Optimization of an online shared freight transportation service platform with the use of Conjoint Analysis

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Abstract. The purpose of this paper is the optimization of an online shared freight transportation service platform with the use of Conjoint Analysis for the region of Balkan – Mediterranean. A Choice-Based Conjoint analysis was performed amongst the partners of the INTERREG Balkan-Med SCOPE project in order to optimize such a platform which is under development in the frame of the project. The results show that the best possible configuration of the platform should be offered at least in the local language, on a website, in the form of an auction platform, the charging should be done per shipment, and its range should be European / international. Moreover, selecting the right levels for each attribute is of crucial importance for the success of a freight transportation service platform, as the best configuration has a market share that is above 100% of the second-best configuration, according to the market simulation that was performed. Therefore, tools as Conjoint Analysis should be incorporated in the planning and design of such products in order to have the best marketable results for shippers, carriers, and consumers; a product that is customized according to their needs and preferences.

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 the optimization of an online shared freight transportation platform with the use of Conjoint Analysis, 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 Conjoint Analysis has been performed. The aim of the Conjoint Analysis was to get some insights regarding the basic attributes that such a platform should have and the optimization of their “levels.”

Conjoint Analysis is one of the most widely used methods in marketing science and market research. It is used to measure the preferences for the attributes (characteristics) of a product (good or service), new or existing, and to study the factors that influence the preferences and the decisions of the consumers. Moreover, it is used for the estimation of the impact on the demand for the product and on possible changes in the price and for the forecasting of the degree of acceptance of the good or service when introduced into the market [4].

Every good or service has various attributes, such as color, price, materials, reliability, environmental impact, etc. In fact, consumers are not able to purchase a product of which every attribute is the best due to its cost. Thus, consumers are forced to make compromises, i.e., trade-offs, when deciding to purchase a good or service. For example, when buying a car, the safety and comfort of a large vehicle are crucial. However, the buyer will have to compromise this aspect with increased acquisition costs, limited flexibility, greater fuel consumption, greater environmental burden, etc. [5].

In Conjoint Analysis, each respondent does not answer which attributes they prefer or consider to be more important for the product but evaluates various potential product profiles, each of which includes various levels of specific product attributes linked together conjointly. The most popular technique for creating such profiles is the Choice-Based Conjoint (CBC), in which each respondent chooses from a set of different profiles the one they prefer [6].

The attributes and levels that make up each profile are carefully selected to be mutually exclusive. The aim is to be able to assess the independent effect of each level of each attribute in choosing a particular profile. This way, the analyst can infer which levels are more desirable and which attributes have the most significant impact on consumer choice. Unlike with more simple methods, where respondents directly choose the attributes that they prefer or consider more important, the preferences of the respondents arise through compromises (i.e., the sets of potential profiles) to achieve inevitable trade-offs [7]. A potential profile means a combination of levels of the attributes of a good or service. When two or more profiles are presented at the same time, a profile set has been defined. From each profile set, the respondent is asked to choose the most preferred one [6].

CBC analysis has attracted much interest in the marketing research field in recent years. There are several reasons for that, as well as for being established as the most widely Conjoint Analysis method currently used [8]:

i. The task of choosing a preferred concept (i.e., profile) is similar to what consumers actually do in the marketplace. Choosing a preferred profile from a group of goods or services is a simple and natural task that everyone can understand.

ii. CBC analysis allows us to include a “None” option for the respondents, which actually means, “I wouldn’t choose any of these.” By this option, a respondent can contribute information regarding the decrease in demand to be expected regardless of the combination of the different attributes’ levels offered, e.g., if the price is too high or the good or service is unattractive for other reasons.

iii. Most conjoint approaches use “main effects only” assumptions. However, experiments using CBC analysis can be efficient enough to quantify interactions.

iv. In CBC analysis, it is possible to have “product-or alternative-specific” attribute levels. For example, in transportation research, walking shoes and bicycles may be both considered. Although the attributes of shoes are different compared to those describing bicycles, one might want to study both kinds of products so as to learn how much improvement in shoes would be required to switch from cycling to walking.

v. Using Hierarchical Bayesian (HB) estimation (which is integrated within CBC), part-worth utilities at the individual level may be estimated. This is a development that occurred in the mid-1990s that significantly improved the usability and predictive validity of Choice-Based Conjoint data [8].
Nevertheless, CBC analysis has a main disadvantage: each profile is composed using many attributes’ levels, and each profile set includes several goods or services, out of which each participant is expected to select one. Accordingly, each participant will have to devote enough time and process a lot of information before giving each answer. In addition, in discrete choice models, the choice is not a direct indication of how preferable it is compared to the other alternatives [7][8].

It seems that there is not much published research regarding Conjoint Analysis and freight transportation groupage platforms. Nevertheless, there are some publications of examples of preferential analytics tools and Conjoint Analysis applications generally on transport. Some examples follow: Noble (1982) applied Conjoint Analysis on the public transport system of Hong Kong and found that out of four attributes chosen for investigation, travel time was by far the most important [9]. De Ruyter and Wetzel (1996) presented a complementary approach to measuring service quality in the context of service encounters in public transport in the Netherlands, based on Conjoint Analysis [10]. Gatta and Marcucci (2007) used Conjoint Analysis to analyze customer preferences, estimate the passengers’ evaluation of different service features, and calculate a robust specification of a service quality index [11]. Liu et al. (2011) studied the passengers’ preferences of the bus service in Nanjing, China, with the use of Conjoint Analysis and found that bus reliability was passengers’ first concern [12]. Mokonyama and Venter (2013) estimated a service quality conjoint model to evaluate the effect of different public transport service packages on passenger satisfaction [13]. Liu and Guo (2015) used Conjoint Analysis and found that on both the commuter and the non-commuter trip, passengers value reliability the most [14]. Nesheli et al. (2017) used Conjoint Analysis, combined with cluster analysis, to evaluate public transport service quality [15]. König et al. (2018) investigated the characteristics of ride-pooling with the greatest value for travelers [16]. Van Cauwenberge et al. (2019) examined the factors that would enhance cycling for people over 65 [17]. Tsafarakis et al. (2019) investigated the preferences of individuals on public transport innovations using the Maximum Difference Scaling method (MaxDiff) [18]. Tsoukanellis et al. (2019) used Conjoint Analysis for the optimization of a potential Flexible Transport Service (FTS) in the region of Zagori, Greece [19]. Papadima et al. (2020) used Conjoint Analysis for the optimization of a potential driverless autonomous bus service in the city of Trikala, Greece, after an acceptability survey that followed a pilot application [20]. Finally, Giannaka et al. (2020) used Conjoint Analysis for the optimization of a night bus service in the city of Thessaloniki, Greece [6].

2. Methodology

After the review of the state of the art of the existing platforms in the frame of the SCOPE project, the main attributes of them were identified, and a Conjoint Analysis among the partners was performed in order to have some insights regarding the preferable levels and attributes of the platform that will be developed by SCOPE project.

Based on the experience gained during the investigation of the state-of-the-art, the conjoint model that was developed included five (5) attributes, i.e., Language, Access, Service, Charging, and Range, with three (3) levels each (see Table 1).

| Levels | Attributes |
|--------|------------|
| No.    | Language   | Access    | Service                        | Charging                           | Range            |
| 1.     | Local      | Website   | Freight planning               | Per shipment (e.g., %)             | National         |
| 2.     | English    | Mobile App| Cargo/truck booking           | Subscription (e.g., per month)     | Balkan           |
| 3.     | German     | By phone  | Auction platform               | Full license (1-time payment)      | European / International |
Initially, the respondent had to answer three (3) simple multiple-choice questions about who they are, namely the name of the entity, the type of entity, and the country of origin. After that, 12 conjoint questions followed in the form of stated preference questions, i.e., in each “question” the respondent saw three (3) profiles of platforms and had just to choose which they preferred out of these, and they could even select “None of these.” Before that, they had to rank the “levels” of each attribute according to their individual preference.

The questionnaire was as simple as that, and the respondents did not need to remember anything. The questionnaire guided the respondents from one step to the other automatically. There was no “correct” or “wrong” answer, as every conjoint answer is subjective.

The profiles had five (5) attributes, each one of which had three (3) levels (as seen in Table 1). Some explanations for the levels per attribute follow, of which the most important are those regarding the “Service” attribute and its levels:

i. **Language:** Local language refers to the language of the respondent’s country. German was added as it is the most common destination of freight transport from the Balkan-Mediterranean area and English as the lingua franca.

ii. **Access:** The levels are self-explanatory, and no further clarifications are needed.

iii. **Service:** 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:** 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:** This is about the range of the shippers and carriers who can use the platform and, consequently, the shipment area.

Although some levels of the same attribute can coexist, the questions had to be posed in a mutually exclusive manner to draw their utilities objectively. Afterward, if some utilities are equally high, e.g., in the case of Language, both Local and English language could be included in the platform.

Answering the questionnaire would not take more than 5-10 minutes. Only one answered questionnaire per SCOPE partner was required, e.g., it could be the member of the Steering Committee or whoever.

For the realization of the CBC survey, the Discover App of Sawtooth Software Inc. was used.

### 3. Results and Discussion

The questionnaire was filled by six (6) participants: three (3) from Greece, two (2) from Bulgaria, and one (1) from Albania. The type of entity of the participants was as follows: three (3) chambers, one (1) university, one (1) ministry, and one (1) research institute. The importance of the attributes is presented as percentages that add up to 100%, with no negative values, as seen in Figure 1 and Table 2.
Figure 1. The importance of the attributes.

Table 2. The importance of the attributes, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Attributes | Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|------------|------------|--------------------|--------------|--------------|
| Language   | 49.96%     | 16.48%             | 36.77%       | 63.15%       |
| Access     | 7.96%      | 6.07%              | 3.10%        | 12.81%       |
| Service    | 16.74%     | 11.28%             | 7.72%        | 25.77%       |
| Charging   | 13.50%     | 7.33%              | 7.64%        | 19.37%       |
| Range      | 11.84%     | 9.01%              | 4.63%        | 19.05%       |

It is obvious that according to the respondents, the most important attribute of a platform is by far its Language (49.96%), followed by Service (16.74%), the type of Charging (13.50%), Range (11.84%), and Access (7.96%). This finding was somehow unexpected, but it seems that the chambers know better that many freight transport drivers are not fluent in English and, therefore, they would not be able to use a platform that will not be offered in their local language. The type of Service that was expected to be the most important attribute follows, but with not a big difference compared to the rest of the attributes.

The utility of the None choice is presented with an absolute value that could be compared to the levels of attributes regarding its negative or positive sign, as seen in Table 3.

Table 3. The utility of the None choice, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|------------|--------------------|--------------|--------------|
| None       | -54.09             | 85.17        | -122.23      | 14.06        |

We cannot derive much information from that, apart from the fact that perhaps this option should not be available, as the available profiles are about a service that is not obligatory for the users and, therefore, even if there was a service that they would not prefer they could just not use it.

Following, the utilities of the levels per attribute will be examined. These utilities are given on a scale that adds up to zero (0). Negative utility values should not be considered to be values that would make the user not use the platform, but values that mean that the market share possibly would be much less than the average.

Regarding the Language attribute, the utilities of its levels are presented in Table 4, the Access attribute in Table 5, the Service attribute in Table 6, the Charging attribute in Table 7, and the Range attribute in Table 8.
Table 4. The utilities of the levels of the Language attribute, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Levels     | Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|------------|------------|--------------------|--------------|--------------|
| Local      | 97.44      | 47.46              | 59.46        | 135.41       |
| English    | 52.50      | 28.52              | 29.68        | 75.32        |
| German     | -149.94    | 40.45              | -182.31      | -117.57      |

Table 5. The utilities of the levels of the Access attribute, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Levels       | Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|--------------|------------|--------------------|--------------|--------------|
| Website      | 18.65      | 11.83              | 9.19         | 28.11        |
| Mobile App   | -0.78      | 15.43              | -13.13       | 11.56        |
| By phone     | -17.87     | 20.69              | -34.42       | -1.31        |

Table 6. The utilities of the levels of the Service attribute, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Levels               | Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|----------------------|------------|--------------------|--------------|--------------|
| Freight planning     | -25.48     | 38.77              | -56.50       | 5.53         |
| Cargo/truck booking  | -16.47     | 18.88              | -31.58       | -1.36        |
| Auction platform     | 41.95      | 30.30              | 17.71        | 66.20        |

Table 7. The utilities of the levels of the Charging attribute, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Levels           | Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|------------------|------------|--------------------|--------------|--------------|
| Per shipment     | 23.10      | 21.37              | 6.00         | 40.20        |
| Subscription     | -6.15      | 31.58              | -31.42       | 19.12        |
| Full license     | -16.95     | 33.58              | -43.83       | 9.92         |

Table 8. The utilities of the levels of the Range attribute, with Standard Deviations, and Lower and Upper 95% Confidence Intervals.

| Levels                | Importance | Standard Deviation | Lower 95% CI | Upper 95% CI |
|-----------------------|------------|--------------------|--------------|--------------|
| National              | 3.29       | 29.83              | -20.57       | 27.16        |
| Balkan                | -13.75     | 20.48              | -30.14       | 2.64         |
| European / International | 10.45     | 43.19              | -24.10       | 45.01        |

From all the above, we can conclude that the best possible configuration of a platform should be offered at least in the Local language, on a Website, in the form of an Auction platform, the charging should be done Per shipment, and its range should be European / International.

The worst possible configuration of the platform would be to be offered only in the German language, By phone, in the form of a Freight planning platform, the charging would be done as a Full license (1-time payment), and its range would be in the Balkans.

Actually, it is possible to use the market simulation of the Discover software to estimate the different market share of these two configurations. Even better, it is possible to add another configuration. Probably a good idea is to add the best configuration with the second-best level of the most important attribute, i.e., English, instead of the Local language. This way, there are three different configurations to add to the market simulator to estimate the respective market share. The results of this market simulation are presented in Figure 2.
From Figure 2, it is obvious that selecting the right levels for each attribute is of crucial importance for the success of such a platform, as the best configuration has a market share that is above 100% of the second-best configuration.

4. Conclusions
According to the insights of the Conjoint Analysis survey, the best possible configuration of the platform should be offered at least in the Local language, on a Website, in the form of an Auction platform, the charging should be done Per shipment, and its range should be European / International. Moreover, selecting the right levels for each attribute is of crucial importance for the success of a freight transportation service platform, and not only, as the best configuration has a market share that is above 100% of the second-best configuration. Therefore, tools as Conjoint Analysis should be incorporated in the planning and design of such products in order to have the best marketable results for shippers, carriers, and consumers; a product that is customized according to their needs and preferences.

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).

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