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
widespread 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 a late coefficient. Then, the results are visualised in the chord chart. 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.

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.

\[
r_{\text{XY}} = \frac{\text{Cov}(X,Y)}{\sigma_X \sigma_Y}
\]

Regarding the sample data, the equation is expressed in Equations 2 and 3. The upper “\(^{-}\)” stands for the average values.

\[
r_{\text{XY}} = \frac{\text{Cov}(X,Y)}{\sqrt{\text{Var}(X) \text{Var}(Y)}} = \sqrt{\frac{n \sum (X_i \cdot Y_i) - (\sum X_i \cdot \sum Y_i)}{n(n-1) \left[ \sum (X_i - \bar{X})^2 \right] 
\left[ \sum (Y_i - \bar{Y})^2 \right]}}
\]

1. Determine evaluation aspects and scoring scale
2. Calculate coefficient
3. Obtain the adjacent matrix and chord chart
4. Explain the results

**Figure 1 – Steps of the method**
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).

Table 1 – Aspects

<table>
<thead>
<tr>
<th>Aspects (( A_i ))</th>
<th>Customisation (( X ))</th>
<th>Semi-personalisation (( Y ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>Service usage area</td>
<td>Manual selection</td>
</tr>
<tr>
<td>A2</td>
<td>Message notification</td>
<td>Manual selection</td>
</tr>
<tr>
<td>II. Route Planning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Favourite location saving</td>
<td>Manual selection</td>
</tr>
<tr>
<td>A4</td>
<td>Preferred mode choice</td>
<td>Selectable, e.g. bus, tram</td>
</tr>
<tr>
<td>A5</td>
<td>Preferred route choice</td>
<td>Selectable, e.g. best/fast/without transfer</td>
</tr>
<tr>
<td>A6</td>
<td>Mobility-impaired information</td>
<td>Manual selection</td>
</tr>
<tr>
<td>A7</td>
<td>Preferred walking speed</td>
<td>Setting is available</td>
</tr>
<tr>
<td>A8</td>
<td>Preferred waiting time</td>
<td>Setting is available</td>
</tr>
<tr>
<td>III. Booking Availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9</td>
<td>Public transport service</td>
<td>Separate booking is available in the same app (1); separate booking turns to specific app (0.5)</td>
</tr>
<tr>
<td>A10</td>
<td>Taxi</td>
<td></td>
</tr>
<tr>
<td>A11</td>
<td>Car-sharing/rental</td>
<td>Separate booking is available in the same app (1); separate booking turns to specific app (0.5)</td>
</tr>
<tr>
<td>A12</td>
<td>Bike-sharing</td>
<td></td>
</tr>
<tr>
<td>A13</td>
<td>Scooter-sharing</td>
<td></td>
</tr>
<tr>
<td>A14</td>
<td>Ride-sourcing</td>
<td></td>
</tr>
<tr>
<td>IV. Ticketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A15</td>
<td>Electronic ticket</td>
<td>Separate tickets for different modes</td>
</tr>
<tr>
<td>A16</td>
<td>Monthly package</td>
<td>Selectable</td>
</tr>
<tr>
<td>V. Payment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A17</td>
<td>Pay per trip in a travel chain</td>
<td>In the same application (1); not the same (0.5)</td>
</tr>
<tr>
<td>A18</td>
<td>Monthly subscription</td>
<td>Pay per month manually</td>
</tr>
<tr>
<td>VI. Feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A19</td>
<td>Feedback opportunity</td>
<td>Manual selection and input</td>
</tr>
<tr>
<td>A20</td>
<td>Statistics report</td>
<td>Manual selection to display</td>
</tr>
<tr>
<td>VII. Added value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A21</td>
<td>Navigation opportunity</td>
<td>Selectable for different modes</td>
</tr>
<tr>
<td>A22</td>
<td>Incentive mechanism</td>
<td>Manual adding and management</td>
</tr>
</tbody>
</table>
He Y, Csiszár C. Correlation Analysis Method of Customisation and Semi-Personalisation in Mobility as a Service

Promet – Traffic&Transportation, Vol. 34, 2022, No. 5, 767-777

Input (frontend or backend)

1. Service usage area
2. Message notification
3. Favourite location saving
4. Preferred mode choice
5. Preferred route choice
6. Mobility-impaired information
7. Preferred walking speed
8. Preferred waiting time
9. Public transport service
10. Taxi
11, 12, 13. Car/bike/scooter sharing
14. Ride-sourcing
15. Electronic ticket
16. Monthly package
17. Pay per trip in a travel chain
18. Monthly subscription
19. Feedback opportunity
20. Statistics report
21. Navigation opportunity
22. Incentive mechanism

Processing (backend)

1. Used area
2. Provided alters
3. Saved place
4. Applied modes
5. Provided routes
6. Provided information
7. Applied walking speed
8. Applied waiting time
9. Booked service (DRT)
10. Booked service
11, 12, 13. Booked service
14. Booked service
15. QR code, etc.
16. Applied monthly plan
17. Payment
18. Subscribed service
19. Mutual feedback
20. Provided reports
21. Provided navigation
22. Applied incentives

Output (frontend)

Used area
Provided alters
Saved place
Applied modes
Provided routes
Provided information
Applied walking speed
Applied waiting time
Booked service (DRT)
Booked service
Booked service
QR code, etc.
Applied monthly plan
Payment
Subscribed service
Mutual feedback
Provided reports
Provided navigation
Applied incentives

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 $M_A_j$, 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.

$$X_j = \sum_{i=1}^{n} X_{i,j}, \quad Y_j = \sum_{i=1}^{m} Y_{i,j}$$

Table 2 – Information of selected MAs

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

### 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. $X_j$ and $Y_j$ are calculated using Equation 6.

$$X_j = \frac{1}{n} \sum_{i=1}^{n} X_{ij}, \quad Y_j = \frac{1}{n} \sum_{i=1}^{n} Y_{ij}$$

(6)

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

$$r_{X_jY_j} = \frac{\sum_{i=1}^{n} (X_{ij} - \bar{X}_j)(Y_{ij} - \bar{Y}_j)}{\sqrt{\sum_{i=1}^{n} (X_{ij} - \bar{X}_j)^2 \sum_{i=1}^{n} (Y_{ij} - \bar{Y}_j)^2}}$$

(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,…,Y25 symbols are introduced to show the column name of the R. The obtained adjacent matrix R is as follows:

\[
R = \begin{bmatrix}
A1 & B2 & C1 & \cdots & Y25 \\
A01 & r_1 & & & \\
B02 & r_2 & & & \\
C0i & r_j & & & \\
\cdots & \cdots & \cdots & \cdots & \cdots \\
Y025 & & & & r_{25}
\end{bmatrix}
\]  

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

Table 4 – Values of coefficient \(r\)

Figure 5 – Chord diagram
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.

REFERENCES


