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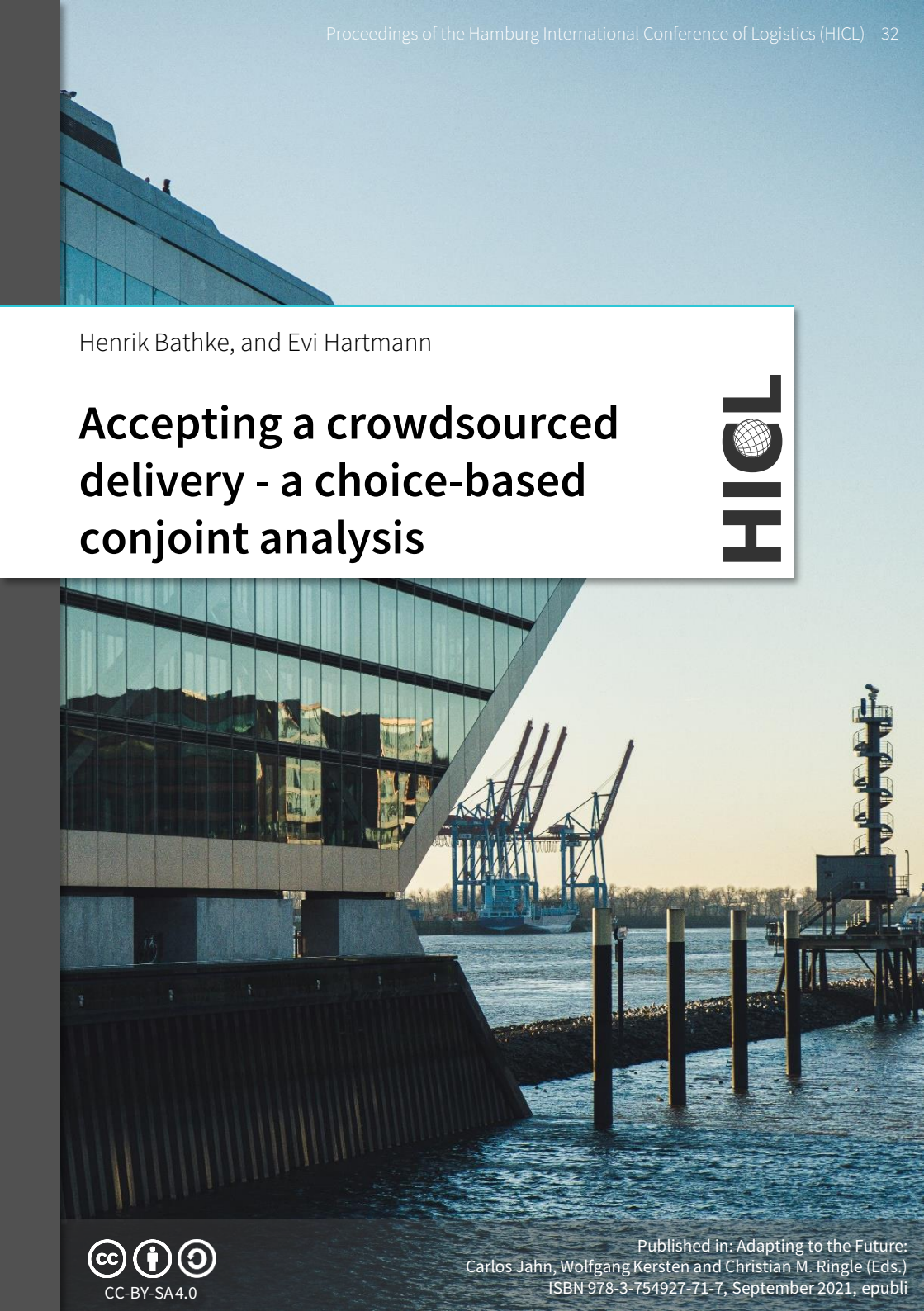

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Accepting a crowdsourced delivery - a choice-based conjoint analysis

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Purpose: The increase in parcel quantities on the last mile requires new and innovative concepts to support sustainability efforts in urban areas. Crowdsourced delivery (CSD) represents a promising concept as it allows private couriers to take over the parcels' last mile on trips they would have traveled anyway. Whereas first research on the attributes leading to the acceptance of CSD requests via platforms exists, the attributes' respective importance remains unclear.

Methodology: A choice-based conjoint analysis with 193 respondents willing to participate in CSDs was conducted. Attributes' relative importance and part-worth utilities were calculated using Hierarchical Bayes estimation.

Findings: Results show that differences in deviation of the original travel time and remuneration have the greatest impact on couriers' request selection, while the degree of familiarity with the recipient and parcel weight are less decisive. Additionally, it became apparent that couriers' sentimental traits of environmental concerns and extraversion affect the choice of a CSD request.

Originality: The study contributes to the scarce literature on the promising concept of CSD to reduce logistics-related environmental externalities and strengthens the application of marketing-related methodologies in logistics research. For CSD platform providers, results enable higher competitiveness through a more individualized request for potential couriers.

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1 Introduction

Last-mile logistics is facing unprecedented challenges in the future. Urbanization is leading to an increase of the total worldwide population that is living in cities by more than 60% until 2050 (United Nations, 2019). This is accompanied by a rapid growth in e-commerce volume particularly accelerated by the ongoing COVID-19 pandemic (United Nations, 2021). The global share of e-commerce in all retail sales is projected to increase by more than 60% until 2024 compared to 2019 (eMarketer, 2021). Both developments are leading to an intensification of urban freight, resulting in negative externalities, such as congestion, noise and carbon emissions (Lim, Jin and Srai, 2018). Additionally, changes in customer behavior require adequate solutions by shippers, including the provision of more sustainable ways of transportation as well as shorter and more flexible delivery times (Kafle, Zou and Lin, 2017; Ta, Esper and Hofer, 2018). These conditions led to the emergence of a new business model for last-mile transportation: crowdsourced delivery (CSD).

CSD is described as the transportation of shipments on the last mile through a network of private couriers, carrying parcels on premeditated trip with only small deviations from the original route (Le and Ukkusuri, 2019a). In this way, excess capacities on travel patterns of the couriers are used (Paloheimo, Lettenmeier and Waris, 2016). The fact that the average passenger car in urban travel is occupied by only 1.3 persons (European Environment Agency, 2021) underlines the potential of higher utilization of individual trips for freight delivery. The positive contribution of CSD on last-mile logistics is threefold. Firstly, it increases the delivery capacity in the urban area by individual people, relieving traditional courier, express and parcel services (CEP) providers (Chen and Chankov, 2017). Secondly, CSD allows for an ad-hoc delivery of parcels, independent of routes and the number of transmission runs of CEP providers (Shen and Lin, 2020). Thirdly, if parcels are delivered on premeditated trips with only small deviations from the original route, CSD reduces traffic and CO2 emissions in the urban area (Carbone, Rouquet and Roussat, 2017). Various firms have identified the need for CSD as a new approach to provide shipments to their customers. In a global research study incorporating more than 2,700 retail professionals nearly 90% expected to use CSD to

handle requests in daily business by 2028 (Zebra Technologies, 2018).

As with all crowd-based services, CSD platform providers need to have a critical mass of participants to offer the fast and reliable deliveries that are expected by customers (Frehe, Mehmann and Teuteberg, 2017; Behrend and Meisel, 2018). For this reason, it is necessary to find out which attributes of a single CSD request influence the couriers' willingness to accept a CSD request. Only a limited number of empirical-based literature has contributed to this field of research. Predominantly, the present literature is focused on financial attributes for request acceptance for potential couriers, followed by demographic and time-dependent determinants. However, none of the studies examined the interrelation between these attributes and insights regarding which attribute outweighs the others in combination are missing (Le and Ukkusuri, 2019b). Still, as supported by other platform business models, it is essential to consider the attributes as a whole rather than individually to make sufficient predictions about the respective importance for potential couriers (Wang and Lai, 2020). Therefore, this paper addresses the interrelationship of different attributes influencing the willingness of potential couriers to take over a request in the CSD concept. It is guided by the following research question.

- RQ1: How are different attributes of a CSD interrelated in the acceptance of a request by potential couriers?

Serafini, et al. (2018) showed that demographics and sentimental traits determine whether potential couriers are willing to participate in a CSD concept. Therefore, it is concluded that the interrelation between attributes characterizing a CSD request diverges between different participant groups. Based on that, a second research question is conducted:

- RQ2: How do the couriers' characteristics affect the interrelationship of different attributes of a CSD in the request acceptance?

The contribution of the paper is the following. It is the first paper to examine the respective importance of different attributes of a CSD request for potential couriers. Based on the results, CSD platform providers can achieve a higher individualization of CSD requests for couriers, leading to more executions of CSDs. In this way, the results allow to a higher competitiveness of CSD platform providers and the reduction of

logistics-related environmental externalities. Moreover, the study contributes to the scarce literature on understanding the promising concept of CSD. Finally, the study strengthens the application of marketing-related methodologies in logistics research.

2 Background

The phenomenon of sharing economy received increasing attention from scholars and is already present in many industries (Kathan, Matzler and Veider, 2016). Driven by digital and technological developments, individuals are enabled to monetize their skills and make use of their underutilized resources (Belk, 2014). These developments contributed to the creation of the neologism “crowdsourcing”, established by Howe (2006). With regards to the delivery of parcels, CSD emerged as “the outsourcing of the last mile delivery to a mass of actors through the coordination of a technical infrastructure” (Mehmann, Frehe and Teuteberg, 2015, p. 123). Technical infrastructure includes innovations, such as mobile communication via smartphones and accurate localization via GPS (Alnaggar, Gzara and Bookbinder, 2021). These enable the exchange of CSD requests via a digital CSD platform (Basik, et al., 2018).

On a CSD platform, shippers and couriers of a parcel delivery are brought together. The shippers are CEP providers having their shipment carried out by a CSD, e-retailers substituting a traditional CEP provider and individual persons (Frehe, Mehmann and Teuteberg, 2017; Alnaggar, Gzara and Bookbinder, 2021). Couriers are individual persons who voluntarily register on the platform. Their motivation to participate in a CSD is mainly the remuneration but also intrinsic motivations, such as new experiences and enjoyment of the task act as further motivators (Huang, et al., 2020). If the shipper wants an item to be delivered to a recipient, the CSD is placed as a request via the platform. Based on the respective information on the CSD, couriers simply select the requests that match their scheduled trip and delivery preferences (Alnaggar, Gzara and Bookbinder, 2021). After a request’s acceptance, the CSD is carried out by the courier’s preferred way of transportation (on foot, bike, car or public transportation) (Seghezzi, et al., 2020). Finally, the courier confirms the successful CSD and receives a pre-defined remuneration from the shipper that is based on a selection of price-determining factors, such as

distance, parcel weight or waiting time.

According to Carbone, Rouquet and Roussat (2017), CSD is a relatively new field of research and differentiates from similar crowdsourcing services in logistics, such as crowd storage or crowd freight forwarding. The existing literature on CSD is differentiated the following. Firstly, literature on CSD operations is addressing the underlying decision-making systems to enable the execution of a CSD most efficiently. This includes the matching of potential couriers with a single CSD request based on the couriers' communicated transportation routes and time constraints (e.g., Archetti, Savelsbergh and Speranza, 2016; Dayarian and Savelsbergh, 2017; Guo, et al., 2019), route optimization for a CSD of multiple parcels (e.g., Macrina, et al., 2017; Arslan, et al., 2019; Ulmer and Savelsbergh, 2020) and the ideal level of remuneration for a courier (e.g., Qi, et al., 2018; Dai and Liu, 2020). Secondly, literature refers to the positive contribution of CSD in reducing CO2 emissions and total costs of delivery (Lee, Kang and Prabhu, 2016; Devari, Nikolaev and He, 2017). Thirdly, literature is examining the motivators to participate in the CSD concept itself. It becomes apparent that most literature identified remuneration as the most important motivator for participation, accompanied by trust in the concept and flexibility of working (Feller, et al., 2012; Mladenow, Bauer and Strauss, 2016; Huang, et al., 2020). Moreover, demographic determinants, such as age, ethnicity and income were identified (Serafini, et al., 2018; Le and Ukkusuri, 2019b; Punel, Ermagun and Stathopoulos, 2019). Fourthly, sparse literature is dedicated to the motivational factors to accept a single CSD request when participating in the concept, considering determinants, such as remuneration, parcel size, day of delivery and delivery distance (Ermagun and Stathopoulos, 2018; Le and Ukkusuri, 2019b).

Ultimately, some limitations of the CSD concept need to be mentioned. Whereas a CSD allows for high flexibility for the couriers by completely leaving the decision for the request acceptance by them, CSD platform providers cannot guarantee a delivery in case the request is not accepted by potential couriers (Alnaggar, Gzara and Bookbinder, 2021). Therefore, it is expected that CSD will be a supplement to traditional shipping by CEP providers, rather than a replacement (Punel, Ermagun and Stathopoulos, 2019). Moreover, several issues concerning the trust and liability of couriers during a CSD are still unclear and call for clarification (Rougès and Montreuil, 2014). Finally, potential

rebound effects are possible, if the increase in individual deviations from the original trip offsets the benefits from a higher utilization in passenger cars (Paloheimo, Lettenmeier and Waris, 2016).

3 Methodology

3.1 Choice-based conjoint analysis

Whereas the choice-based conjoint analysis (CBC) is rarely used in the supply chain management domain, it is a commonly applied quantitative research methodology in marketing (Maldonado, Montoya and Weber, 2015). The purpose of CBC is to examine customers' preferences towards the features or functions of a product or service. However, it is also applicable for other contexts beyond purchasing decisions (Reutterer and Kotzab, 2000). The following characteristics of CBC emphasize the methodology is particularly well suited to answer the proposed RQs. Firstly, participants consider all attributes of a CSD simultaneously by asking them to choose one of several different CSD requests that randomly diverge by a predefined set of attributes (Anderhofstadt and Spinler, 2020). Thus, a realistic situation is simulated since in practice more than one isolated attribute determines the decision of accepting a CSD (Green and Srinivasan, 1990). Secondly, unlike similar preference methods, CBC is suitable for evaluating

preferences for hypothetical products or services (Scherer, Emberger-Klein and Menrad, 2018). Assuming that most respondents are still unfamiliar with CSD, the CBC is preferred as a research methodology in this paper. Figure 1 illustrates the subsequent process outlined by Anderhofstadt and Spinler (2020) for CBC, further described in the following.

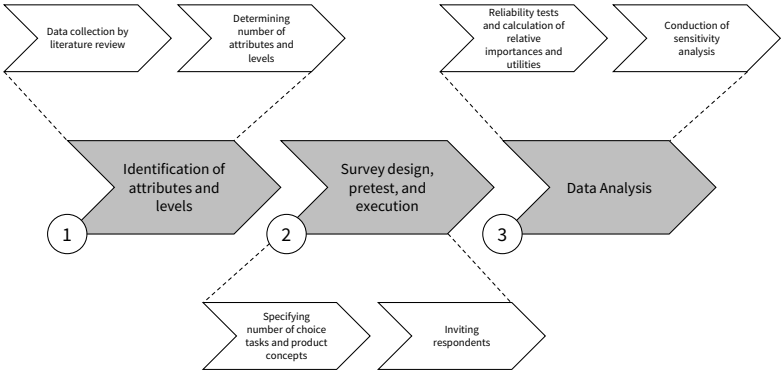

Figure 1: CBC experiment process phases, own representation based on Anderhofstadt and Spinler (2020)

3.2 Identification of attributes and levels

A careful selection of relevant and limited attributes and levels is very important when conducting a CBC to provide simplified, yet realistic alternatives (Lohrke, Holloway and Woolley, 2010). In this context, levels express the different characteristics of an attribute. The attributes and their levels used in this paper are described in Table 1. According to Le and Ukkusuri (2018), delivery time is considered an important influencing factor to the willingness to work as a crowd-shipper. As CSD is characterized by delivery on a commuter route rather than an additional trip, delivery time is specified as the deviation from the travel time that takes place anyway. Following Le and Ukkusuri (2019a), the delivery time range was defined from five up to 30 minutes of extra time. Additionally, remuneration referred to the monetary compensation of a courier when executing a CSD request. The levels of remuneration ranged between one to five EUR per delivery,

Table 1: Attributes used in the CBC analysis

Attribute	Levels
Delivery time	5 minutes, 10 minutes, 20 minutes and 30 minutes
Remuneration	None, 1 €, 2 €, 3 €, 4 EUR and 5 €
Degree of familiarity	Relative, close friend, neighbor, working colleague, acquaintance, unknown person
Parcel weight	2 kg, 5 kg, 10 kg and 15 kg

following the typical range of two to four EUR provided by existing CSD platforms (Paloheimo, Lettenmeier and Waris, 2016; Marcucci, et al., 2017). To address potential altruistic motivation among the respondents, the level of "none" remuneration was added. The degree of familiarity was selected as another attribute, defining the relationship of the potential courier to the recipient of the CSD. Based on the studies of Devari, Nikolaev and He (2017) and Le and Ukkusuri (2019a), a set of six levels was selected, containing relative, close friend, neighbor, acquaintance, working colleague and unknown recipient. Since other means of transportation than a car can be considered for a CSD, the parcel weight was defined as the last attribute. Based on the standard weights of parcels from the CEP service provider DHL (2021), the levels ranged from 2 kg to 15 kg. Although the maximum possible weight of parcels can be higher, the levels were selected to assure that all potential CSD requests could be delivered without auxiliary means of transport.

3.3 Survey Design, Pretest and Execution

The CBC was conducted using the online survey tool Sawtooth Software Lighthouse Studio 9.9.1. Sawtooth is a standard software used in academic literature to generate and analyze CBC and has been used in several previous CBC studies (e.g., Apostolakis, et al.,

2018; Scherer, Emberger-Klein and Menrad, 2018; Anderhofstadt and Spinler, 2020). At the beginning of the survey, CSD, as well as the research scope, were briefly explained. Afterward, demographic information of the respondents was requested. Subsequently, the respondents' previous experiences with CSD and their willingness to work as a courier in a CSD concept were asked. Those participants who were willing to take part in a CSD were asked to put themselves in the position of a potential courier by selecting a common route and means of transportation and were presented the choice tasks. After the explanation of the CBC procedure, a total number of twelve choice tasks was presented to each participant. For online-based CBCs, about ten choice tasks per respondent are recommended to avoid a decline in data quality (Sawtooth, 2019b). One choice task included four single CSD requests that were differentiated by the random selection of a level for each of the four attributes. To maximize the efficiency of the survey design in the selection of decision options, both a balanced design and orthogonality were ensured (Hair, J., Black, W., Babin, B. and Anderson, R., 2014). Therefore, the choice tasks were generated using Sawooth's balanced-overlap function that guaranteed no duplication of the same attribute levels within the same task. Each choice task included a "none" option to make the CBC even more realistic in case that none of the decision options was attractive (Sawtooth, 2019b; Souka, et al., 2020). To measure the validity and reliability of the CBC model, two fixed tasks with manually selected attributes' levels were included (Anderhofstadt and Spinler, 2020). Both were identical for all respondents. The fixed tasks comprised one more preferred and three less preferred choices. They were used to test whether participants decided the same for both tasks or if decisions were made randomly. After finishing the twelve choice tasks, further questions regarding the participants' frequency of parcel delivery, individual attitude to sustainability and personality traits were questioned.

Before the official survey launch, a pre-test was conducted with six candidates from academics and practice to test the survey design and their feedback was included in the final study design. The CBC was conducted between November and December 2020 in Germany by inviting potential respondents to participate via mail. Additionally, the survey links were shared on social media platforms (Halassi, Semeijn and Kiratli, 2019).

The survey link was opened 544 times, thereof 329 respondents completed the

questionnaire (60.5%). In the analysis of the CBC, only participants willing to participate in a CSD (63.8%) were included, of which another eight "straight liners" and an additional nine participants having a relatively low RLH value below 0.4 (see section 4.1) were excluded. This resulted in a final sample of 193, which is far beyond the necessary 50 respondents for a CBC proposed by Hair et al. (2014).

4 Results

4.1 Data Analysis

The data analysis was conducted using an iterative process by Hierarchical Bayes (HB) estimation (Sawtooth, 2021b). Following Scherer, Emberger-Klein and Menrad (2018), 20,000 iterations were performed, whereas the first 10,000 were necessary to achieve convergence and the following 10,000 were applied for the actual model estimation. To secure the results' validity and reliability, several tests were conducted. Based on the two fixed choice tasks, the test-retest rate was calculated. It showed that 91% of the participants answered both fixed tasks as intended, accounting for a high internal consistency (Apostolakis, et al., 2018). Moreover, the goodness of fit of the HB model was tested by calculating its root likelihood (RLH) value. The closer the RHL is to 1.0 and the further away from the critical value of 1/k, the more likely it can be assumed that respondents did not choose randomly (Sawtooth, 2021a). K is indicating the number of decision options presented in one choice task. The RLH of the present model was 0.69, displaying a much better fit than the 0.25 of a potential chance model with four different choices.

4.2 Demographics

The sample for the CBC included 193 participants that were willing to act as a courier of a potential CSD platform. The sample was mainly female (68.0%) and had an average age of 33 years. Most of the participants had a university degree (43.1%), followed by a high school diploma (27.9%) and a middle school diploma (23.9%). The sample included mainly full-time employees (55.3%) and students (26.4%). The level of income was very

diverse with a median income of between 30.000 and 49.999 EUR. 2.5% of the participants had made experiences as a courier in a CSD concept already. With regards to the commuter route, most respondents chose to deliver parcels on their way from work to home (42.1%), followed by going out for shopping (22.8%). On these routes, the majority favored using a car (63.5%) over public transportation (13.7%) and bicycle (13.2%). The sample was predominated by respondents that were willing to participate at least one to two times per week (66.0%), whereas 10.7% outlined participation only once or twice a month.

4.3 Relative importance and part-worth utilities

Relative importance and part-worth utilities were calculated for all attributes. The relative importance represents the individual attributes' contribution to the decision-making process within a CBC (Sawtooth, 2019a). It was calculated by taking the absolute distance between the part-worth values (regression coefficients) of the most and least preferred level (highest and lowest importance) of a particular attribute, divided by the sum of the ranges across all attributes (Tabi and Wüstenhagen, 2017). The part-worth utilities indicate the degree of influence of each attributes' level on the choice of the respondent. Consequently, it serves as a predictor for the respondents' choice task decisions. Part-worth utilities for the four identified attributes were calculated across all 193 participants, using computer-supported HB estimation. The results for the relative importance presented in Figure 2.

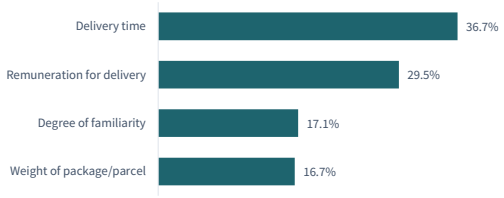

Figure 6: Relative importance of CSD attributes, own representation

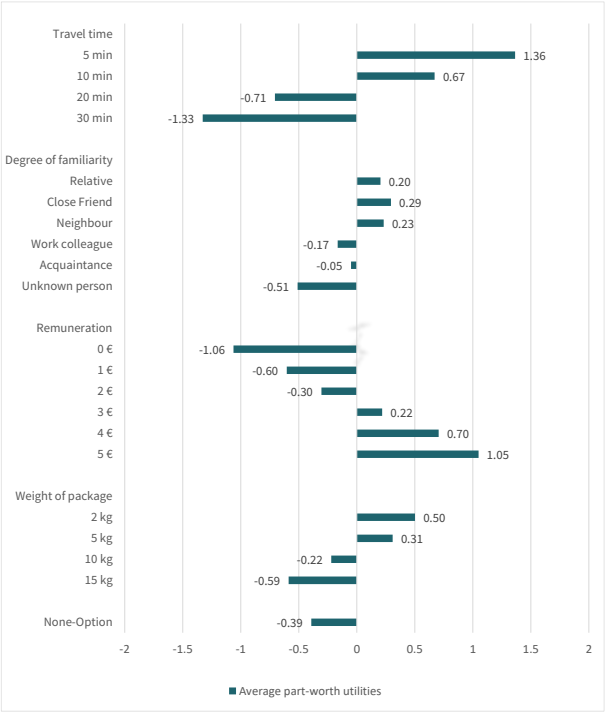

Figure 3: Average part-worth utilities of attributes' levels, own representation

The results of the part-worth utilities analysis are displayed in Figure 3. They are scaled to an arbitrary additive constant within each attribute. Negative utility values indicate that the respective level is less preferred to the other attribute's levels. The results show that CSD couriers prefer shorter delivery times, higher compensation and lower parcel weight. Surprisingly, participants preferred delivering a parcel to close friends and neighbors over their relatives. Moreover, results show that delivering a parcel to an acquaintance is preferred over a working colleague.

4.4 Sensitivity Analysis

To refine the results of the part-worth utilities, a sensitivity analysis was conducted by using Sawtooth Market Simulator. This analysis shows how sensitive participants react

Table 2: Scenarios of the sensitivity analysis, own representation

Scenario	Share of Preferences	Delivery Time	Remuneration	Degree of familiarity	Parcel weight
Best Case (1)	99.0 %	5 min	5 €	Relative	2 kg
2	97.0 %	10 min	5 €	Relative	2 kg
3	78.7 %	20 min	5 €	Relative	2 kg
4	61.6 %	30 min	5 €	Relative	2 kg
5	99.0 %	5 min	4 €	Relative	2 kg
6	96.9 %	5 min	3 €	Relative	2 kg
7	94.8 %	5 min	2 €	Relative	2 kg
8	88.7 %	5 min	1 €	Relative	2 kg
9	80.3 %	5 min	none	Relative	2 kg

Scenario	Share of Preferences	Delivery Time	Remuneration	Degree of familiarity	Parcel weight
10	98.7 %	5 min	5 €	Close Friend	2 kg
11	99.1 %	5 min	5 €	Neighbour	2 kg
12	99.0 %	5 min	5 €	Working colleague	2 kg
13	98.5 %	5 min	5 €	Acquaintance	2 kg
14	96.8 %	5 min	5 €	Unknown person	2 kg
15	98.3 %	5 min	5 €	Relative	5 kg
16	92.9 %	5 min	5 €	Relative	10 kg
17	85.8 %	5 min	5 €	Relative	15 kg

to different changes around a predefined base scenario (Danielis, Marcucci and Rotaris, 2005). The results of the sensitivity analysis can be more easily interpreted than the part-worth utilities and allow for comparison between different potential CSD requests. For conducting the sensitivity analysis, the best-case scenario (shortest delivery time, highest remuneration, delivering to relatives, lowest parcel weight) was selected as the base case scenario. Based on the part-worth utilities, individual shares of preference were calculated. These indicate the probability of choosing a simulated decision option by the respondents over all other possible decision options. For instance, a share of

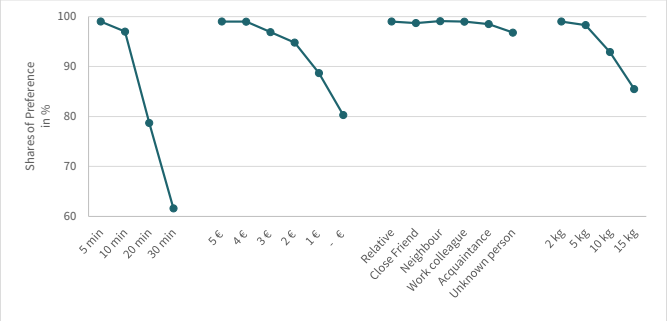

Figure 4: Sensitivity analysis based on the total sample, own representation

preference of 99% for the base case scenario signifies that 99% of the respondents would choose this decision option over the others, whereas 1% would not. By “changing one attribute level while holding all other attributes at base case levels” (Sawtooth, 2019a, p. 81), all levels within the respective attributes were tested. This approach resulted in 17 different scenarios, presented in Table 2.

The results (see Figure 4) show, for instance, that the increase of a delivery time from five to ten minutes only leads to a reduction in preference of two percentage points. Contrary, if delivery time increases from 10 to 20 minutes, the share of preference decreases by 18 percentage points. Sensitivity analysis was repeated for different groups within the sample, to allow further refinement of the respective share of preferences.

Firstly, differences in sensitivity for delivery time and remuneration between male and female potential couriers were noticed (see Figure 5 in appendix). Men were far more sensitive to an increase in delivery time of more than 10 minutes in their share of preference. For instance, whereas women’s share of preference for scenario 4 was 65%, it only reached 53% share of preference among men. Simultaneously, men were slightly more sensitive to the remuneration, if the remuneration was less than two EUR.

Secondly, it became apparent that the age group with the more mature respondents is the most sensitive to changes (see Figure 6 in appendix). This particularly refers to the delivery time and parcel weight. Interestingly, sensitivity for the remuneration was highest among the mature group and lowest among the middle-aged group.

Thirdly, extensive differences were discovered with regards to the four groups of frequency of delivery that potential couriers would be willing to execute a CSD (see Figure 7 in appendix). The respondents with the lowest frequency of delivery were far more sensitive than the other three groups. For instance, whereas respondents willing to deliver one to two times a month preferred scenario 4 (see Table 2) with only 40%, it was 74% among the frequent deliverers (three to five times a week).

Fourthly, attention was paid to the respondents' personal characteristics (Figure 8 in appendix). For assessing the respondents' attitude to environmental protection, their degree of environmental concerns was questioned. The analysis shows that respondents being very worried about the environment were more sensitive to parcel weight than respondents that were worrying less about the environment. Additionally, respondents that were less worried about the environment were more sensitive to remuneration.

With regards to the sentimental traits of the respondents, a shortened version of the widely used OCEAN model was applied (Gosling, Rentfrow and Swann, 2003). This model quantifies the human personality traits into five broad, empirically proven dimensions. Respondents were asked to rate the extent the respective dimension matched their personality on a five-point Likert scale. Based on the rating of all participants, the median was calculated. Those respondents with a rating below the median were assigned to the "negatively" connoted expression of the dimension (e.g., reserved), while others were assigned to the "positive" connoted group (e.g., extraverted) for each of the respective dimensions. Exemplary, the analysis shows a higher sensitivity for the extraverted respondents in delivery time and parcel weight (see Figure 9 in appendix). Contrary, concerning remuneration, reserved respondents were more sensitive.

5 Discussion

The success of a CSD platform is determined by the critical mass of its users working as potential couriers (Buldeo Rai, Verlinde and Macharis, 2019). From all the 329 respondents, a considerable 63.8% said that they were willing to participate in a CSD concept. This is remarkably higher than the 30% discovered by Miller, Nie and Stathopoulos (2017), but still less than the 87% as surveyed by Marcucci, et al. (2017). Considering that these studies' samples were comparable in their panel composition regarding the demographics but different in the country the sample was generated, this study indicates that the willingness to act as a CSD courier may dependent on cultural backgrounds. Therefore, further research is needed on country-specific effects to act as a courier to enable practitioners to adapt their CSD platforms to the national couriers' requirements.

Marcucci, et al. (2017) showed that the willingness of participants to receive a parcel by a CSD is significantly higher (93%) than to deliver a parcel. To secure that this demand can be satisfied, the "supplier side" is of particular interest to scholars and practitioners. If attractive CSD requests are presented to potential couriers, the chance of finding a respective courier increases. Based on that, RQ1 ("How are different attributes of a CSD interrelated in the acceptance of a request by potential couriers?") will be discussed.

In the present study, delivery time turned out to be the most important determinant in selecting a particular CSD request. That is opposed to the existing literature that suggested remuneration being the most important factor for participating in a CSD (e.g., Paloheimo, Lettenmeier and Waris, 2016; Miller, Nie and Stathopoulos, 2017). The relevance of delivery time in this study is further emphasized by the fact that respondents were more sensitive to changes in this attribute than to remuneration. This can be accounted to the fact that the potential courier in the present sample are pursuing more altruistic objectives with taking over a CSD than to profit financially. However, their resources in time dedicated to CSD are limited to a maximum of ten minutes in deviation on their commuter way. Therefore, limiting the deviation of travel distance to 2.4 km for an individual courier as proposed by Marcucci, et al. (2017), is a decisive factor for the success of a CSD platform. Practitioners are recommended to follow this through the

algorithms proposed by Giret, et al. (2018) or Wang, et al. (2016). Although remuneration was less decisive as delivery time, this attribute still accounted for nearly a third of the respondents' decisions. Consequently, further research on algorithms to find the best remuneration, whereas reducing the deviation in travel time is proposed.

With regards to the degree of familiarity of the recipient, the results differ from the findings of Devari, Nikolaev and He (2017). Their study showed a large proportion (72%) of respondents that were only willing to participate in a CSD if they would be delivering parcels to (close) friends. Still, in the present sample, respondents merely declined a CSD, if delivering a parcel to acquaintances or even unknown recipients. Further, the degree of familiarity accounted less for respondents' overall share of preference. This could be attributed to country-specific perceptions of security. As the sample only contained German participants, respondents might have fewer concerns regarding their safety compared to the studies conducted in other countries (Mamdooh, 2016). Therefore, this study suggests that the degree of familiarity is less decisive in taking over a CSD in Germany. This is a positive outcome, as when couriers were only delivering to known persons, the crowd effect would often not be feasible. For practitioners, the results highlight that potential couriers can be attracted to their platforms, albeit their social network is not participating in CSD.

Only a few studies have considered parcel weight as a determinant of selecting a CSD request. As existing studies assumed that the CSD is executed by car, parcel weight did not represent a limiting factor. The present study explicitly considered other ways of transportation as well, allowing for a higher influence of this factor. Surprisingly, the analysis revealed that the parcel weight's relevance is much lower than for delivery time and remuneration. This is accounted to the fact that, although all means of transportation were included, most of the respondents would execute the CSD by car. Therefore, parcel weight should not represent a limiting factor, as compared to other ways of transportation. Simultaneously, respondents were more sensitive to changes in parcel weight than to the degree of familiarity. Therefore, it is suggested for CSD platform providers to individualize the requests for potential couriers based on their preferred way of transportation. To refine the relevance of parcel weight for different ways of transportation, further research is needed under the consideration of the modal shift of

individual traffic in urban areas.

Studies further show that individual behavior is dependent on surface-level characteristics of an individual as well as its deep-level characteristics (Spickermann, Zimmermann and van der Gracht, 2014). Thus, surface-level characteristics (gender, age, delivery frequency) and deep-level characteristics (environmental concerns, extraversion) of the respondents were accounted for within the sensitivity analysis. Based on that, RQ2 ("How do the couriers' characteristics affect the interrelationship of different attributes of a CSD in the request acceptance?") is examined. It is worth mentioning that the best case was chosen as a base case scenario in the analysis. Therefore, the shares of preferences are relatively high. Selecting another scenario as a base case would lead to lower shares of preference, yet the sensitivities would be the same.

The results show that men are more sensitive to remuneration than women. It is suggested that this is justified by the fact that women are more open to CSD than men (Le and Ukkusuri, 2019a). Consequently, men experience the participation as more effortful, resulting in higher expected remuneration. Moreover, women showed a higher willingness to deliver parcels on an additional trip longer than 10 minutes. Thus, it is recommended to process CSD requests with a higher deviation in travel time by women. Surprisingly, no significant differences concerning the parcel weight were identified. Despite different physical conditions, the results indicate that parcel weight can be neglected when individualizing requests in consideration of gender.

The results of the sensitivity analysis were more diverse when accounting for the couriers' age. The daily routines of older couriers are more established, resulting in a lower acceptance of higher deviations for a CSD from the original trip. In contrast to gender, parcel weight plays a decisive role for couriers of different ages. These results reflect physical constraints due to an increase in age. The provision of easy-to-handle tools for frequent couriers through the CSD platform provider represents a potential solution to this limitation. Interestingly, the sensitivity for remuneration was highest among the middle-aged group. This age group subsumes the highest income earners in Germany (Destatis, 2017). Therefore, an additional income by CSD is perceived as less necessary among this group, resulting in a higher decline of lower-paid CSD requests. For

practitioners, these results highlight that offering an attractive remuneration is particularly relevant for the age area (Roberts and Manolis, 2000). Consequently, to reduce the costs for a CSD, particularly younger and older age groups should be addressed as potential couriers.

Moreover, it is assumed that respondents who were willing to frequently participate in CSDs value its positive effects for the environment and themselves higher as the less frequent couriers. This is reflected in the sensitivities, as respondents that were willing to frequently participate in CSDs are characterized by a lower sensitivity along with all attributes. Therefore, it is proposed for CSD platform operators to actively present the most attractive requests to couriers with a lower delivery activity. In this way, their engagement is increased, whereas the frequent CSD couriers are still satisfied with less attractive requests.

With regards to the deep-level characteristics of environmental concerns, it was expected that respondents that paid lower relevance to environmental protection would be more sensitive. Surprisingly, this applies only to remuneration and parcel weight. Consequently, these participants must pursue alternative objectives with their participation that kept their motivation to select a CSD request on a high level. To examine these motives in depth is proposed as a promising field for further research. Interestingly, respondents with higher environmental concerns were more sensitive to changes in parcel weight. This might be accounted by the fact that they use more environmentally friendly ways of transportation, such as a bicycle or public transportation, limiting the parcel weight that they are capable to carry. Finally, the sensitivity in consideration of the respondents' extraversion as an additional sentimental was exemplary examined. The analysis showed minor, yet recognizable differences between the respondents. Summarized, it is emphasized that the deep-level characteristics of environmental concerns and extraversion influence the decision-making process in a CSD. For practitioners, it is recommended to account for these differences by individualization of CSD requests. Therefore, it is recommended to apply surveys to identify their couriers' sentiments beforehand.

6 Conclusion

The last mile logistics faces major upcoming challenges. Increasing parcel quantities are accompanied by higher customer expectations of immediate delivery, yet causing environmental externalities. CSD represents a complementary for traditional last mile logistics. Based on the principle of crowdsourcing, CSD outsources the last mile delivery to a mass of voluntary couriers via digital platforms. Through the delivery of parcels on premeditated trips with only small deviations from the original route, CSD leads to higher utilization of urban transportation capacities. Whereas first literature deals with CSD attributes that result in the acceptance of a respective delivery, the attributes' relative importance towards others remains unclear. Therefore, a choice-based conjoint analysis was conducted, including 193 respondents who were willing to participate in a CSD concept. Respondents were asked to select one of three different potential CSD requests in 12 scenarios. The CSD requests were distinguished by different levels of delivery time, remuneration, degree of familiarity with the recipient and parcel weight.

The analysis of the relative importance displays that deviation of the original travel time and remuneration had the greatest impact on customers' request selection. The results show that the degree of familiarity with the recipient and parcel's weight were less decisive in a request selection. Based on sensitivity analysis, it became apparent that the sensitivity for the delivery time was higher than for remuneration among all groups. Moreover, results of the sensitivity analysis were further refined for various groups, differentiated by surface-level and deep-level characteristics. By considering the results, a higher individualization of CSD requests is enabled for CSD platform providers, leading to a higher acceptance rate among potential couriers.

Eventually, some limitations need to be mentioned. Firstly, most of the sample had no previous experience in working as a courier. Consequently, they might behave differently when choosing a real CSD request. Secondly, the respondents' motivation for participating in a CSD remained unclear. Further research could explicitly examine the motivation's influence on respondents' decisions. Thirdly, CBC was limited to four attributes of a CSD to limit complexity. Thus, further research might consider other attributes, such as platform usability, delivery day or flexibility of pick up/delivery time.

Appendix

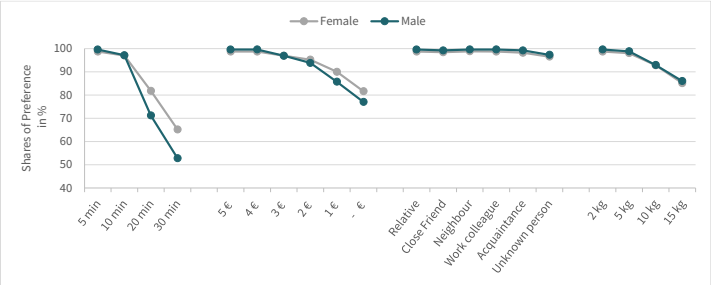

Figure 5: Sensitivity analysis based on gender, own representation

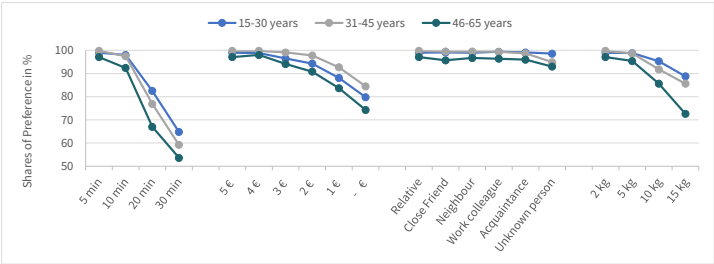

Figure 6: Sensitivity analysis based on age, own representation

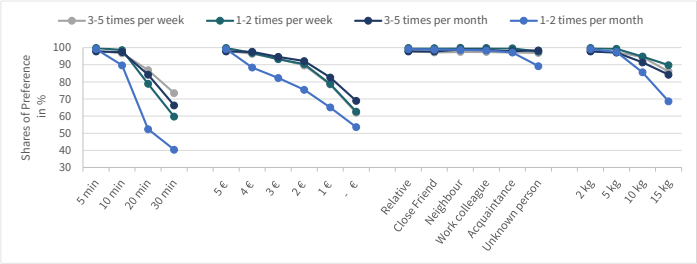

Figure 7: Sensitivity analysis based on the frequency of delivery, own representation

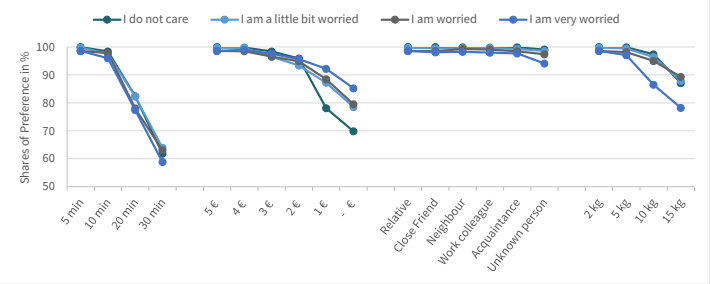

Figure 8: Sensitivity analysis based on environmental concerns, own representation

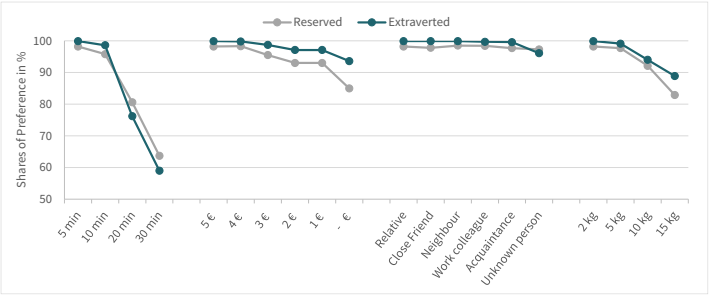

Figure 9: Sensitivity analysis based on extraversion, own representation

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