Hierarchizing the importance of the attributes of an online shared freight transportation service platform with the use of Multi-Actor Multi-Criteria Analysis (MAMCA)

Dimitrios Nalmpantis¹,²,⁴, Evangelos Genitsaris¹, Vasiliki Amprasi¹, Attila Akac³ and Afroditi Anagnostopoulou³

¹School of Civil Engineering, Faculty of Engineering, Aristotle University of Thessaloniki, PO Box 452, 541 24 Thessaloniki, Greece
²School of Science and Technology, Hellenic Open University, 263 35 Patras, Greece
³Hellenic Institute of Transport, Centre for Research and Technology Hellas, 1 G. Kasimati str., 185 31 Piraeus, Greece

⁴Corresponding author: dnalba@civil.auth.gr

Abstract. The purpose of this paper is to hierarchize the importance of the attributes of an online shared freight transportation service platform with the use of Multi-Actor Multi-Criteria Analysis (MAMCA). A MAMCA was performed amongst the partners of the INTERREG Balkan-Med SCOPE project in order to hierarchize the attributes of such a platform which is under development in the frame of the project. The results show that all the actors agree that the most important criterion is the Service, i.e., the services that the platform will provide. The research institute and the chambers actors agree that the second most important criterion is Access, i.e., the interface of the platform, while the university actor thinks that Range is the second most important criterion, i.e., the service area of the platform. Probably, the actors who are closer to the market understand better the needs, requirements, and preferences of the users than academia, and that once you set up the platform for a specific Range, it can be easily expanded to cover more areas in the future. Nevertheless, it has to be underlined that these results have been derived by a very small sample, i.e., the partners of the SCOPE project and probably a broader MAMCA, including more stakeholders, should be performed in order to validate them.

1. Introduction
Freight transportation is developing to a major global market estimated to reach 17.45 billion USD by 2023 [1], and this could increase even further by modern technology, e.g., digitalization, the Internet of Things (IoT), etc. Digital freight transport platforms and electronic marketplaces have emerged since the early 2000s resulting from the advances in Information and Communication Technology (ICT), and Business to Customer (B2C) and Business to Business (B2B) hubs have developed new tools to facilitate information exchange and support the processes of negotiation, contracting, and settlement between the actors in the freight transportation industry. Such kinds of tools could focus on delivering Cooperative Intelligent Freight Transport Systems (C-ITS) and, in this way, optimizing cost efficiency and enhancing a sustainable mobility environment in the European Union (EU) [2][3].
The purpose of this paper is to hierarchize the importance of the attributes of an online shared freight transportation service platform with the use of Multi-Actor Multi-Criteria Analysis (MAMCA), which was realized in the frame of the “Shared freight transport services connecting shipper and carrier operations” (SCOPE) project of the “INTERREG Balkan-Mediterranean 2014-2020” Programme.

Based on the results of previous research of SCOPE partners, a MAMCA has been performed. The aim of the MAMCA was to get some insights regarding how the SCOPE project partners hierarchize the basic attributes that such a platform should have and also the differences that can be observed between the role of each partner as a stakeholder or “actor.”

MAMCA is a new approach of Multi-Criteria Decision Analysis (MCDA) in which the stakeholders’, or actors’, view is taken into account, as they can proceed to MCDA evaluations separately in order to see in which criteria they are close to consensus and in which their views deviate. The ultimate aim is to achieve consensus regarding the alternatives. MAMCA was developed and introduced by the Mobility, Logistics and Automotive Technology Research Centre (MOBI) of the Vrije Universiteit Brussel (VUB), Belgium, and its Director Prof. Cathy Macharis.

MAMCA consists of seven (7) steps [4]:

i. The first step is the definition of the problem and the identification of the alternatives. These alternatives can take different forms according to the problem situation [4].

ii. Next, the relevant stakeholders are identified. Stakeholders are people who have an interest, financial or otherwise, in the consequences of any decisions taken [4].

iii. The key objectives of the stakeholders are identified and given a relative importance or priority (weights). These first three steps are executed interactively and in a circular way [4].

iv. For each criterion, one or more indicators are constructed. Steps 1 to 4 can be considered as mainly analytical, and they precede the “overall analysis” [4].

v. Construction of the evaluation matrix. The alternatives are further described and translated into scenarios that also describe the contexts in which the policy options will be implemented. The different scenarios are then scored on the objectives of each stakeholder group. For each stakeholder group, an MCDA is being performed [4].

vi. The different points of view are brought together in a multi-actor view. This yields a ranking of the various alternatives and reveals their strengths and weaknesses. Afterward, the stability of the ranking can be assessed through sensitivity analyses [4].

vii. The last stage of the methodology includes the actual implementation. Based on the insights of the analysis, an implementation can be developed, taking the wishes of the different actors into account [4].

MAMCA has already proven its usefulness as it has been used in several transport-related decision problems. It was used by Macharis (2000) who developed it, in an intermodal terminal location decision problem [5], by Macharis and Boel (2004) for a study on the choice between waste transport alternatives in the Brussels region [6], by Macharis et al. (2004) for the evaluation of different driver assistance systems in the ADVISORS project [7], by Macharis et al. (2010) in the Flanders in Action Process to structure the discussions on how to turn Flanders into a top region by 2020 in terms of logistics and mobility [8], by Turcksin et al. (2011) in the choice of different biofuel options in Belgium [9], by Keseru et al. (2014) for sustainable urban mobility decisions in the city of Leuven, Belgium [10], by Macharis et al. (2016) for the evaluation of alternative construction logistics measures [11], by Sirikijpanichkul et al. (2017) for a transit system selection model in Bangkok, Thailand [12], by Cornet et al. (2018) for the evaluation of High-Speed 2 (HS2) rail [13], by Roukouni et al. for the assessment of alternative financing options for urban public transportation [14], by Buldeo Rai et al. (2018) for the environmental impact and stakeholder analysis of a crowd logistics platform in Belgium [15], by Kouta (2019) for the selection of the safety level of a of Safe and Secure Truck Parking Area (SSTPA) on the Greek motorway network [16], by Williamson et al. (2020) for the evaluation of business models for dedicated container freight on Swedish inland waterways [17], by Fredriksson et al. (2021) for creating stakeholder awareness in construction logistics [18], etc.
2. Methodology

In order to perform a MAMCA survey, the researcher needs to identify the alternatives, the actors, and the criteria, which in the case of MAMCA, can be even defined per actor.

Since there are no actual platform alternatives yet, two imaginary alternatives were selected:

i. The best platform: the prospective SCOPE platform, which should have the best possible attributes.

ii. The existing platform: this is the imaginary average of the existing platforms in the market.

Since the respondents are SCOPE project partners, the actors were identified according to the type of entity of partners of the SCOPE project, namely:

i. University.
ii. Research Institute.
iii. Chamber.

The criteria were the attributes that were selected for a Conjoint Analysis that was performed before MAMCA, i.e.:

i. Language: refers to the language in which the platform should be offered, and in the case of Conjoint Analysis it could have the following levels: i) Local, ii) English, and iii) German.

ii. Access: refers to the way that the user can access the platform, and in the case of the Conjoint Analysis it could have the following levels: i) Website, ii) Mobile App, and iii) By phone.

iii. Service: refers to the service that the platform will be able to provide, and in the case of Conjoint Analysis it could have the following levels: i) Freight planning: The platform contains a variety of freight management services, e.g., truck route planning, cargo space management, cargo/truck tracking, etc. The platform operates as a host of the different platforms that are offered to the users at different packages and prices. ii) Cargo/truck booking: The platform operates in the same context as the first category but, additionally, it offers the option of booking a truck (for clients) or cargo types (for carriers). The booking process is handled via the platform owner and the respective partners via the platform itself or on an external source. iii) Auction platform: The platform operates in the same way as in category ii) but with an important difference; auctions replace booking reservations between the users. The platform follows the same auctioning regulations and procedures as in the other sectors that use auctioning platforms. In this case, all transactions and reservations are confidential, and the deals are coordinated by the platform owner.

iv. Charging: refers to the way that the platform will charge its services, and in the case of Conjoint Analysis it could have the following levels: i) Per shipment (e.g., %): this is a commission per shipment, usually a low percentage of the shipment value. ii) Subscription (e.g., per month): this is a time subscription, e.g., per month, year, etc. iii) Full license (1-time payment): this is a full license paid once (but at a much higher cost, obviously).

v. Range: refers to the range of the shippers and carriers who can use the platform and, consequently, the shipment area, and in the case of Conjoint Analysis it could have the following levels: i) National, ii) Balkan, and iii) European / International.

The respondents were asked to compare the criteria in a pairwise manner, in the 9-point Saaty scale, as seen in Figure 1.
After that, the respondents were asked to proceed with an Analytic Hierarchy Process (AHP) evaluation of each alternative per criterion, as seen in Figure 2 for the criterion of Language.

**Figure 1.** Pairwise comparison of the criteria in the 9-point Saaty scale.

**Figure 2.** AHP evaluation of alternatives per criterion, in this case, Language, in the 9-point Saaty scale.
In this case, since the alternatives were the Best platform and the Existing platform, they should choose nine (9) to the Best platform side for all the criteria.

The MAMCA v.2 platform was used for the realization of the survey [19].

3. Results and Discussion

There were five (5) answers in total: three (3) from Greece, one (1) from Bulgaria, and one (1) from Albania. The type of entity of the participants was as follows: three (3) chambers, one (1) university, and one (1) research institute.

The only useful results from this approach are the results of the actor average results of the criteria per actor, as there were no actual alternatives between which the actors could choose.

The results of the MAMCA actor average results of the criteria per actor are presented in Figure 3 (university), Figure 4 (research institute), and Figure 5 (chambers).

**Figure 3.** MAMCA university actor average results per criterion.

**Figure 4.** MAMCA research institute actor average results per criterion.
Figure 5. MAMCA chamber actor average results per criterion.

The MAMCA average results per criterion for the university actor are presented in Figure 3 as follows:

i. Service: 53.6%,
ii. Range: 19.7%,
iii. Language: 14.8%,
iv. Access: 8.6%, and
v. Charging: 3.3%.

The MAMCA average results per criterion for the research institute actor are presented in Figure 4 as follows:

i. Service: 47.7%,
ii. Access: 28.8,
iii. Charging: 14.1%,
iv. Range: 6.2%, and
v. Language: 3.3%.

The MAMCA average results per criterion for the chambers actor are presented in Figure 5 as follows:

i. Service: 36.6%,
ii. Access: 23.5%,
iii. Range: 18.7%,
iv. Charging: 18.7%, and
v. Language: 2.6%.

From the results above, some interesting findings can be derived:

- All the actors agree that the most important criterion is the Service. This was expected as since we talk about a platform, one automatically thinks that the most important criterion is the services that it will offer.

- Nevertheless, a Conjoint Analysis that was performed before MAMCA showed that the Language criterion is the most important criterion. Indeed, the type of service is logically the most important factor, but as many road freight transport drivers are not fluent in English, how could they use the platform in a foreign language despite the service it offers? Apart from that, in the case of Conjoint Analysis, the respondent is forced to make trade-offs, something that is not the case with MAMCA: in MAMCA, the respondent might have thought that Language is not so important simply because nowadays it is easy to have a multilanguage platform.
• The research institute and the chambers actors agree that the second most important criterion is Access, while the university actor thinks that Range is the second most important criterion. Probably, the actors who are closer to the market understand better the needs, requirements, and preferences of the users than academia, and as previously, they understand that once you set up the platform for a specific Range, it can be easily expanded to cover more areas in the future.

It needs to be underlined that in the case of MAMCA, five (5) respondents answered to one (1) pairwise comparison of five (5) criteria, i.e., ten (10) pairwise comparisons, totaling to fifty (50) comparisons. As mentioned earlier, MAMCA is a tool to compare alternatives, although it was not used for that reason in this application. Therefore, the MAMCA results should be considered with a grain of salt.

4. Conclusions
The MAMCA results showed that all the actors agree that the Service criterion is the most important one. This contradicts the results of a Conjoint Analysis that was performed before MAMCA, according to which the Language criterion was found to be the most important one. The Conjoint Analysis that was performed will also be published, and it is based on previous research of the authors [20][21][22]. The difference can be explained both by the different research and methodological approach each method has, i.e., in the case of the Conjoint Analysis, the respondent has to make trade-offs, and the fact that in MAMCA the information gathered was much less compared to the Conjoint Analysis. Obviously, both the Service and Language criteria/attributes are very important.

Acknowledgments
This research has been co-funded by the European Union and national funds of the participating countries through the Interreg Balkan – Mediterranean program “SCOPE - Shared freight transport services connecting shipper and carrier operations” (MIS: 5048545).

References
[1] Marketsandmarkets 2018 Freight Management System Market (Report No. TC 2659) https://www.marketsandmarkets.com/Market-Reports/freight-management-system-market-214631371.html
[2] European Commission 2019 Transport in the European Union – current trends and issues (Brussels: European Commission) p 167 https://ec.europa.eu/transport/sites/default/files/2019-transport-in-the-eu-current-trends-and-issues.pdf
[3] Akac A, Anagnostopoulou A and Nalmpantis D 2021 Digitalization in freight transport services: Balkan area Advances in Intelligent Systems and Computing vol 1278 ed E Nathanail, G Adamos and I Karakikes (Cham: Springer) chapter 101 pp 1056–1065 https://doi.org/10.1007/978-3-030-61075-3_101
[4] Macharis C, Turcksin L and Lebeau K 2012 Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: state of use Decis. Support Syst. 54 (1) 610–620 https://doi.org/10.1016/j.dss.2012.08.008
[5] Macharis C 2020 Strategische modellering voor intermodale terminals: socio-economische evaluatie van de locatie van binnenvaart/weg terminals in Vlaanderen (PhD dissertation) [in Flemish] https://lib.ugent.be/catalog/rug01:002177308
[6] Macharis C and Boel B 2004 BRUGARWAT: Brussels Garbage by water Bijdragen vervoerslogistieke werkdagen 2004, eds C J Ruijgrok and R H J Rodenburg (Delft: VLU) pp 229–242 https://doi.org/10.1007/978-3-030-02305-8_58
[7] Macharis C, Verbeke A and De Brucker K 2004 The strategic evaluation of new technologies through multi-criteria analysis: the ADVISORS case Res. Transp. Econ. 8 443–462 https://doi.org/10.1016/S0739-8859(04)08019-9
Macharis C, De Witte A and Turcksin L 2010 The Multi-Actor Multi-Criteria Analysis (MAMCA) application in the Flemish long-term decision making process on mobility and logistics Transp. Policy 17 (5) 303–311 https://doi.org/10.1016/j.tranpol.2010.02.004

Turcksin L, Macharis C, Lebeau K, Boureima F, Van Mierlo J, Bram S, De Ruyck J, Mertens L, Jossart J-M, Gorissen L and Pelkmans L 2011 A multi-actor multi-criteria analysis to assess the stakeholder support for different biofuel options: the case of Belgium Energ. Policy 39 (1) 200–214 https://doi.org/10.1016/j.enpol.2010.09.033

Keseru I, Bulckaen J and Macharis C 2016 The multi-actor multi-criteria analysis in action for sustainable urban mobility decisions: the case of Leuven Int. J. Multicriteria Decis. Mak. 6 (3) 211–236 https://doi.org/10.1504/IJMCDM.2016.079713

Macharis C, Kin B, Balm S and Ploos Van Amstel W 2016 Multiactor participatory decision making in urban construction logistics Transp. Res. Record 2547 83–90 https://doi.org/10.3141/2547-12

Sirikijpanichkul A, Winyoopadit S and Jenpanitsub A 2017 A multi-actor multi-criteria transit system selection model: a case study of Bangkok feeder system Transp. Res. Proc. 25 3736–3755 https://doi.org/10.1016/j.trpro.2017.05.228

Cornet Y, Barradale M J, Gudmundsson H and Barfod M B 2018 Engaging multiple actors in large-scale transport infrastructure project appraisal: an application of MAMCA to the case of HS2 high-speed rail J. Adv. Transport. 2018 9267306 https://doi.org/10.1155/2018/9267306

Roukouni A, Macharis C, Basbas S, Stephanis B and Mintsis G 2018 Financing urban transportation infrastructure in a multi-actors environment: the role of value capture Eur. Trans. Res. Rev. 10 (1) 14 https://doi.org/10.1007/s12544-017-0281-5

Buldeo Rai H, Verlinde S and Macharis C 2018 Shipping outside the box. Environmental impact and stakeholder analysis of a crowd logistics platform in Belgium J. Clean. Prod. 202 806–816 https://doi.org/10.1016/j.jclepro.2018.08.210

Kouta M 2019 Siting and selection of the security level of Safe and Secure Truck Parking Areas using Multi-Actor Multi-Criteria Analysis (MSc dissertation) [in Greek] p 234 https://apothesis.eap.gr/handle/repo/42812

Williamsson J, Rogerson S and Santén V 2020 Business models for dedicated container freight on Swedish inland waterways Res. Transp. Bus. Manag. 35 100466 https://doi.org/10.1016/j.jrtbm.2020.100466

Fredriksson A, Janne M, Nolz P, de Radigues de Chenneviere P, van Lier T and Macharis C 2021 Creating stakeholder awareness in construction logistics by means of the MAMCA Cities Env. Interact. 11 100067 https://doi.org/10.1016/j.cacint.2021.100067

Mobility, Logistics and Automotive Technology Research Centre nd Multi-Actor Multi-Criteria Analysis https://mamca.vub.be/

Tsafarakis S, Gkorezis P, Nalmpantis D, Genitsaris E, Andronikidis A and Altsitsiadis E 2019 Investigating the preferences of individuals on public transport innovations using the Maximum Difference Scaling method Eur. Transp. Res. Rev. 11 (1) 3 https://doi.org/10.1186/s12544-018-0340-6

Tsoukanelis A, Genitsaris E, Nalmpantis D and Naniopoulos A 2019 Conjoint Analysis for the optimization of a potential Flexible Transport Service (FTS) in the region of Zagori, Greece Advances in Intelligent Systems and Computing vol 879, eds E Nathanail and I Karakikes (Cham: Springer) chapter 58 pp 370–377 https://doi.org/10.1007/978-3-030-02305-8_58

Papadima G, Genitsaris E, Karagiotas I, Naniopoulos A and Nalmpantis D 2020 Investigation of acceptance of driverless buses in the city of Trikala and optimization of the service using Conjoint Analysis Util. Policy 62 100994 https://doi.org/10.1016/j.jup.2019.100994