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The Urban Freight Distribution in Medium Size Cities: Descriptive Data Taken From Pamplona (Spain) and Angers (France)

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Abstract

Medium-size cities around the world are experiencing rapid changes in their urban centers regarding sustainable mobility, pedestrianization of streets, and vehicle-access control to their city center. This situation is particularly important in the last-mile urban distribution in city centers due to the fact that private cars, public transportation, and freight transportation fiery compete for the same space. This article contextualizes this phenomenon in two European medium-size cities: Angers (France) and Pamplona (Spain). The paper also draws the current situation regarding their mobility and freight-delivery systems in their city centers. Thus, an apposite survey has been deployed in both cities in order to collect social perceptions and mobility patterns data. Additionally, we have included a conjoint analysis study for examining the characteristic determinants for aerial (drone) distribution. Likewise, meaningful conclusions can be extracted from the analysis of the results generated by the current analysis. Firstly, we have realized the immediate effects of a recent sustainable urban-mobility plan at Pamplona, which contrasts with the Angers case, where no similar plan has been deployed yet. Secondly, we have focused our attention on the socio-economic factors that determine the mobility in both cities. Thirdly, we have observed, in both cities, a clear preference for electric vehicles and cargo-bikes for driving inside the city center. Finally, there is a rejection to use drones for merchandise delivery.

Keywords: Last Mile distribution; City Logistics; Conjoint Analysis

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1. Introduction

Urban distribution in medium-size cities is facing a major challenge. On the one hand, the growth in e-commerce and the development of commercial and leisure streets in the inner areas of cities are demanding for better freight and passenger transportation systems. On the other hand, medium cities do not have the required infrastructures for absorbing such a demand due to scarce public transportation and weak transportation network, among other factors. As a result, private cars, public transportation, and freight transportation fiery compete for the same space. Additionally, medium size cities are also encouraging sustainable transportation such as walking, biking, and a greater utilization of public transport (Boisjoly and Yengoh, 2017). That leads to pedestrianization of streets, creation of biking lanes, and higher frequency for bus lanes, respectively. Consequently, freight transportation companies have to comply with this new urban environment (Gedik and Yildis, 2016; Atakara and Akyay, 2017; Slovic and Ribeiro, 2018). Accordingly, this work draws the current urban freight distribution situation in two European medium size cities, i.e.: Pamplona, in Spain, and Angers, in France. Both cities have around 200,000 inhabitants in their metropolitan areas. In the study, we conduct a survey for collecting social perceptions and mobility patterns data to understand how urban freight distribution could be improved in medium size cities. Moreover, the survey pays a special focus on drone freight (Frachtenberg, 2019), medical distribution (Rabta et al., 2008), and the use of other environmental-friendly vehicles (Juan et al., 2016).

1.1. Angers and Pamplona: a tale of two cities

Angers is located in Western France, at the intersection of three major motorways: the A11 between Paris and Nantes, the A87 bound to La Roche-sur-Yon, and the A85 bound to Tours and Lyon. Due to its location, Angers is one of the most important logistic centers in the region. Furthermore, the city has several trains (including a high-speed connection to Paris) and central bus stations with direct connection to big cities. Hence, it is a transportation hub for travelers and freights from Western France to Paris. The transportation network is completed with a tramway system that runs through the Eastern part of the city. Moreover, there are more than 30 bus lines and a self-service cycling system. Likewise, Pamplona is located in Northern Spain, about 45 km away from the French border. The city is crossed by one major motorway, the AP15 bound to Madrid, Zaragoza, and San Sebastian. It is also near another two motorways, the A12 and A21 to Logroño and Huesca, respectively. There are also train and bus central stations, but without high-speed connections. Finally, buses, including one electrified line, are the core of its public transportation. As a final point, Table 1 contains socioeconomic information regarding the two cities, remarking the homogeneity among them. With respect to urban freight transportation, both city centers are characterized by the irregular morphology of their narrow streets, which makes it difficult for vehicles and pedestrians to share these spaces. Moreover, the areas are very dynamic, with shops, government offices, bars, and restaurants. Table 2 shows the characteristics of the city centers of Angers and Pamplona.

Additionally, the sustainable urban mobility plan (SUMP) of Pamplona, which was recently adopted (Alvarez et al. 2018), led to many changes in the freight transportation in the city center. In particular, the SUMP establishes time windows for freight distribution, while deliveries are only allowed from 8am to 11am and between 2pm to 16:30pm. This policy is not running in Angers.

Table 1. Socioeconomic data from Angers and Pamplona.

	Angers	Pamplona
Population (number of people)†	152,960	199,066
Area (km^2)	42.70	23.55
Density (people per km^2)	3,582	8,500
Per capita GDP (EUR €)‡	28,619	28,520

† Data from 2018

‡ Data from 2015 at regional level (Maine et Loire for Angers and Navarre for Pamplona).

Table 2. City center characteristics of Angers and Pamplona.

	Angers city center	Pamplona city center
Area	0,7 km^2	0.48 km^2
Road length	14 km	10 km
# bars[§]	40	20
# stores[4]	20	20
# hotels[4]	19	17

2. Methodology

Data collection consisted in the development of some online surveys carried out between April and June 2019 in the cities of Angers and Pamplona. The questionnaire dissemination was based on mailing distribution lists at the Public University of Navarre and at the Polytechnic University of Angers, as well as its promotion from local authorities and retailers in the area. As a general approximation, we obtained 178 valid observations, 71 from Angers and 107 from Pamplona. The questionnaire contained 38 closed questions and one open question organized in four different sections. The average duration for completing one of the questionnaires was about 14 minutes.

Concerning the survey structure in general, and its inner description of its questionnaire, we can make the following description. Firstly, there is an introductory section in which the respondent is asked for sociodemographic information, including age, gender, and economic status, among others. Secondly, the respondent comes across a number of questions regarding the mobility habits in the city. These include how often he / she uses public transportation and the frequency in which he / she visits the city center. Moreover, this section also includes questions with the aim of identifying weaknesses in the city center, e.g.: too much traffic, lack of public transportation, lack of cycling lanes, etc. Thirdly, there is a specific section for the freight transportation that includes different issues the respondent may suffer from. Thus, this group of questions is particularly important, since the social perception is clearly revealed in the areas of air and noise pollution, urban space invasion, or visual impact.

Additionally, the restriction of entering / delivering in the city center is also investigated. To this respect, we differentiate between traditional internal combustion engine vehicles, electric vehicles based on vans or small trucks, and cargo bikes / trikes deliveries. Finally, the survey contains a section devoted to aerial distribution. Similarly, we include in that section the following characteristics: firstly, general information related to drone-delivery concerns and, secondly, a conjoint analysis (Green et al., 2011) with the attributes and levels shown in Table 4. In the conjoint analysis subsection, two options are made up by randomly blending their attributes levels. Then, the respondent is asked to choose one of those. Finally, this is repeated 5 times per respondent with the different options randomly generated.

Table 3. Drone distribution attributes and levels for the conjoint analysis.

Attribute	Level
Height/ noise	20 meters off the ground
	120 meters off the ground
Frequency	Few times per day
	Many times per day
Product type	Medical deliveries
	Parcel deliveries
Proximity	Drones do not fly around my house
	Drones may fly around my house

[§] Data from 2019

3. Results

A comparative descriptive analysis is provided simultaneously in Table 5 and Figure 1. Gender and age distribution is generally balanced in both Angers and Pamplona samples. Nevertheless, they are slightly biased with respect to their populations. In particular, our samples contain a higher proportion of young participants and a lower proportion of elderly population. This is mainly explained by the data sources as we used the mailing lists of the local universities in Angers and Pamplona. Gender proportion are consistent as 55% and 45% are male or female in the samples and populations, respectively. Regarding the educational level, both samples show similar proportions in elementary, secondary, and undergraduate levels whereas graduates show a higher proportion in the Angers sample and Master / PhD holders show a higher proportion in Pamplona sample.

Table 4. Gender/age sample distribution in Angers and Pamplona.

		Angers	Pamplona	Total
Men	>64	1	0	1
	55-64	1	8	9
	45-54	8	10	18
	35-44	7	10	17
	25-34	4	5	9
	<24	18	22	40
	Total Men	39	55	94
Women	>64	0	2	2
	55-64	2	6	8
	45-54	5	13	18
	35-44	6	5	11
	25-34	4	10	14
	<24	15	16	31
	Total Women	32	52	84
Total		71	107	178

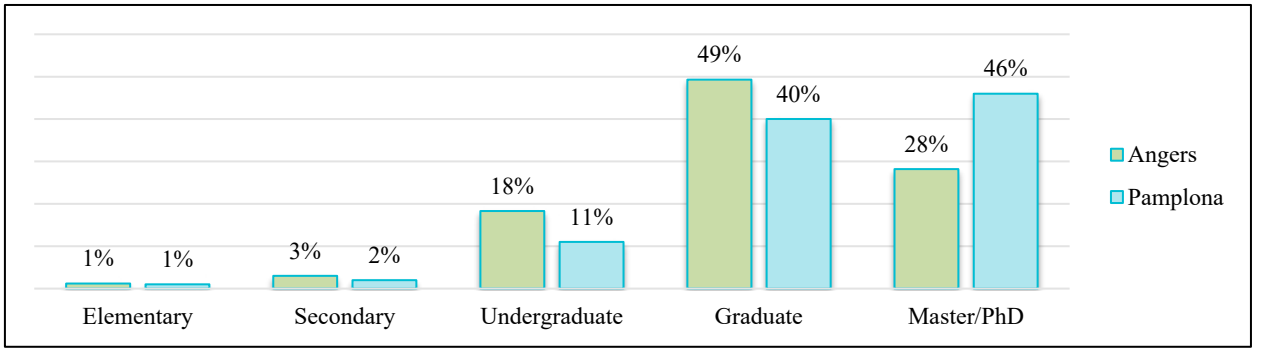

Fig. 1. Level of education in Angers and Pamplona.

The mobility habits are described in Figure 2. Most of the respondents walk regularly to move around the city. Nevertheless, a significantly higher proportion of Angers citizens habitually walk to reach their destinations. Similarly, biking and public transportation are more frequent in the city of Angers. The explanations of these figures are based on two characteristics. Firstly, the public cycling service that is currently running in Angers, which is not in Pamplona. Secondly, the stronger public transportation system in Angers which counts with more bus lines and the tramway system. Consequently, the use of private cars is significantly higher in the city of Pamplona than in Angers. As the focus of our research is on the freight distribution in the city centers, we also asked for the patterns of going to the city center. These results are shown in Table 6. There are higher proportions of Angers citizens going to the city center

more often than citizens from Pamplona. In particular, 69% of Angers respondents go frequently to the city center (at least once a week) whereas that number drops to 42% in the case of Pamplona.

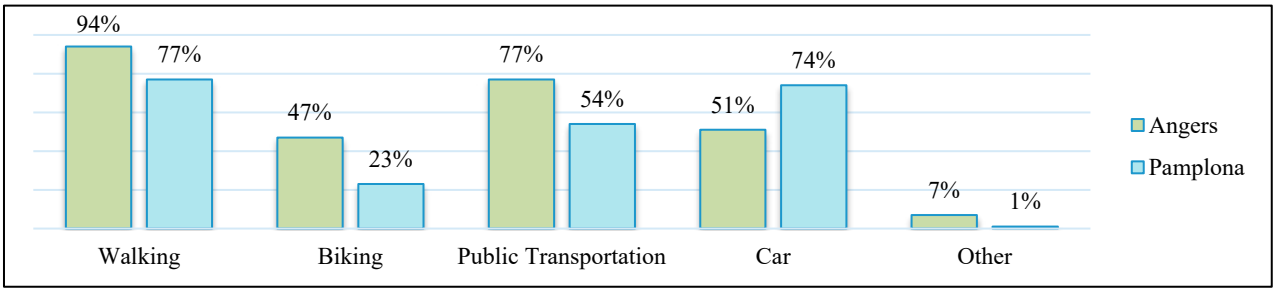

Fig. 2. Mobility habits in Angers and Pamplona.

Table 5. Frequency of going to the city center in Angers and Pamplona.

	Angers	Pamplona
Everyday	28%	10%
At least once a week	41%	32%
Several times a month	4%	48%
Once a month	10%	6%
Almost never/ never	7%	4%

Table 7 refers to results associated with the restrictions of entering the city center depending on the type of the vehicle (combustion or electric characteristics), and the purpose (freight delivery, including parcels, taxi / bus / ambulance / police services, private nonresident, and private resident). It is particularly interesting how the percentage of participants significantly drops when denying the access to electric vehicles. For example, in Angers 62% would deny entry in the city center to combustion private nonresident vehicles, whereas that figure falls to 23% in the electric case. Similarly, respondents from Pamplona have a higher propensity to allow the entrance of combustion vehicles.

Finally, the respondents identified the city center weaknesses shown in Figure 3. To this respect, pollution, noise, and the lack of cycling lanes are the weakest points in Angers, whereas the noise, excessive freight traffic, and pollution are the ones in Pamplona. Additionally, levels of importance are always greater in Pamplona than in Angers. That is particularly clear in the case of public transportation and the excessive freight traffic perceptions.

Table 6. Denying vehicles entry in the city center of Angers and Pamplona.

	Angers		Pamplona	
	Combustion	Electric	Combustion	Electric
Deliveries	23%	13%	22%	7%
Services	22%	18%	13%	4%
Private nonresident	62%	23%	50%	39%
Private resident	7%	5%	7%	4%

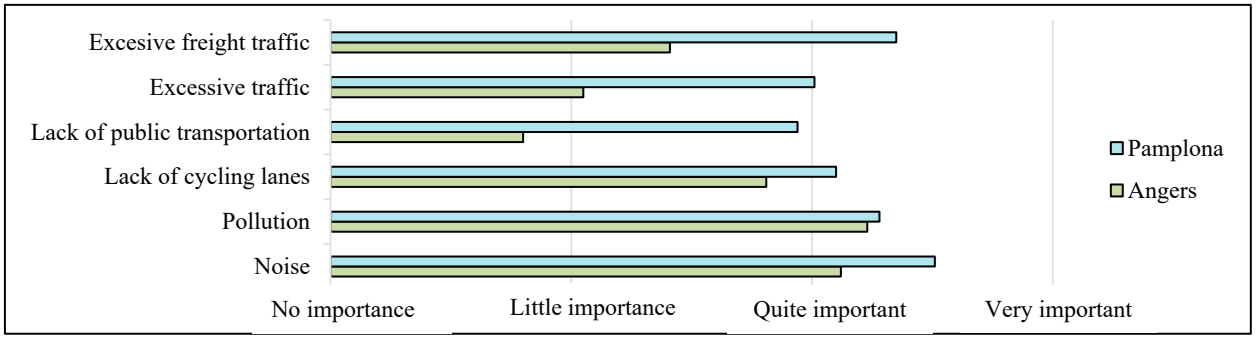

Fig. 3. Transportation issues importance in the city center.

Concerning the freight transportation particularities, Figure 4 shows the results corresponding to the sustainability perception of the urban deliveries by age group, while Figure 5 shows the freight distribution issues identified. On the one hand, young participants found freight deliveries to be more sustainable than older responders. This is particularly strong in the case of Pamplona, in which there is a clear downward tendency. On the other hand, Pamplona city center is clearly more annoyed by the freight distribution than Angers one as urban space invasion, excessive speed, and the visual impact are much more important for the former than for the later. However, there are still important issues in the city center of Angers, especially the case of accidents.

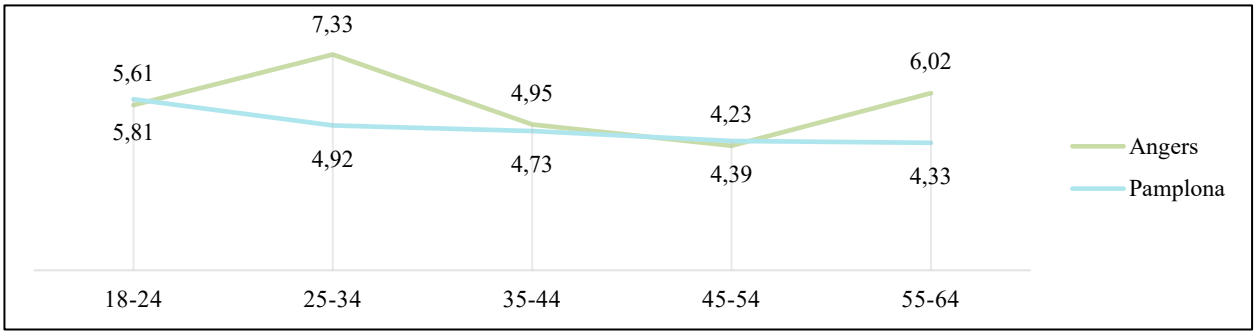

Fig. 4. Sustainability of freight delivery by age group (0: least sustainable; 10: most sustainable).

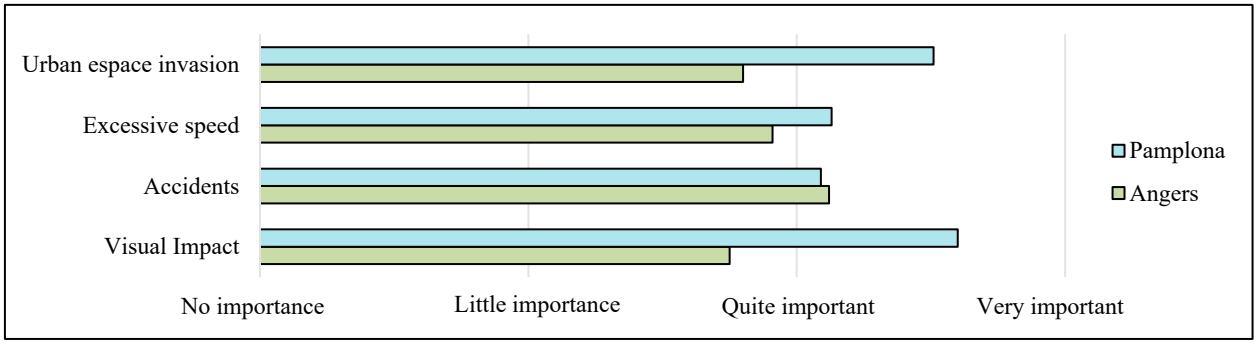

Fig. 5. Freight transportation issues importance in the city center.

Finally, future perspectives of urban deliveries are investigated, with a special focus on aerial distribution (drones). To this respect, Table 8 shows the outcomes regarding using the same distribution policy (vans and small trucks), changing to electric vans, changing to a cargo bikes and trikes distribution, and changing to an aerial distribution. Most of the respondents declared that they would like to change the current approach (81.7% and 76.0% in Angers and Pamplona, respectively) to a more sustainable distribution mode. Thus, most of the population agrees on the use of electric vans or cargo bikes / trikes for urban deliveries. The aerial distribution is still scarcely preferred in

Pamplona, as only 39.5% of the respondents approved it. This mode is supported in Angers by 69.0% of the respondents. Following with the drone distribution, Figure 6 shows a preliminary exploration of the conjoint analysis we have developed in these two scenarios. It summarizes the attribute relative importance of choosing an option as a consequence of mixing the attribute levels described in Table 4. As can be seen in the charts from Angers and Pamplona (Figure 6), the 'product type' attribute (i.e., whether the drone is used for delivering parcels or medical deliveries) results in the most determinant with a 38% and 30%, respectively. It means that the use of aerial distribution for medical commodities or parcels significantly affects its approval. Secondly, the flying proximity also strongly determines the drone characteristics. Here, it is interesting to observe the small distance between the 'product type' and 'proximity' attribute distance in Pamplona city (around 1%), whereas that distance grows up to 11% in Angers. Thirdly, the flying height, which is related to the noise a drone produces, weighs around 25% in both cities. Finally, the least important attribute is related to the flying frequency, as only accounts for about 15%. All in all, the most preferred product consisted in a drone carrying medical supplies that flies high, a few times, and far from home.

Table 7. Opinion about changing (maintaining) to new distribution approaches.

	Maintaining		Electric vans		Bikes and trikes		Drones	
	A	P	A	P	A	P	A	P
I'd very much	0.0%	1.9%	33.8%	40.4%	40.8%	30.8%	35.2%	13.5%
I'd like	18.3%	22.1%	52.1%	50.0%	52.1%	45.2%	33.8%	26.0%
Yes	18.3%	24.0%	85.9%	90.4%	92.9%	86.0%	69.0%	39.5%
I'd like a little	57.8%	52.9%	12.7%	8.7%	1.4%	14.4%	21.1%	25.0%
I'd not like	23.9%	23.1%	1.4%	0.9%	5.6%	9.6%	9.9%	35.6%
No	81.7%	76.0%	14.1%	9.6%	7.0%	24.0%	31.0%	60.6%

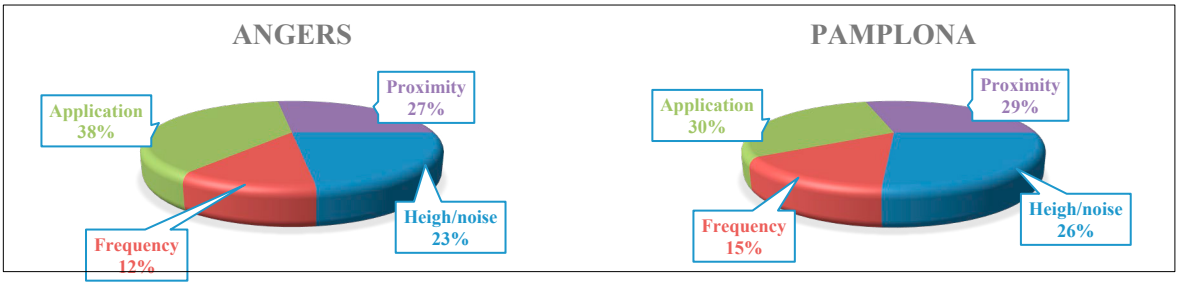

Fig. 6. Attribute relative importance resulting from the conjoint analysis

4. Conclusions

Medium-size cities are experiencing many changes related to sustainable mobility, which significantly affects the traditional last-mile urban distribution. In this paper, we have deployed a survey in the cities of Angers (France) and Pamplona (Spain) in order to investigate the current status of their mobility policies, with a special focus on the comparison of their mobility patterns and city center freight transportation. That is particularly interesting as the city of Pamplona has recently unfolded a sustainable urban mobility plan whilst Angers has not.

The analysis of the results allows us to describe a number of conclusions:

The current situation of transport and mobility in both cities are similar in terms of city-center dimension and services, i.e.: administrative-related paperwork, monuments, and bars or restaurants. However, Angers transport and mobility infrastructure seems to be stronger as the presence of public transportation is higher. While the mobility in each city includes buses routes, in Angers, cycling is an important transportation mode, with a self-service bike service. The tramway also brings variety to the French city.

As regards to freight delivery, both cities are at the same point, finding solutions like cargo bikes or tricycles and other electric vehicles to replace traditional combustion vans and small trucks. However, mobility patterns are significantly different, being Angers much more sustainable in the way of higher use of public transportation and lower use of private cars. However, the frequency and the affluence of people in the city center is greater in Angers than in Pamplona. Clearly, the transportation systems and mobility policies are ruling better in the French city, while the SUMP in Pamplona is not offering comparable results in terms of the public transportation share.

Both cities face similar weaknesses in their city centers. Nevertheless, in Pamplona these weaknesses are considerably more serious. In fact, noise and air pollution are major problems in both city centers, and some other problems have been identified affecting specially to Pamplona -e.g., the excessive freight traffic or the lack of biking lanes.

It is of high interest the propensity to allow electric vehicles to enter in the city centers. This policy involves the detriment of the traditional combustion vehicles, especially if they are private cars. Actually, there is a clear tendency to change the current freight distribution systems, which are generally supported by the population. This behavior is particularly evident when moving towards electric distribution. Furthermore, freight transportation is clearly worse organized in Pamplona, resulting in higher levels of urban space invasion, excessive speed, and visual impacts concerns.

Aerial distribution at city centers are somehow conflictive. On the one hand, around half of the sample are prone to allow drone distribution, a much lower ratio than the use of electric distribution using vans or bikes / trikes, which accounts for approximately 90% of respondents. On the other hand, there is a clear difference between the approval of the two cities. Just 39% of Pamplona participants support drone distribution, whilst this figure grows up to 69% in the city of Angers. Thus, we have observed clear culture-related issues to tune when dealing with a real and effective drone distribution deploy. Finally, we have identified what are the most important characteristics of this kind of distribution, being dominated by the product type transported (medical / parcel) and height the drone flies. Hence, a clear rejection for using drones for parcel distribution has been observed in our survey.

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