# Applying the AHP to Smart Mobility Services: A Case Study

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Abstract: Making decision is a far from straightforward process, as it often requires to consider a number of complex criteria whose importance relies on the experiences and the preferences of the decision makers involved. Being able to structure and reproduce this knowledge is a challenging issue in the context of strategic decision making, and also common BI analytics can benefit from the joint use of that knowledge. As a contribution, in this work we describe how a multi criteria decision making technique, i.e., the Analytic Hierarchy Process, has been applied to a smart-mobility context, where the decision goal was to weight the factors that support the innovation of a smart mobility service in the city of Milan. The AHP has been selected as it allows considering both tangible and intangible factors that guide the decision within the model. We employed three distinct kind of stakeholders, namely *service providers*, *over 35*, and *under 35* users and we synthesised a ranking of criteria on the basis of the preferences they provided. The results shed the light on the different judgments that each group gives to the identified criteria in terms of both ranking and importance.

## 1 INTRODUCTION

Making decisions is part of everyday life, and this process always involve a number of subtended and implicit criteria that one draws on the past experience. To give an example, buying a smartphone is a decision process that takes into account several criteria, some tangible like *cost*, *performances*, *battery life*, and some factors that are intangible, such as *having a comfortable grip*, *the style*, and the *past experience with the vendor*, too. All these factors affect our final decision in a way that is hard to be reproduced or explained.

In such a scenario, the basic idea of Multi Criteria Decision making (MCDM) is to provide a set of methods that allows decision makers to *structure* and to *weight* the criteria that guide their decision. This activity has proved to be beneficial in a large number of real-life domains (Wu and Lee, 2007; Madas and Zografos, 2008; Bello-Dambatta et al., 2009; Abdi and Labib, 2003), as it enables the formalisation of the decision process, making possible to iterate and to validate it (e.g., to validate whether the judgments on the criteria are sound or not) and to make evidence of the decision process to the decision makers involved. When prior experience is missing on formalising and understanding complex decision making processes involving several actors, a systematic and comprehensive approach as MCDM is very useful. Being able to explain, formally motivate, and share the reasons behind decision making is far from negligible, as it helps obtaining a more reliable and shared decision process.

On the other side, the smart-city context is growing in importance in both academic and industrial communities, as it aims at improving the sustainability and the quality of citizens' life (see, e.g., (Nam and Pardo, 2011)). A report of the European Commission has recently listed the (most) important elements (aka *dimensions*) that compose the smart-city ecosystem (Manville et al., 2014), namely: *environment*, *people*, *economy*, *government*, *living*, and *mobility*. In the EU vision, the glue of all these dimensions are *Human*, *technological*, and *institutional* factors that allow the smart-city ecosystem working.

### 1.1 Motivation and Contribution

In this paper we report our experience in applying the Analytic Hierarchy Process (AHP) method (Saaty, 1988; Saaty, 1990) to a smart-mobility decision making process. Our aim here is to extract and structure knowledge about the decision making processes of the several mobility service stakeholders (i.e., final users and service provides).

In the context of strategic decision making, the use


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of AHP would represent an added value for classical Business Intelligence and Analytics applications, as it sheds the light on the *dynamics* that form the decision making process (i.e., the *criteria* and their relative importance for decisor makers). This result is quite important as in many real-life domains indicators and analytics are not sufficient to exhaustively explain the phenomena under study. To give an example, a variant of AHP (i.e., ANP[1]) has been applied for selecting knowledge management strategies of a company whose administrators were unable to decide *how* to invest the year-profits, even though a lot of indicators and forecasting analyses were available, due to the personal preferences and beliefs of each on how to invest profits. Here the ANP was helpful to guide them in understanding and highlighting the dynamics of the decisions, first by selecting criteria, then by evaluating each criterion and finally by summarising a common decision (see, e.g.(Wu and Lee, 2007)).

In this paper the AHP has been applied to three distinct groups of stakeholders, namely *service providers*, *over 35*, and *under 35* users for obtaining the weighted criteria that would rank the enabling factors for innovating a smart-mobility service in Milan. To this end, we have built an AHP model on the basis of the service innovation enabling factors emerged at the CityTech meeting.[2] Then, we employed a number of stakeholders for weighting these criteria. The main outcome of this work is a weighted hierarchy of criteria that hold all the knowledge about this group of stakeholders - in a formal, deterministic and replicable way - regardless of the employed mobility solutions. Then, a domain analyst may exploit the weighted hierarchy of criteria to draw up a rank of the best mobility solutions in Milan, according to stakeholders weighted criteria.

The paper is arranged as follows. In Sec. 2 we briefly introduce some backgrounds on AHP technique and its strong/weak points with respect to our purposes. In Sec. 3 we describe the AHP model built in terms of criteria and sub-criteria while in Sec. 4 we show the results obtained. Finally, the conclusions are outlined in Sec. 5

[1]the Analytic Network Process differs from AHP as (1) the model is arranged as a network rather than a tree, thus (2) it allows expressing dependences between criteria and sub-criteria whilst independence amongst criteria is required in the AHP model

[2]An international forum held in Milan, October 27th, 2014, see http://www.citytech.eu/

## 2 BACKGROUNDS ON AHP

Roughly speaking, Multi Criteria Decision Making (MCDM) refers to a set of methods that allows constructing a global preference relation for a set of alternatives to be evaluated by using several criteria. A literature review on MCDM falls out the scope of this paper, the reader can refer to (Figueira et al., 2005a) for a survey.

The MDCM approaches are able to deal with dependence amongst criteria (ANP, see e.g., (Saaty, 2004)), conflicting criteria (ELECTRE, see e.g., (Figueira et al., 2005b)), to synthesise compromise solutions (TOPSIS, see e.g., (Yoon and Hwang, 1995; Tadić et al., 2014)), as well as to deal with uncertainty over the judgments (Fuzzy sets theory applied to the previous methods, see, e.g., (Chen et al., 1992)). Even though the AHP is one of the most widely MCDM method used in the literature, we employed it as it is particularly useful for evaluating complex multi-attribute alternatives involving subjective criteria to capture stakeholders' knowledge of phenomena under study. Basically, AHP consists of the following main steps.

**Build up the Criteria/Alternatives Tree.** In this step the analyst identifies the criteria that compose the decision problem and structure them in a hierarchical fashion, so that a criterion may have sub-criteria, and so on. The leafs of this tree are the alternatives that the decision process aims at selecting.

**Pairwise Comparison.** In this step the stakeholders are required to perform a pairwise comparison of each criterion at each level of the hierarchy, and the results are collected in a matrix summarizing the local priorities for each domain-expert. The main intuition here is that it is easier (and more accurate) to compare the importance of two criteria at a time than simultaneously evaluating all of them. AHP uses the Saaty's 1 to 9 scale to perform the pairwise comparison, the scale ranges from *equal important* (1) to *extreme important* (9) and allows expressing the intensity of importance of a criterion over another. It is worth noting two relevant characteristics of AHP. First, the same preference scale is used to perform the evaluation of both (quantitative and qualitative) criteria and alternatives. Second, the expert does not provide any numerical absolute judgement; instead a comparative evaluation is used, which is more familiar to people.

Comparisons are recorded in a positive reciprocal matrix, in which $a_{ij}$ represents the comparison between element $i$ and $j$.

$$P = \begin{pmatrix} 1 & a_{1,2} & \cdots & a_{1,n} \\ a_{ji} = 1/a_{ij} & 1 & \cdots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n,1} & a_{n,2} & \cdots & 1 \end{pmatrix}$$

The rationale of the relationship $a_{ji} = 1/a_{ij}$ is that if A is 4 times more important than B, then B is $1/4$ important with respect to A. Thus, if the matrix is perfectly consistent, the transitivity rule is satisfied for all the comparisons, namely $a_{ij} = a_{ik} \cdot a_{kj}$. Intuitively, it is expected that if A is *moderate important* (3) than B, and *B* is *weak important* (2) than C, thus a consistent judgment would have that A is $3 \cdot 2 = 6$ *strong important* than C. One should observe that the inconsistencies are natural in human judgments, for this reason AHP supports the computing of the consistency ratio (see (Saaty, 1977; Ishizaka and Labib, 2009) for more details). It was proved that inconsistencies in answers can be tolerated if the consistency ratio remains within a small interval, that is 10%, see (Saaty, 1977; Ishizaka and Labib, 2009).

**Synthesise Global Priorities.** The last step requires to synthesise the global priorities (i.e. the priority vector) from the pairwise comparisons to determine the ranking of alternatives, taking into account the stakeholders judgments as a whole. Mathematically speaking, the priority vector is the solution of an Eigenvalue problem over the matrix previously introduced. The results of the pairwise comparisons are arranged in a matrix. The first (dominant) normalised right Eigenvector of the matrix gives the ratio scale (weighting) while the Eigenvalue determines the consistency ratio.

### 2.1 AHP - Strong and Weak Points in our Scenario

Here we report some strong points of AHP that make it the best choice for our purposes.

First, it is flexible, intuitive and it derives ratio scales from paired comparisons of criteria, thus allowing small inconsistencies in judgments, as we specified above.

Second, since the problem is arranged into a hierarchical structure, the importance of each element becomes clear to whom will make the judgment, and this facilitates the pairwise evaluation of criteria bearing in mind different decision goal contexts.

Third, it has been implemented into an on-line and free platform[3] as a supporting tool for decision making processes. There are however some critical points that one should address while using AHP. First, while on the one side AHP allows combining group judgments for obtaining a global one, on the other side the use of aggregation function to combine a high number of group judgments makes possible to lose some relevant information. To stem this effect, we identified three groups of stakeholders on the basis of their characteristics, namely *Service-Providers*, *users* and *young users*. This would allow us having a fine-grained analysis of the weighted criteria of each group, as it will be clarified later. Furthermore, another weak point of AHP relies on the number of pairwise comparisons that grows exponentially in the number of criteria to be evaluated. To avoid this, the number of criteria have been carefully selected and limited to 8 to prevent the stakeholders being overloaded of questions.

[3]http://www.bpmsg.com/academic

## 3 AHP FOR INNOVATING A SMART-MOBILITY SERVICE

Figure 1 shows the AHP model we have built.

The criterion *Accessibility and Usability* focuses on the (main) features that a smart transportation service should provide to *users*. Thus, all its sub-criteria have to be read by looking at a user-perspective, that is: *"A user should be able to perform:"*

**Online Registration.** Service/platform registration doesn't require going to a specific physical location. Notice that this feature is far from trivial, as some services require to meet the user, to check her/his driving licence, and to get a driving licence photo-copy.

**Presence of Smart-card.** The service-smart card is used to access the service (e.g., car-sharing services often uses smart-cards to recognise the user, underground pass-card, etc).

**E-ticket.** Electronic tickets (e.g., mail, QR-code, loading money to a card) can be used instead of printed ones. This sub-criterion differs from the previous one since in some cases a user may use the smart-card but may not remotely load money on it (e.g., access to physical totems is sometimes required).

**Onboard Travel Planner.** It refers to the ability to plan the route from my actual position to the desired one, and this includes the proposition of several routes to the user on the basis of both congestion and user-preferences (e.g., minimise plan time, number of transfers, walking meters, etc.)

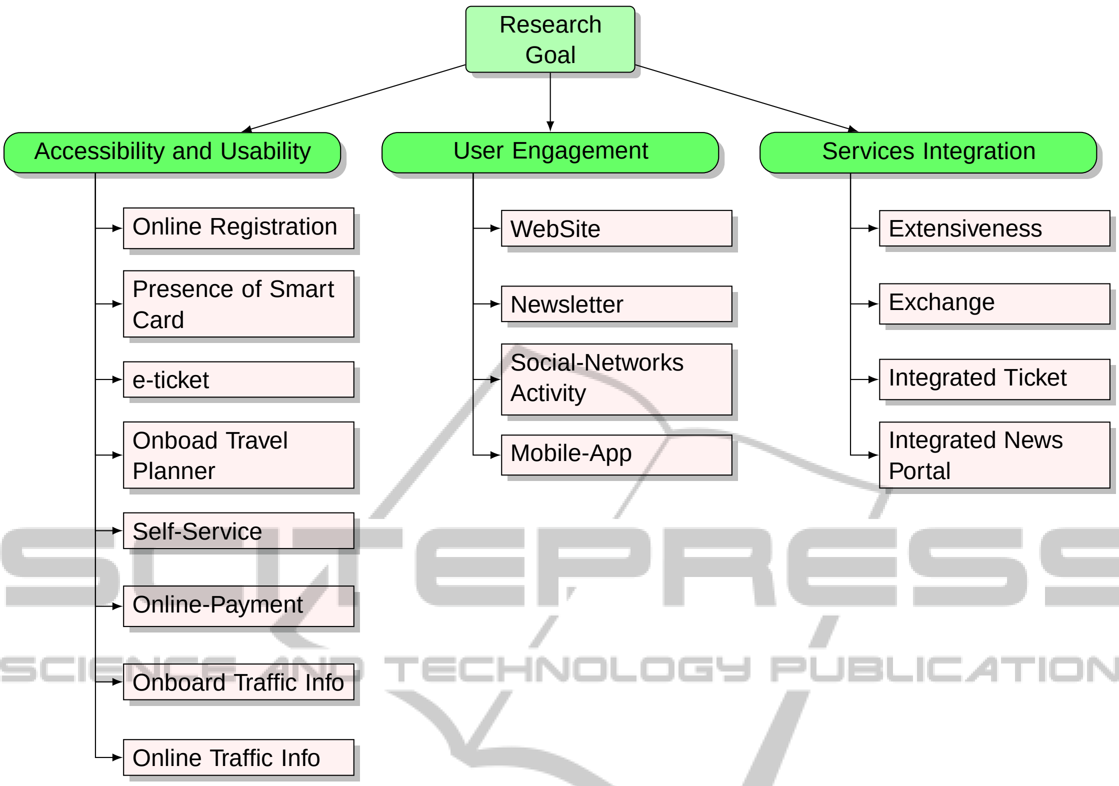





Figure 1: The AHP model. Notice that the node *Research Goal* refers to *"which are the enabling factors for innovating a smart-mobility service?"*

**Self-Service.** Tickets can be autonomously purchased, without any human intervention, independently of the modality through which the purchase is realised (e.g., through totems, website, Mobile-App, etc.).

**Online Payment.** Deal with all the payment issues through an online service. This includes recharging prepaid cards with money, to access the transactions history, to download invoices, and to add/remove credit-cards, too.

**Onboard/Station Traffic Info.** Service traffic and network congestion information are provided through physical devices, using e.g., screen within the bus/train/car or informative totems placed in the stations.

**Online Traffic Info.** Access to all service traffic and network congestion information is provided through Internet based services, namely Social-Network, Websites, Mobile-Apps, etc.

The *"user engagement"* criterion would identify all the main channels that allows to engage the user. For the sake of clarity we would clarify the meaning of this term, as it is nowadays abused and it may be misleading. Here the term engagement includes all the instruments, services and tools that allows obtaining "a desirable - even essential - human response to computer-mediated activities" (Laurel, 2013). In this direction, we identified the following features that an innovative smart-mobility service should have to engage users: *Web Site*, *Newsletter*, intensive *Social-Networks Activities*, and a *Mobile-App*. As the meaning of these services are very common concepts, we omit to specify each of them.

Finally, the *Services Integration* criterion has been identified as it is strongly related to the concept of *intermodality*, that refers to the joint use of several (and different) transportation services. Being able to realise such a service actually represents a challenge in the context of smart mobility where several operators are involved. Within this criterion, we can distinguish between the following sub-criteria.

**Extensiveness.** Here intended as the ability to cover the whole city territory, Milan in such case. Notice that this information is intentionally qualitative rather than quantitative (i.e., no extension measures or granularity information has been provided) to capture the expert's opinion about the importance of a *full* coverage when providing a city smart-mobility service, in spite of its granularity.

**Exchange Between Services.** To establish a *geographical* coordination among the mobility services provided in the area, so that users can switch between services easily and quickly.

**Integrated Ticket.** Being able to use the *travel ticket* across several transportation services. This characteristic becomes quite important in case of public and private services integration. To give an example, having one travel ticket that gives access to all public transportation services (e.g., subway, buses, trams, trains) and private ones (e.g., bikes, car sharing) would really contribute in improving and increasing the usage of smart-mobility services within the City.

**Integrated News Portal.** Having a unified web-portal that provides all the information about the city transportation services is probably the most (challenging) issue to be dealt. Clearly, this portal would be easy to be realised by public operators as they can straightforward include traffic news on trains, subways, trains, buses etc. Conversely, this is hard to be done by private operators, that should exchange their information about cars and bikes positioning as well as vehicles reservation. Finally, merging both public and private operators into one informative service could be a really challenging task as because a permanent information exchange process should be established among operators that might be competitors (e.g., the operators may lose users accesses to their own platforms in favor of the integrated portal).

# 4 RESULT COMMENTS

Once the hierarchical model of criteria and sub-criteria has been built, we can proceed through the pairwise comparisons of each criteria and sub-criteria as described in Sec. 2. To this end, we recruited three distinct groups of mobility stakeholders, namely *Service-Providers*[4] and users. The latter has been split into two subgroups: *under 35 years-old* and *over 35 years-old*. We compared the priorities synthesised by the AHP process through the pairwise comparisons for each sub-criterion of Fig. 1. The results of each service-provide judgments are shown in Tab. 2. The results have been arranged into a series of radar plots where the following can be observed:

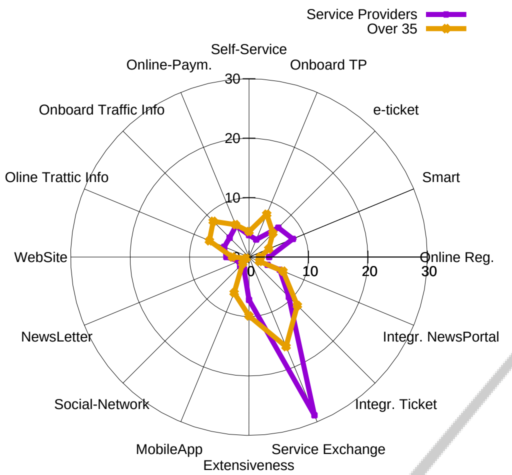
[4]This group is composed by stakeholders of mobility services in Milan, that includes a subsidiary company, a public agency, a private operator, and the Municipality of Milan

**Service-providers vs Over 35.** Figure 2(a) shows the results for these two groups of stakeholders showing that both *Service Providers* and *Over 35* users agree in considering the *Services Exchange* as the most important factor for innovating a smart-mobility service, but the relative weights are quite different (i.e., 30% and 16% respectively). The shapes depicted in Fig. 2(a) overlap for the great part, and this reveals these two groups of stakeholders weight in a similar way all these sub-criteria.

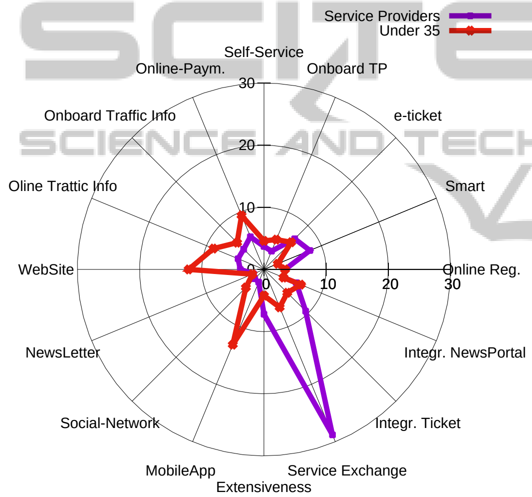
**Service-providers vs Under 35.** The Figure 2(b) shows that the *Under 35* users give to Services Exchange less importance than MobileApp, WebSite and Online Payment that represent the sub-criteria of the *User-engagement* and *Accessibility and Usability*. Here a gap - in terms of point of views - emerges between these two targets of stakeholders: while on one side *Service Providers* and *Over 35* users rank sub-criteria similarly although with different weights, on the other side the rank of criteria provided by *Under 35* group diverges significantly. This result could be explained by the age gap: considering the raw judgments shown in Tab. 2, the service providers group is mostly composed by people older than 35 years (namely, SC, A, and M in Tab. 2). Only the Private service provider (P) is younger than 35 years, and its ranked sub-criteria are quite similar to the ones belonging to the *Under 35* cluster. This dynamic is highlighted by the radar plot in Figure 2(c), where only the sub-criteria weighted priorities of *Under 35* and *Over 35* users are provided.

**Weighted Criteria.** In Fig.3 we show a radar plot of the weighted criteria for each group. Still in this figure the age gap among groups can be used to explain the different point of views on the importance given to the enabling factors for innovating smart-mobility services. Indeed, both service providers and *Over 35* users consider the Service Integration criterion the most important factor for innovating a smart-mobility service, then Accessibility and Usability account for the 44.8% and 46.1% respectively while the User engagement criterion seems to have a very low importance (about 10% for both). Conversely, the *under 35* users give importance to Accessibility and Usability then to the User Engagement and the Service Integration criterion account only for 22%.

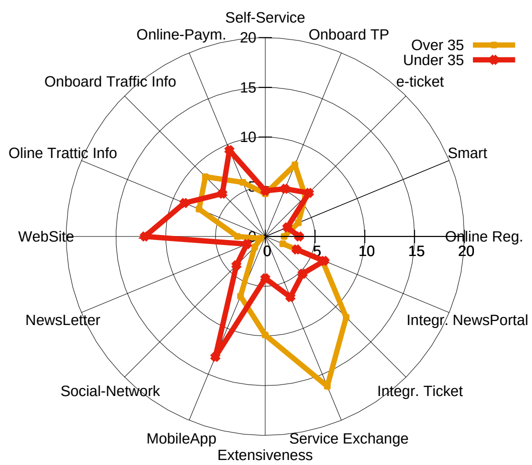
In Tab.1 we also report the relative weights that each group assigned to each criterion, including the average consensus reached amongst groups.




(a) *service providers* vs *Over 35 users sub-criteria*




(b) *service providers* vs *Under 35 users sub-criteria*




(c) *Under 35 users* vs *Over 35 users sub-criteria*

Figure 2: Sub-criteria pairwise-comparisons.

Table 1: Comparison of stakeholders' priorities with respect to the AHP criteria shown in Fig.1. Values in parenthesis report the average consensus reached amongst each group participant. All values are in percentage.

| Groups | Access. & Usab. | User Engagement | Service Integration | CI |
|---|---|---|---|---|
| Service-Providers | 39 (49.1) | 9.9 (43.7) | 51.1 (52.9) | 2.2 |
| Users > 35 | 44.8 (58.5) | 11.3 (81.8) | 43.9 (62.2) | 0.4 |
| Users < 35 | 46.1 (52.8) | 31.4 (75.9) | 22.5 (70.5) | 0.1 |

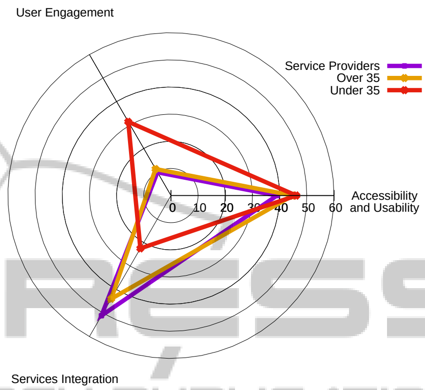



Figure 3: Comparison of weighted criteria between groups.

For the sake of completeness, in Tab. 2 we provide the results of the pairwise comparison for each group. Notice that the AHP allows computing the overall *group results* that would summarise the overall group judgment for a set of criteria (or sub-criteria). Furthermore, we recall that each comparison has obtained a *consistency index* within the 10%, which is considered as a limit for obtaining reliable and not contradictory results (Saaty, 2003).

## 5 CONCLUSIONS

In this paper we reported our experience in applying a Multi Criteria Decision Making technique to the smart-mobility context. Specifically, we built an AHP model and we employed three distinct groups of stakeholders (namely, Service Providers, Under 35 and Over 35 users) *to rank the factors for innovating a smart-mobility service in city of Milan*. The outcome of the AHP is a hierarchy of criteria and sub-criteria weighted accordingly to the stakeholders preferences. Our outcomes reveal that both *service providers* and *over 35* groups preferences are quite similar, as they both indicate *Service Integration* and *Accessibility and Usability* as the most important innovating factors while they give low importance to the *User Engagement*. On the contrary, for *under 35* the *Accessibility and Usability* grows in importance at the expense of the *Service Integration*,

Table 2: Results of the pairwise comparisons. SC = subsidiary company ; A = (public) Agency; P = Private Operator; M = Municipality; U = User.

| Cat. | Part. | Accessibility and Usability | | | | | | | | User Engagement | | | | Service Integration | | | | Cons. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Online Reg. | Smart Card | e-ticket | On-board TP | Self-Service | Online-Pay | On-board Traffic | On-line Traffic | Web-Site | News-letter | Social-Network | Mobile-App | Extens. | Exch. | Integ. Ticket | Integ. News Portal | CI |
| Service Providers | Group | 3.4 | 8 | 7 | 3.2 | 3.7 | 5.7 | 4.6 | 4.5 | 3.8 | 1.8 | 2.1 | 2.2 | 7.2 | 28.8 | 9.5 | 5.6 | 4.1 |
| | SC | 1.2 | 3.2 | 4.9 | 0.9 | 1.9 | 4.3 | 1.2 | 2.6 | 0.2 | 0.5 | 3.5 | 1.3 | 6.3 | 47.3 | 18.1 | 2.5 | 10.1 |
| | A | 1.1 | 2.8 | 1.8 | 3.3 | 5.7 | 1.4 | 7.4 | 4.3 | 5.1 | 1.3 | 0.3 | 0.6 | 2.6 | 40.4 | 6 | 15.8 | 6.4 |
| | P | 12.3 | 9.8 | 1.9 | 4 | 1 | 6.4 | 2.6 | 2.2 | 6.6 | 1.6 | 3.6 | 8.2 | 3 | 17 | 10 | 10 | 0.6 |
| | M | 4.5 | 15.2 | 22.8 | 2.2 | 5.8 | 4.9 | 11.3 | 1.6 | 5.1 | 1.6 | 0.9 | 0.6 | 15.3 | 5.8 | 1.7 | 0.8 | 6.2 |
| Users over 35 | Group | 1.9 | 3.6 | 5.7 | 7.8 | 4.3 | 5.9 | 8.5 | 7.2 | 2.8 | 0.5 | 1.5 | 6.5 | 9.9 | 16.3 | 11.5 | 6.2 | 1.8 |
| | U | 6.4 | 1.3 | 1.7 | 11.4 | 0.6 | 1.3 | 16.1 | 8.4 | 1.6 | 0.2 | 0.6 | 2.9 | 18 | 19.4 | 3.2 | 6.7 | 4.5 |
| | U | 1 | 3.7 | 1.2 | 4.6 | 2.5 | 1 | 6.2 | 6.1 | 13.7 | 1.5 | 5 | 34.4 | 3.5 | 10.5 | 3.5 | 1.4 | 2.1 |
| | U | 11.8 | 8.7 | 6.5 | 2.8 | 4 | 16 | 1.8 | 17 | 1.3 | 0.4 | 3.2 | 3.2 | 7.1 | 2.5 | 1.6 | 12.2 | 8.6 |
| | U | 0.6 | 1.4 | 0.3 | 4.4 | 1.4 | 1.5 | 5.6 | 2.6 | 3.5 | 0.2 | 0.6 | 1.6 | 5.9 | 22.9 | 44.6 | 2.9 | 6.5 |
| | U | 0.3 | 0.9 | 1.8 | 2.7 | 0.9 | 3.7 | 2.1 | 1.8 | 3.1 | 1.4 | 6.4 | 17.6 | 4.9 | 18.5 | 24.2 | 9.5 | 1.3 |
| | U | 1.8 | 3.1 | 4.8 | 8.5 | 10.8 | 3.3 | 13.3 | 1.1 | 1.3 | 0.3 | 0.5 | 4.5 | 5.4 | 28.5 | 11 | 1.8 | 2.2 |
| | U | 0.9 | 5.3 | 11.1 | 8.8 | 11.3 | 6.7 | 9.3 | 4 | 1.3 | 0.2 | 0.5 | 4.5 | 3.7 | 12.5 | 8.2 | 11.7 | 3.5 |
| | U | 1.7 | 1.1 | 14.2 | 5.7 | 4.1 | 11.9 | 17.1 | 14.5 | 4.2 | 0.3 | 0.4 | 2.4 | 6.9 | 9.5 | 5.4 | 0.8 | 1.4 |
| | U | 1.4 | 13.5 | 6.7 | 7 | 15.8 | 4.6 | 10.9 | 2.6 | 3.8 | 0.6 | 1.7 | 7.6 | 9.3 | 9.6 | 3.1 | 1.9 | 0.4 |
| | U | 0.6 | 1.2 | 3.7 | 6.5 | 0.6 | 3.6 | 1.5 | 7.9 | 1.9 | 0.4 | 0.6 | 7.6 | 17.3 | 7 | 5.1 | 34.4 | 4.7 |
| | U | 1.3 | 7.4 | 4.9 | 4.3 | 12.8 | 19 | 2.9 | 19.5 | 2.1 | 0.4 | 0.4 | 4.4 | 11.5 | 2.5 | 4.9 | 1.5 | 3 |
| | U | 0.3 | 0.7 | 9.6 | 2.6 | 0.5 | 1.9 | 3 | 2.5 | 0.5 | 0.2 | 2.3 | 2.3 | 2.3 | 18.1 | 47.8 | 5.5 | 8.7 |
| Users under 35 | Group | 3.4 | 2.4 | 6.2 | 5.2 | 4.6 | 9.4 | 6.1 | 8.8 | 12.1 | 2 | 4.1 | 13.1 | 4.2 | 6.6 | 5.3 | 6.4 | 1 |
| | U | 5.9 | 1.9 | 12.5 | 1.7 | 3.9 | 15.1 | 1.9 | 26.8 | 2.1 | 0.2 | 2.1 | 2.1 | 3.7 | 3.7 | 5.6 | 10.8 | 2.3 |
| | U | 1.5 | 2.9 | 2.3 | 5.3 | 6.4 | 3.5 | 18.7 | 13.4 | 17.3 | 6.9 | 2 | 3.6 | 4.4 | 7.8 | 1.1 | 3 | 1.5 |
| | U | 0.5 | 0.4 | 2.3 | 2.4 | 1.9 | 2 | 2.4 | 2.4 | 13 | 3.2 | 16.9 | 24 | 3.2 | 6.3 | 6.3 | 12.7 | 0 |
| | U | 5 | 1.6 | 13.7 | 1.4 | 1.6 | 21.5 | 1.3 | 3.8 | 7 | 1.7 | 5.6 | 25.3 | 1.6 | 0.8 | 1 | 7.1 | 2.6 |
| | U | 6.8 | 1.7 | 3.4 | 3.2 | 7.5 | 20.2 | 4.1 | 3.9 | 9.7 | 1.5 | 4 | 22.7 | 4.8 | 1.4 | 0.7 | 4.4 | 1 |
| | U | 2.4 | 1.1 | 1.8 | 9.3 | 1.4 | 3.9 | 13.1 | 12.8 | 15.6 | 2.7 | 1.1 | 2.7 | 1.7 | 7.6 | 12.2 | 10.4 | 1.7 |
| | U | 2.5 | 4.8 | 2.5 | 1.2 | 1 | 6.9 | 1.8 | 0.5 | 45 | 2.2 | 7.4 | 15.8 | 0.9 | 4.8 | 2.3 | 0.4 | 5.8 |
| | U | 2.6 | 1.4 | 1.2 | 8.7 | 2.8 | 1.8 | 12.7 | 8.7 | 3.9 | 0.8 | 5.7 | 9.6 | 13.3 | 12.3 | 10 | 4.4 | 2.2 |
| | U | 1.1 | 2.2 | 21.2 | 12.6 | 2.6 | 7.3 | 3.5 | 5.2 | 4.9 | 0.6 | 1.5 | 5.1 | 2.7 | 13.1 | 11.3 | 4.8 | 1.5 |
| | U | 3.2 | 1.2 | 9.6 | 2.8 | 4.8 | 14.5 | 0.9 | 7.5 | 14.2 | 2.2 | 2.3 | 30.2 | 2.2 | 1.1 | 2.9 | 0.6 | 1.1 |
| | U | 1.3 | 1.4 | 2.2 | 3.1 | 6.2 | 1.9 | 7.5 | 7.6 | 5.3 | 0.8 | 0.8 | 12.6 | 3.2 | 16 | 8.6 | 21.5 | 2.5 |



whilst the *User Engagement* criterion becomes quite important (30%) for them. Concluding, this knowledge could strongly integrate and support sense making from large amount of data collected about smart-mobility service usage, and it describes the dynamics that guide the stakeholder decision. In our opinion, using this knowledge with common BI analytics (such as service usage patterns identification, forecasting, process mining, etc.) could be beneficial for improving service effectiveness.

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