

Developing and testing a methodology for acquiring the logistical characteristics of shopping malls in Budapest, for city logistical solutions

Bálint Mészáros, Dávid Lajos Sárdi

Budapest University of Technology and Economics,
Department of Material Handling and Logistics
Bertalan Lajos str. 7-9, 1111 Budapest, Hungary
Email: meszaros_balint@hotmail.com;
david940624@gmail.com

Krisztián Bóna, PhD

Budapest University of Technology and Economics,
Department of Material Handling and Logistics
Bertalan Lajos str. 7-9, 1111 Budapest, Hungary
Email: krisztian.bona@logisztika.bme.hu

Abstract—Urban freight transport poses significant problems in cities around the world: trucks play a major role in congestion, environmental and noise pollution and damage the roads. Shopping centers are problematic in particular as they concentrate a large number of retail stores in a relatively small space. There are 18 shopping malls in Budapest alone, each containing 180 stores on average, therefore there is great potential in streamlining their deliveries. The most effective solution is a cooperative city-logistics system, a freight consolidation scheme. Goods would be shipped to consolidation centers located on the periphery of the city and forwarded from there to shopping centers in a coordinated manner by using eco-friendly vehicles. However, there is a shortage of available data regarding the logistical operations and freight quantities of shopping malls, therefore prior to creating such a consolidation scheme, it is inescapable to develop a methodology by which the logistical characteristics of any shopping center can be obtained. This paper presents the development and structure of this methodology as well as the data we have gathered after testing it on one of Budapest's shopping centers, Allee. At the end of the paper we make conclusions on the methodology's usability, strengths and shortcomings, with special attention as to whether it can serve as a basis for a cooperative consolidation scheme.

Keywords—city logistics, consolidation scheme, shopping mall, urban freight distribution, methodology, research, environment

I. INTRODUCTION

In the case of shopping centers there appear to be a number of logistical problems that could be alleviated with a specifically designed city logistics system. In general, during the design and operation of shopping malls, the primary focus is to satisfy the needs of shoppers and to maintain a high level of shopping experience, therefore the design and optimization of their logistical processes are often neglected to some extent.

Shopping malls concentrate a large number of stores into a relatively small space. Budapest's 18 malls contain 180 stores on average. Inner city malls are only accessible using the city's roads, therefore trucks play a major role in congestion, environmental and noise pollution and the deterioration of roads. These problems are not prominent to the public in the case of shopping malls, since their logistical areas are usually out of sight, and it is not always obvious that freight vehicles play a

role in congestion. Moreover, it can be said in general that there are no available data regarding the freight traffic quantities, storage management and other logistical processes. Thus, in order to establish an integrated development concept, it proved to be necessary to create a methodology that helps to uncover the problems and challenges in the current, real life processes, as well as to quantify inbound deliveries and amount of storage needed.

A modern and environment friendly freight transport system would consist of a consolidation center located on the periphery of the city, from which goods could be shipped to shopping centers in a coordinated manner by using eco-friendly vehicles [1]. This scheme could utilize the city's railway network, the waterways, but even the road network with certain innovations (e.g.: electric vehicles). The transport network of Budapest has enormous potential. The tram network is 156.85 km long [3] and there are existing tracks in the close vicinity of nearly all shopping malls from which side tracks could provide direct access to the malls' logistical areas.

Utilizing the city's railways for freight transport would not be an entirely new concept/phenomenon in Budapest as up until 1997 several factories were served via the tram network [4]. Currently a couple of European cities exploit the potential in their railway network outside passenger transport. Zurich uses it for garbage collection [5], and in Dresden a large Volkswagen company employs it as a freight shuttle service through Dresden's city center [6].

An other environment friendly possibility for Budapest would be to take advantage of the immense potential that the river Danube offers. In this scenario the so called cargo ships would function as floating warehouses carrying electric vehicles that could serve nearby shopping malls after docking. This system layout couldn't reach all of the shopping malls in Budapest, but more than half, specifically 12 of them would be within reach. A similar system is in operation in Amsterdam, where DHL utilizes cargo trams for small parcel deliveries [7].

The Broadmead freight consolidation scheme in Bristol, England can be perceived as a benchmark in our opinion. This scheme is a cooperative goods delivery service with 53 participating retailers in a 300 store shopping mall located in

Bristol's city center. Data after the scheme's first two years of operation is more than encouraging: between 2004 and 2006 vehicle movements were reduced by over 72% on average, which equates to a reduction of over 96,000 truck kilometers. This in turn has contributed to an environmental improvement through reductions of CO₂ emission by 11,3 tons, NO_x by 1.75 tons and PM10 by 243 kg's. Retailers have also benefited from an improved delivery service with no lost or damaged stock and 100% on time deliveries to date. A retailer satisfaction survey carried out revealed that 94% would recommend the service to another retailer and more than half of retailers are saving over 20 minutes per delivery, additional time they can spend on the shop floor [8].

II. PRESENTATION OF THE METHODOLOGY

The main objective of the methodology is to uncover, gauge and quantify the logistical problems that may arise regarding shopping centers' operations. To achieve this, we employed both qualitative and quantitative approaches that complement each other. The first part of our methodology is an exploratory research which includes an expert interview and a field study. These methods help to closely observe and understand in detail the shopping mall's internal logistical processes (e.g.: freight traffic volume, loading and unloading, inverse logistics) as well as the external characteristics (e.g.: location, access, limited freight zones). The topics of the exploratory research phase can be found in TABLE I.

TABLE I. TOPICS OF THE EXPLORATORY RESEARCH SEGMENT OF THE METHODOLOGY

External Characteristics	Internal Characteristics	
Limited zones for freight traffic in the neighborhood of the mall, congestion charges	Size of the mall, number of shops in the mall	Collection and transport of waste
Tram lines in the vicinity of the mall	Inbound delivery periods of the mall	Handling of hazardous waste
Proximity of the Danube	Freight receiving areas of the mall, capacity and size	Number and location of storage areas in the mall
Bus lanes in the area of the mall	Moving of goods inside the mall	Possibilities for renting warehouses in the area of the mall
Other limitations on the roads in the area of the mall	Places for loading and unloading in the mall	Summary of discovered problems

The other part of our methodology is a descriptive research. It includes a comprehensive questionnaire that is to be filled out by all of the shopping center's retailers. We used a census survey since our target population and their locations are well defined, and furthermore the objective of the questionnaire is to obtain data on the shopping mall as a whole. The reason why we chose to include a questionnaire is that it is a great tool for quantifying the mall's logistical properties and problems.

The 26 questions in the questionnaire make up 7 topics, which may be found in TABLE II. The most important topic that also includes the most questions, deals with the properties of inbound deliveries. This comes from the main objective of the methodology; in order to establish the basis of a cooperative

delivery scheme it is imperative to determine the volume of freight traffic, its distribution in time and other properties.

TABLE II. TOPICS OF THE QUESTIONNAIRE

Topics of the questionnaire	Number of questions
Basic properties of the shops	5
Properties of inbound deliveries	12
Properties of the storage areas	3
Reverse logistics of the shops	1
IT background of the shops	1
Electronic commerce in the mall	3
Willingness to participate in the cooperative delivery scheme	1

We tested our methodology at the end of 2015 in Budapest, in Allee Shopping Center, which represents an average Budapest shopping mall very well due to its location and size (159 stores). Shopping center designs are fundamentally identical, as malls comprise similar retail stores and face similar challenges due to their location. Furthermore, there is a clear tendency that shopping malls are becoming the dominant form of retail, since they provide consumers with greater spatial convenience compared to inner city shopping strips, therefore store locations are getting more and more concentrated [9]. As a result, the conclusions drawn from researching one shopping center will mostly pertain to other, similar shopping malls as well. We designed our questionnaire to be applicable to any shopping center, but a few questions and their answer options may be modified according to the given mall's regulations and the physical parameters of their logistical areas.

III. THE RESULTS OF THE TESTING

A. Issues discovered during the exploratory research

We found a number of problems regarding the researched shopping center during our exploratory research. In some cases, the lack of adequate storage capacity led to the goods and empties being placed in such positions where they interfered with the loading and unloading of freight vehicles. There had often been congestion at the entrance of the logistical areas because of the stochastic arrival times of trucks. Numerous stores have not been owning direct access to their storage areas, therefore they have been needing to move their goods through the shopping areas interfering with consumers, even causing risk of accident. Many times bottlenecks (e.g. elevators) contributed to an increase in waiting times, hence transferring goods to the stores became slower. The biggest issue outside of the building has been that if a vendor's truck exceeds the allowed weight limit for a limited freight zone he has to pay a significant amount of fee per vehicle.

All the problems listed above underscore the need and potential impact of logistics innovations.

B. Testing the questionnaire

Field work lasted 12 days during which we collected data from 149 of Allee's 159 retail outlets. Ten stores cannot be integrated into a cooperative delivery scheme because of their logistical uniqueness. Two banks, a lottery and a money exchange office only require money shipments while six ticket offices require virtually no deliveries. We managed to reach 140

shops because in nine cases the competent person was unavailable. Out of these 140 stores, 105 filled out the questionnaire which means a response rate of 75%. 11 stores declined because their regulations prohibited them from answering, 8 stores could not find time to fill out the questionnaire and 16 stores did not wish to participate. We feel our high response rate is partially caused by the support of Allee's management who asked all of the retailers to participate in our study.

We entered the answers into *Microsoft SQL Server Management Studio* where we ended up with 49 by 105 data table then exported it to *Microsoft Excel*. The evaluation of the data was done by this two software and also by *SPSS Statistics*. We applied descriptive statistics, built various diagrams to showcase our data and examined the relationships between the answers to certain questions.

C. Demographics - Basic properties of the shops

The stores that filled out the questionnaire marked 15 different profiles. For the category *miscellaneous* we received answers that could all be assigned to one of the categories already on the questionnaire. This showed us that our categories need to be clarified. The profile with the most shops was *clothing, underwear and bags* (25 stores), *shoes* (16) and *fragrance and beauty products* (12). 90.38% (N=104) of the respondents possessed one main profile, while the rest had two or more. The average floor size of the shops was 159.84 m², with a standard deviation of 465.73 m². The smallest shop among the respondents was 4 m², and the largest 3 900 m². This supports our hypothesis that a mall's retail outlets are very heterogeneous in their profile and size as well.

The ensuing questions showed that 51.92% (N=90) of the responding stores were under Hungarian ownership (44.23%, under foreign, rest was both), 54% (N=100) were chain stores (23% were franchises and 23% individual stores). 25% (N=104) of the responding retailers stated that all of their outlets were in shopping centers and an additional 41.3% said the same for over half of their outlets. Overall, 78.85% retailers had at least half of their shops in shopping malls, which is a very important result, because these stores' deliveries (or at least half of them) could be integrated into a cooperative delivery scheme that spans all shopping centers. 13.5% of the respondents only own the one store in Allee that we included in our research. (see Fig. 1)

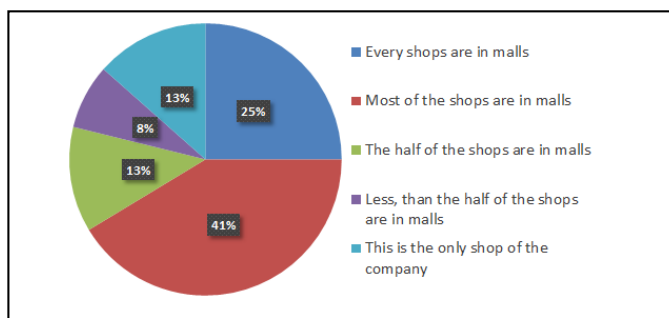


Fig. 1. Where are the companies' shops located?

D. Properties of inbound deliveries

In the case of 56.31% (N=103) of shops there was a contract supplier handling the deliveries, 36.89% used their own fleet and

11.65% of them utilized their own employees' vehicles. The overwhelming majority, 94.17% of the stores only had one method of getting their supplies, however in the case of others, logistic providers and own fleet were used simultaneously. Regarding the distribution of types of vehicles used, for 35.64% (N=101) of the stores it was passenger cars, 55.45% indicated small to medium trucks, while the use of larger trucks was rarer (see Fig. 2.). Vehicles over 12 tons were used by only one retailer, thus we can only determine the payment of entrance fees into the limited freight zones in this one case. This goes to show that smaller deliveries are more typical. 84.16% of the shops used only one kind of vehicle; the rest did two or more. During our field study we found that deliveries were not always carried out by motor vehicles but by bikes or motorcycles as well.

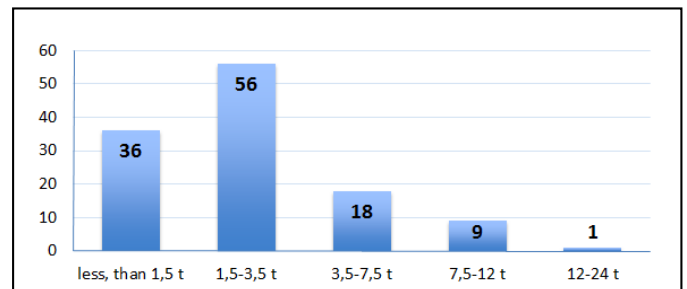


Fig. 2. The number of utilized freight vehicles by capacity

Allee has two courtyards for receiving deliveries. Most stores (48.81%, N=84) used the larger, more accessible one that opens to Fehérvári street (No. 1 on Fig. 3), while 17.86% shipped to the one on the Bercsényi street side (No. 2). This reveals that many shops handle their deliveries through the parking lot. It is worth noting that several respondents had trouble identifying these courtyards.

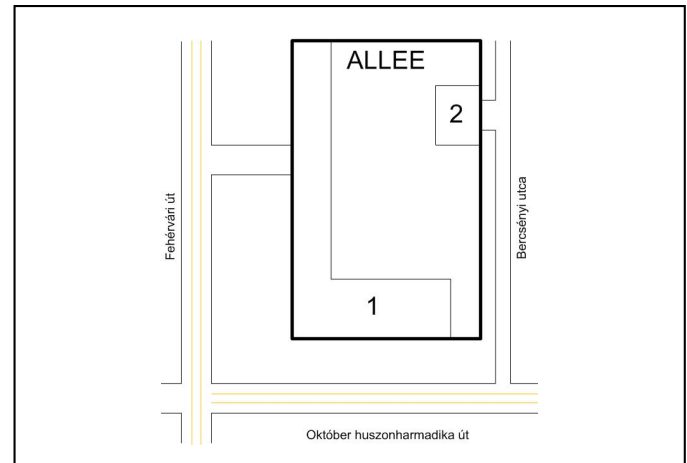


Fig. 3. Layout of freight receiving areas in Allee

It is interesting to examine the relationships and interplays between the answers to the previous three questions. Since all of these were choice questions, we can't calculate correlation coefficients, but so-called bubble graphs are a good way to visualize the connections. For example, we revealed that contract logistics providers predominantly use small trucks, and that retailers' fleets seldom contain vehicles upwards of 3.5 tons (see Fig. 4.)

The received answers showed that 81.4% (N=83) of the retailers had their goods delivered in boxed packages, and 15.7% (N=16) on pallets. There was only one store using containers and for *miscellaneous* we received answers such as crates, bags, plastic bags, hangers, and others. Such high share of boxes presents some difficulties regarding the scaling of the cooperative delivery scheme, since the weight and volume of boxes vary on a rather large scale. In the case of pallets this does not seem to be an issue because of their standardized dimensions. Our respondents said that an average delivery meant 21.73 boxes (min. 1, max. 160, std. deviation: 35.73) and 5.55 pallets (min. 1, max. 20, std. deviation 5.68). In the case of half of the stores, shop assistants were required to transfer the goods from the point of delivery up to the store, while altogether 64.7% (N=66) of the stores marked *employees of the shop* (meaning assistants and shop managers as well). This confirmed our hypothesis that moving goods take up some of the employees' time in the majority of shops, which interferes with their core competencies such as sales and sometimes they are not physically fit either. 35.3% (N=36) of the respondents said that employees of the delivery firm transfer the goods.

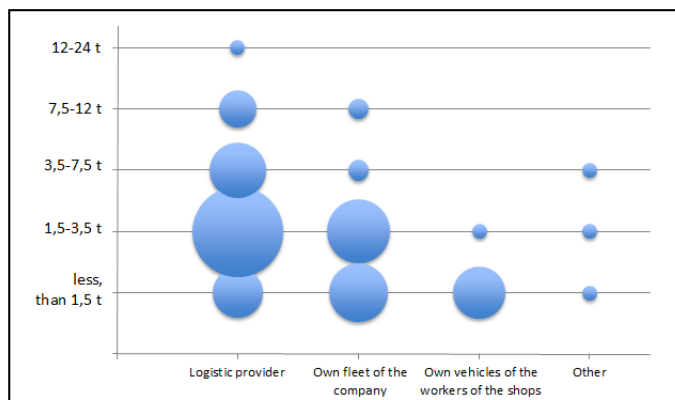


Fig. 4. The correlation between the capacity of the vehicles and the type of the provider

The subsequent two questions about the number of products and product groups carried created the most confusion among respondents. Thus these questions had to be modified and amended both during data collection and for our refined questionnaire as well. According to our answers, shops in Allee carried 9.73 product groups on average (min. 1, max. 100, std. deviation 18.12), and 905.73 different products (min 1, max 20 000, std. deviation 3 067.84). If we exclude the exceptionally high values for the latter (17 000 and 20 000) the average becomes 410.11; the maximum 4 000, while the standard deviation remains large at 722.89.

These results are further proof for the notion that in shopping centers the product assortment and heterogeneity are remarkably large. These data excellently demonstrate the appeal of shopping malls resulting from their extensive product diversity and their ability to serve every need of the consumers, however it also shows that a common delivery scheme is going to be faced with a very complex task.

47.6% (N=102) of the shops carried products that necessitate special care. 33 of 102 shops needed shipment fragile goods (on average 52.36% of the goods were fragile for these stores), 19

had high value products (70.31% of their goods), and 15 had goods that needed to be refrigerated (38.33% of their goods). There were no stores in Allee requiring shipment of live animals and only a few needed hazardous goods.

The average proportion of goods that needed special handling for all stores that submitted a comprehensible answer (including the ones that did not have any) was 24.61% (std. deviation 37.1%). 19 stores indicated two or more different types of special care. The above mentioned high ratio entails that a common/cooperative delivery scheme will most definitely be required to not only consolidate and transport goods but to be capable of providing special care and handling for some of them as well. For instance, this will have to be considered during the design of the scheme's freight vehicles.

The following question in our questionnaire instructed respondents to estimate the two most typical frequencies of their inbound deliveries, and also the proportion of their products for which that frequency was applicable. Unfortunately, this question highly perplexed our respondents, which is apparent from both the relatively low number of answers (96), many erroneous answers, and our experiences during data collection. Shop managers interpreted the question in different ways, therefore our data are not entirely consistent, they are to be treated with some reservations. Nevertheless, it is apparent that only 31 stores had two distinct shipment frequencies for their deliveries. 20 stores indicated daily shipments as their primary answer, with an average of 2.47 instances (std. deviation 2.72), together with 63 shops indicating weekly deliveries, with 3.58 instances (std. deviation 12.48). After tallying our data, we see that 86.5% of shops had 2.98 shipments per day, which validates our hypothesis regarding frequent inbound deliveries in the case of shopping malls. Furthermore, even according to the secondary answers, 61.3% of the stores had shipments at least weekly, 1.92 times per day in total. For the ensuing question, 23 stores indicated that they have significant deviation from their typical shipment frequencies, for 13.47% of their products on average (std. deviation 11.56%).

Summing up all the responses, we were able to calculate an aggregated daily traffic. According to our data, there were 88 vehicles for the 96 stores that submitted a comprehensible answer. As an experiment we scaled that up to the whole mall (159 stores), and it resulted in 146 vehicles arriving to Allee per day, which gives us a basis for the volume of the inbound deliveries. The ratio between boxes and pallets is known from a previous question, and their masses and volumes may be estimated with an upper and a lower value in a way that their actual dimensions likely fall in the intervals. In the case of Allee, we used 3 and 10 kg for boxes and 0,5 and 1 tons for pallets. Using these values, we obtained 43 000 kg and 92 000 kg as the whole quantity of freight traffic. In the former case, the entire shopping mall's shipments could be realized using only three 20 ton-vehicles, and even in the latter, five of them would suffice. Using the same methodology for volumes we estimated 0.125 m³ and 0.5 m³ for boxes and 1 m³ and 1.44 m³ for pallets (standard size: 800x1200x1500 mm). We determined that in the best case scenario four, while in the worst case eleven 70 m³ trucks could serve the needs of the mall. It is interesting to note however, that according to our exploratory research, there were 180-200 vehicles entering Allee each day.

Examining the relationship between shipment frequencies and other properties of the stores promises to be greatly insightful. After binning the floor area of Allee's stores, the F-test showed a weak but significant relationship between the stores' size and their average number of daily deliveries (sig=0.019, Eta squared=0.128). Basically, the larger the shop is, the more shipments it needs (see TABLE III).

TABLE III. RELATIONSHIP BETWEEN THE FLOOR SIZE OF SHOPS AND THEIR SHIPMENT FREQUENCIES

Area (m ²)	N	Average number of daily deliveries	Standard deviation
0 - 25	20	0.367	0.62
26 - 40	18	0.450	0.41
41 - 83	16	0.499	0.51
84 - 140	19	0.675	1.14
141+	17	1.863	2.99

76 of 104 stores received their deliveries between 9:00-17:00, thus we are able conclude that freight traffic shows only a limited amount of overlapping with passenger traffic whose peak is typically between 6:30-9:30 and 16:30-18:30. 21 stores received shipments before the 9:00-17:00 interval and 6 later (see Fig. 5). 17 stores indicated multiple intervals that are typical for them.

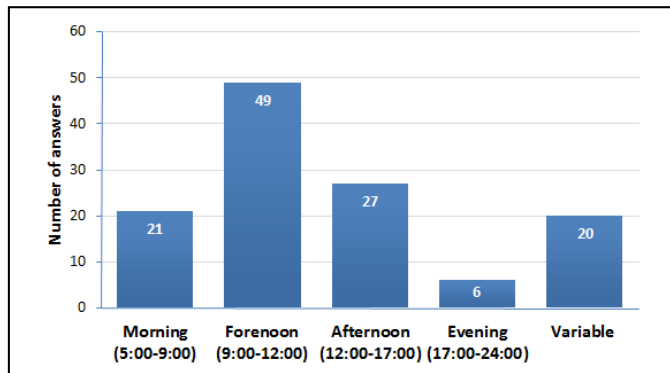


Fig. 5. Typical delivery periods of stores in Allee

97 stores responded to our question regarding the starting point of their inbound deliveries. 32 of them indicated that they only receive shipments from outside of Budapest, while 25 store only shipped from inside of the city. 15 stores did both. In Allee, 25 retailers utilized shipments between their own stores, but the quantity of these was negligible, since it involved merely 3.58% of their products on average. Moreover, based on our questionnaire, one might calculate the proportion of delivered quantities from outside and inside of the city, compared to the shops' entire goods traffic. In our case 47% of the goods originated from inside and 53% from outside.

E. Properties of the storage areas

Nearly 75% (N=103) of shops possessed storage spaces, which was consistent with the 80-85% we expected based on our expert interview, however it somewhat contradicts the hypothesis that retailers lack adequate storage options in shopping malls in general. 62 retailers owned storage areas in their shop, 21 had them at other locations in the shopping center (6 did both) while 26 did not have any storage. The average

storage size was 40.79 m² but the standard deviation is very large, 78.65 m² that is in connection with the range of the answers: from 2 m² up to 500 m². If we exclude the five largest values, the average becomes 20.34 m² with a standard deviation of 15.36 m². The inventory kept in storage was sufficient for 33 days on average, but the standard deviation and range were substantial here as well (54.86 days; min. 0 days, max. 1 year, N=52).

Similar to other topics, we believe that is insightful to test the relationship between the properties of the stores' storage areas and their other answers. We examined whether larger storages equal longer supply, and found that there is no statistically significant relationship, just like there is none between the main profile of the stores and the length in days that their inventory kept in storage is sufficient for. At the same time it can be observed that stores with different profiles are capable of storing products for noticeably different periods of time. Additionally, the profile of a store determines whether it possesses storage options at all; the association is medium based on cross-tabulation (Cramer's V = 0.432). We found it exceptionally surprising that there is no significant correlation between neither the size of shops nor their inventory turnover and the frequency of their inbound deliveries.

F. Properties of reverse logistics

67.3% (N=101) of stores conducted backwards shipments. 47 of them shipped unsold products, 17 shipped reusable packaging, and 13 retailers shipped to their other location(s). 24 stores indicated that they employ more than one type of the reverse logistics processes. The frequencies of the backward shipments told us the followings: the most frequent answers were *weekly* and *half-yearly*, and typically the shipped quantities could be best described in months and/or years, therefore they paled in comparison to the daily and weekly quantities of inbound shipments.

G. IT background of stores

40 of the 94 responding stores in Allee used no ERP systems at all, and only 21 wished to identify their software in use. Out of these, there were 16 different systems (only SAP came up more than once) with 4 developed in-house. Based on these results, it would be a significant challenge in Allee to establish the integration and compatibility between the common delivery scheme's and the stores' informatics systems.

H. Electronic commerce in the mall

During the research of e-commerce in shopping malls, the most important information is the number of stores shipping from their own inventory to consumers' homes, because the proposed common delivery scheme would need to deal with those deliveries. In Allee, nearly half of the retailers, 46 utilized e-commerce, however only 30 of them shipped from the shopping center at least partially. Additionally, only 6.64% of the total number of products sold was shipped to the consumer (including all stores providing a comprehensible answer, N=84), therefore we concluded that e-commerce in Allee has not yet reached a critical mass that would justify integrating home deliveries into the common delivery scheme.

I. Willingness to participate in the common goods delivery scheme

We measured retailers' willingness of joining the cooperative delivery scheme on a five-point scale, 1 meaning *absolutely not*, and 5 meaning *definitely willing*. Our questionnaire asked them to indicate their willingness in case of five different potential outcomes of the implementation of the scheme. All in all, the *reduction of environment pollution* turned out to be the most important for retailers (2.96), and the *improved reliability of shipments* the least important. Based on our exploratory research we expected *financial gains* to be the most compelling, but it came in third of the five aspects (2.7). It is important to note that the willingness of retailers remained under 3, i.e. *indifferent* for all five aspects, therefore it is crucial to devise an excellent communication strategy before the implementation of the scheme.

To assist with reaching the communication goals, we propose assigning stores into homogenous groups using cluster analysis, and then examine the properties of these groups. In our case, for Allee's stores the creation of 4 clusters seemed appropriate, they can be seen in Fig. 6.

	Name of cluster	Environmentally conscious	Uncertain	Positive	Opposing
	N	23	14	12	27
Potential Outcomes of the Delivery Scheme	Improved reliability of inbound deliveries	2.61	2.57	4.25	1.00
	Financial gain	3.52	2.86	4.58	1.00
	Environmental protection	4.22	2.43	5.00	1.00
	Enhancement of the city's transportation in general	3.91	2.36	4.83	1.00
	Decreasing the time spent on order processing	3.22	2.43	4.83	1.00

Fig. 6. Output of Cluster Analysis in Allee

IV. CONCLUSIONS

Based on our results, and the gathered data, we are able to conclude that our methodology is capable of researching a shopping center's logistical characteristics, quantifying the amount and heterogeneity of goods to be consolidated and delivered and to collect the challenges to be solved. Based on our results and experiences during data collection we modified our questionnaire to be easier to comprehend, and to provide us with more exact information (especially regarding inbound quantities). We expanded the answer choices regarding the origin of goods so we can get a better understanding of the spatial distribution of the shipments' starting points. Additionally, we added a number of questions that relate to the topics of cargo-bikes and shipments within a certain shop's own stores in different locations in the city.

To further test our methodology and to gain a more comprehensive knowledge of shopping malls so we may be able to do benchmarking, we are examining additional shopping centers in Budapest.

V. SUMMARY

Our methodology is capable of establishing the basis of a cooperative delivery scheme, but there are numerous additional tasks to be carried out in the future, primarily a pilot-project would be practical. The involved retailers would need to be identified, for which a suitable communications and marketing strategy has to be devised. Financing of the project needs to be taken care of; e.g. a list of possible tenders is required to be compiled. In order to launch a pilot project, certain logistical-technological and organizational developments are to be carried out. All these pose significant challenges to both the involved professionals, users and city management as well.

ACKNOWLEDGMENT

The publication of the work reported herein has been supported by National Talent Programme, Ministry of Human Capacities, Human Capacities Grant Management Office (EMET) (the contract number NTP-HHTDK-15-0009). The project is implemented by BME Faculty of Transportation Engineering and Vehicle Engineering

REFERENCES

- [1] András Bakos, Krisztián Bóna, Szilvia Foltin. The development of a complex city logistics cost model according to a multiple-stage gateway concept, URL: <http://www.pp.bme.hu/tr/article/viewFile/2117/1249>
- [2] Központi Statisztikai Hivatal. A kiskereskedelmi üzletek számának alakulása (2012-2014). URL: http://www.ksh.hu/docs/hun/xstadat/xstadat_evkozi/e_okk012.html
- [3] Wikipedia. Budapest villamosvonal-hálózata. (2015). URL: https://hu.wikipedia.org/wiki/Budapest_villamosvonal-h%C3%A1l%C3%B3zata
- [4] Fejes Balázs. A BKV teherszállításáról. URL: <http://www.villamosok.hu/balazs/teher/index.html>
- [5] Zürichi szemétszállítás villamosokkal. URL: https://www.stadt-zuerich.ch/portal/en/index/portraet_der_stadt_zuerich/filmportraits_stadt_zuerich/zuerich_202511.html
- [6] Dresdner Verkehrsbetriebe AG. CarGoTram: Autoteile fahren Bahn. URL: <https://www.dvb.de/de-de/die-dvb/technik/fahrzeuge/cargotram/>
- [7] Reed Stevenson. In Amsterdam, packages travel via canals, bicycles. (2009). URL: <http://www.reuters.com/article/2009/07/15/us-dhl-amsterdam-boat-idUSTRE56E2TE20090715>
- [8] Niche Transport. Broadmead Freight Consolidation Scheme. (2006). URL: http://www.osmose-os.org/documents/118/Os_Aw_Appl_Bristol.pdf
- [9] Vaughan Reimers, Val Clulow. Retail Concentration: a comparison of spatial convenience in shopping strips and shopping centres, Journal of Retailing and Consumer Services, Volume 11, Issue 4. (2004). pp. 207-221