratio of covariance and variance of two variables, which indicates the relative difference compared with the average value. As only the correlation direction is shown in the scatter diagram, the coefficient is a supplement value to show the intensity of the correlation. The calculated coefficients r_j:(X_j,Y_j) regarding each MA according to *Equation 3* are presented in *Table 4*. $\bar{X}_j$ and $\bar{Y}_j$ are calculated using *Equation 6*.

$$\bar{X}_j = \frac{1}{22}\cdot\sum_{i=1}^{22} X_{i,j},\quad \bar{Y}_j = \frac{1}{22}\cdot\sum_{i=1}^{22} Y_{i,j} \tag{6}$$

Step 2: The r_j for each MA j is calculated according to *Equation 7* regarding data in *Table 3*.

$$r_{X_j Y_j} = \frac{\sum_{i=1}^{22}(X_{i,j} - \bar{X}_j)\cdot(Y_{i,j} - \bar{Y}_j)}{\sqrt{\sum_{i=1}^{22}(X_{i,j} - \bar{X}_j)^2 \cdot \sum_{i=1}^{22}(Y_{i,j} - \bar{Y}_j)^2}} \tag{7}$$

Considering the requirement of the software to generate the chord diagram: the name of the row and the column of input matrix should be different. Thus, both in the following matrix and in the chord diagram, the capital letters as A,B,…,Y are used to stand for each MA indicated by 1,2,…,25. A01,B02,…,Y025 symbols are introduced to show the row name of the R, and $A1, B2, \ldots, Y25$ symbols are introduced to show the column name of the R. The obtained adjacent matrix R is as follows:

$$\mathrm{R} = \begin{bmatrix} & A1 & B2 & Ci & \cdots & Y25 \\ A01 & r_1 & & & & \\ B02 & & r_2 & & & \\ C0i & & & r_j & & \\ \cdots & & & & \ddots & \\ Y025 & & & & & r_{25} \end{bmatrix} \tag{8}$$

Step 3: As X_j and Y_j refer to MA j, the coefficients r_j only exist on the diagonal of the R. Accordingly, the obtained chord diagram is presented in *Figure 5*.

Step 4: The absolute values of r_j are used in the chord diagram to show the results of correlation analysis. The correlation intensity is shown by the width of the ribbon. Different colours are applied to distinguish the elements (MAs in this work, MA is also indicated by capital letter), which is the default setting of the software. As the matrix is a diagonal matrix, no crossing ribbon exists. According to the diagram, r_j values of certain MAs are very weak (L, M, U, V: 12 Mein GVH, 13 MVG, 21 Ubigo, 22 Urbi), and some are relatively strong (B, G, Q, R, T, W: 2 DiDi, 7 Leipzig Move, 17 ReachNow, 18 Transit, 20 TripGo, 23 Whim App). The comparison among values or "ribbon width" is not needed, as each r_j value only reflects the correlation between X_j and Y_j of that corresponding MAj. For example, the r_{23} of Whim is -0.411, which indicates that the X_{23} and Y_{23} have negative correlation regarding each $X_{Ai,23}$ and $Y_{Ai,23}$. The tendency is: customisation setting obtains higher scores, semi-personalisation obtains lower ones, and vice versa. The r_{21} value in the case of Ubigo is "0.054", the correlation is slightly positive, which indicates that customisation and semi-personalisation obtain either higher or lower scores at the same time. Regarding aspects Ai, the aggregated scores are presented in *Table 5*.

Table 4 – Values of coefficient r

MA, j	1	2	3	4	5	6	7	8	9	10
r_j	-0.219	-0.451	0.262	-0.359	-0.379	-0.376	-0.408	-0.153	-0.325	-0.281
MA, j	11	12	13	14	15	16	17	18	19	20
r_j	-0.25	-0.085	0.113	-0.316	-0.149	-0.363	-0.484	-0.463	-0.3	0.437
MA, j	21	22	23	24	25					
r_j	0.054	0.028	-0.411	-0.386	0.19					

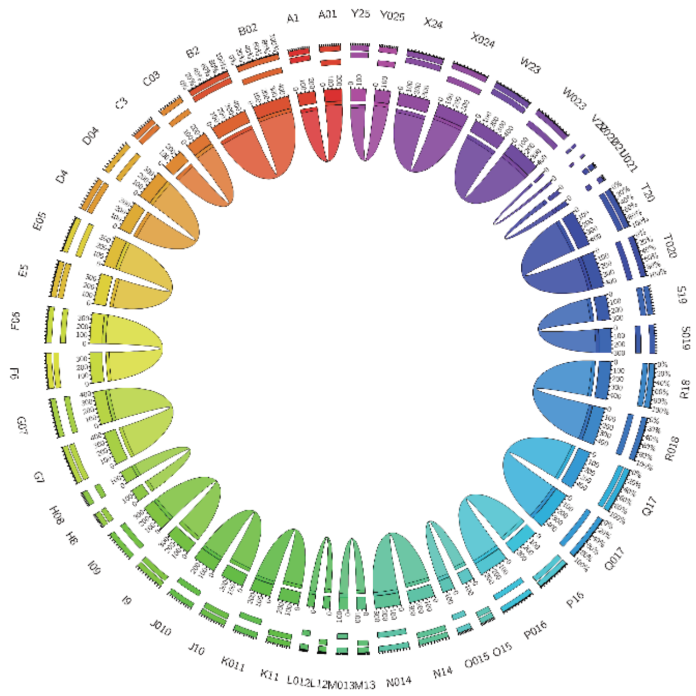

Figure 5 – Chord diagram

Table 5 – Scores of aspects

A*i*	1	2	3	4	5	6	7	8	9	10	11
X_i	13	13	16	18	8	9	5	1	21	11.5	15
Y_i	6	10	2	13	13	5	15	15	1	1	1
A*i*	12	13	14	15	16	17	18	19	20	21	22
X_i	13.5	7.5	4	19	10	19	4	23	2	9	9
Y_i	1	1	0	3	3	0	5	1	0	5	7

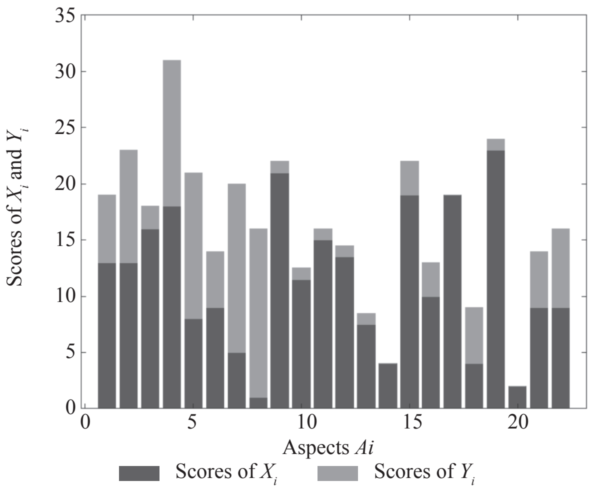

Figure 6 – Comparison scores of X_i and Y_i regarding Ai

The comparison of values is presented in *Figure 6*.

Regarding aspects A*i*, X_i obtains higher scores than Y_i, which indicates that development of customisation settings first is still the current tendency. The values of X_i and Y_i are calculated by using *Equation 9*.

$$X_i = \sum_{j=1}^{25} X_{i,j}, Y_i = \sum_{j=1}^{25} Y_{i,j} \quad (9)$$

The overall result of r is r=0.313 calculated according to *Equation 3*, where $\bar{X}$ and $\bar{Y}$ are calculated by using *Equation 10*.

$$\bar{X} = \frac{1}{22} \cdot \left[\sum_{i=1}^{22} \left(\sum_{j=1}^{25} X_{i,j} \right) \right], \quad \bar{Y} = \frac{1}{22} \cdot \left[\sum_{i=1}^{22} \left(\sum_{j=1}^{25} Y_{i,j} \right) \right] \quad (10)$$

The scores regarding main functions are also summarised in *Table 6*.

Regarding the 25 selected MAs, the scores of semi-personalisation are relatively low compared with those of customisation. It can be stated, that the selected MaaS MAs are customisation setting oriented applications.

Table 6 – Scores of main functions

F	I	II	III	IV	V	VI	VII
X_i	26	57	72.5	29	23	25	18
Y_i	16	63	5	6	5	1	12

4.3 Discussion

The obtained coefficients indicated by r_j are to present the descriptive correlation in numerical values, which is a quantitative method to show the correlation intensity. From the results, all obtained r_j<0.5, which means the correlation between customisation and semi-personalisation is not strong, whether in each MA (r_j) or from an overall (r) point of view. Positive values are obtained in the case of 6 MAs, the others are negative values. The positive correlation indicates that functionalities of customisation settings and semi-personalisation are developed together. The negative correlation indicates that the functionality development is in opposite direction, one of which is developed first. The absolute values show the correlation intensity: strong or weak.

The customisation setting options are well developed among the selected MAs. However, the availability of semi-personalisation is to be improved. In the recent development phase, detailed customisation settings are recommended to collect data, and fewer manual selections from options are expected in the more personalised services.

Compared with the work of other authors [7, 8], we have distinguished customisation and semi-personalisation of MAs in a quantitative way. We have assessed the selected MAs regarding customisation and semi-personalisation. Furthermore, the correlation intensity r has been calculated and interpreted.

5. CONCLUSION

In our research, we addressed the following question: what kind of input activities are needed from travellers to achieve customisation or personalisation. Regarding an entire travel process, the virtual information management together with the vehicle movement is experienced by the traveller as a customised and/or a personalised mobility service.

The main contributions of our work are:

- definitions of customisation and semi-personalisation regarding the MA,

- determined assessment aspects and the objective scoring method,
- correlation between customisation and semi-personalisation is quantitatively analysed.

The key findings regarding the assessed 25 MAs are:
- the values of coefficients are small (r<0.5), the correlation between customisation and semi-personalisation is not strong,
- the selected MAs are customisation setting oriented applications,
- the aspects that obtained lower scores regarding Y semi-personalisation could be further developed in a MA, e.g. feedback interaction, statistics report provision.

The purpose of customisation and personalisation is to provide additional input data either actively or passively and to optimise the information management. The continuous development of functions supported by personalisation is recommended, as the tendency of a MaaS MA is to provide information about personalised services. Fewer manual inputs are expected in the future.

What we found out is that the definitions of terms are changing along with the development. For example, customisation and personalisation are considered in a different way in a traditional mobility service and in a digitalised service.

The further research direction is to introduce a mobile application concept for the MaaS service based on autonomous vehicles. The results obtained in this work support interface function analysis of MAs. Both backend functions and frontend interface functions will be analysed, the information flows regarding travel phases will be presented. In addition, the input data which connect frontend and backend functions will be summarised. The differences between MaaS and MaaS based on autonomous vehicles will be summarised from the information system point of view, focusing on MAs.

ACKNOWLEDGEMENT

This work was supported by EFOP-3.6.3-VEKOP-16-2017-00001: Talent management in autonomous vehicle control technologies. The Project is supported by the Hungarian Government and co-financed by the European Social Fund. The research was also supported by the Ministry of Innovation and Technology NRDI Office within the framework of the Autonomous Systems National Laboratory Program. At the 19th European Transport Congress "European Green Deal Challenges and Solutions for Mobility and Logistics in Cities" held in Maribor, October 2021, by the European Platform for Transport Sciences (EPTS), the scientific chair chose the best-presented papers for publishing in extended form in the journal Promet – Traffic&Transportation.

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出行即服务*(MAAS)*中对定制化和半个性化的相关分析方法

摘要：

“出行即服务”*(MaaS)*是作为一种以用户为中心、数据驱动和个性化的服务而提出的。然而，完全的个性化还未能实现。在移动应用程序中已经开发了很多关于自定义设置的功能选项，也引入了多种半个性化功能。定量分析两者之间的关系，可为今后移动应用界面功能的发展趋势提供参考。因此，本文的研究目标被确定为:半个性化功能与定制设置之间的定量相关分析。据此，采用多准则定性分析方法确定移动应用的评价方面。并介绍了评分方法。然后运用相关定量分析方法计算相关系数。我们根据提出的评价方面评估了*25*个*MaaS*移动应用。计算了各应用的相关系数和总体系数，总结了评价结果，并对相关趋势进行了解释。从评估结果来看，现阶段定制设置与半个性化之间的相关性不强。所选的*MaaS*移动应用是面向自定义设置的应用。在进一步以个性化为导向的服务中，手动选择和输入有望减少。我们的研究结果旨在促进*MaaS*移动应用程序中进一步个性化功能的开发。

关键词

出行即服务（*MaaS*）；移动应用；定制化；
半个性化；相关分析

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