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Assessing Nighttime Deliveries in Stockholm, Sweden

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Off-peak-hour delivery programs are a promising but challenging concept for promoting sustainable urban logistics. Stockholm, Sweden, initialized a nighttime freight delivery program in 2014, aimed at a more efficient and environmentally friendly delivery system within the central area of the city. The policy of shifting freight deliveries from daytime to off-peak hours generates a wide range of effects that can be analyzed from several angles. This paper identifies the social costs and benefits, how these are distributed between stakeholders, and their effects on the everyday life and operations of all interested parties. According to information and data collected through in-depth interviews with public and private stakeholders, the social benefits mainly consist of increased efficiency and productivity for carriers and receivers, reduced transport costs, fuel cost savings, and reduced congestion and accidents when trucks are moved from peak to off-peak hours. Social costs may include increased noise levels and noise disturbances; additional staff requirements, equipment, and wage costs; and higher risks in handling goods deliveries at nighttime, especially in the case of unassisted deliveries. This paper concludes by discussing the lessons learned from the trial, challenges and opportunities that arose during implementation, and the implications for enhancement of off-peak-hour delivery in Stockholm and other cities.

In this era of urbanization, cities are experiencing rapid growth in demand for transport, resulting in high volumes and decreased transport efficiency because of crowding and limited accessibility in the limited street space. The need for allocation of public space among passenger and freight transportation thus becomes more intense. All these factors generate negative societal, environmental, and economical effects, such as traffic congestion, increased fuel emissions, accidents, noise, and reduced quality of life. Freight transport corresponds to approximately 20% of the total vehicle kilometers in urban areas, but emissions and energy consumption have a much higher share. To remedy the situation and alleviate these negative effects, new mechanisms and alternative policies are needed.

In the specific context of highly populated cities, infrastructure utilization is highly imbalanced across times of day. During daytime hours, infrastructure is oversaturated, whereas in the evening and at night, volumes are much lower and the same space is underutilized. To rationalize transport, increase the utilization of existing infrastructure, and enhance the efficiency of distribution of goods, a policy, widely used in recent years, is to shift freight deliveries from daytime to off-peak hours, when traffic is much lower—such as early morning, late evening, or night. These policies are often described as off-hour delivery or off-peak delivery programs. There is no specific definition of the term because there is great variation in the distribution of traffic among hours of the day in different areas and cities: larger cities tend to have prolonged peak hours, whereas in smaller areas the peak covers only a few hours.

Off-peak deliveries can generate a variety of benefits, such as increased efficiency, higher productivity for both carriers and receivers, reduced transport costs, fuel cost savings, and reduced congestion and accidents, as well as costs such as increased noise levels and noise disturbances, and additional staff, equipment, and wage costs. Results from previous studies showed 20% lower energy consumption at night compared with daytime. However, security issues emerge for handling goods deliveries at night, especially in the case of unassisted deliveries.

The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives. The introduction and development of off-peak deliveries requires complex, dynamic interactions among a wide range of stakeholders with contradicting perspectives.
pilot case in Stockholm. The paper targets stakeholders and entities highly involved in off-peak deliveries and policy making, suggesting which basic parameters should be taken into consideration.

The paper proceeds as follows. The next section briefly reviews the literature on OPHD, and the section that follows describes the landscape of freight transport in the Stockholm urban area, as well as how the concept of off-peak deliveries was born in Stockholm. The section also describes the case study as well as the methodological framework used for the collection of the data. Then the following section presents the key findings from the analysis of the attitudes and involvement of the various participants in the Stockholm pilot case (incentives, prerequisites, costs and benefits, lessons learned, etc.). The paper ends with the main conclusion and suggestions for future research.

**LITERATURE REVIEW**

Urban freight transport and its environmental impacts are an alluring area for research, generating numerous publications on such topics as the impact of traffic restrictions in urban logistics as expressed by Yannis et al. (10), who concluded that restrictions in distribution in peak hours positively affects urban areas with respect to transport efficiency and sustainability. A substantial part of urban logistics research, off-peak deliveries in particular have received special attention in recent years, specifically for identifying and assessing key parameters related to off-peak deliveries such as the attributes of stakeholders involved in the process (11) and the environmental impacts of night deliveries (12).

The idea of off-peak deliveries and use of transport networks outside of peak hours has existed since ancient times. Although there is no proof or documentation, it has been claimed that the first ban of deliveries of goods was on the roads of ancient Greek cities (1). Later, Julius Caesar, identifying the need to rid the road network of commercial traffic, established a law in Rome, Lex Iuliana Municipalis, which prohibited freight deliveries in the daytime (1).

Since the early 1970s, when an off-peak delivery trial called Operation Moondrop took place in London (13), many experiments, studies, pilot cases, and studies have been conducted to identify and assess the main benefits of delivering in off-peak hours. Barcelona, Spain, conducted a pilot demonstration of silent overnight deliveries in the city center in 2003, highlighting the benefits in terms of both social impacts and the return on investments for operators (14). In the forefront of urban freight cities in Europe, Paris recognized the importance of the impact of commercial goods transport on the urban environment and engaged in freight-oriented transport policy, incorporating nighttime deliveries since 2009 (15). The adoption of off-peak delivery schemes resulted in improved transport efficiency (travel time decreased by about 50%) and environmental savings [carbon dioxide (CO2)] was reduced 36% to 40% (2).

A few years later, during the Olympic Games in 2012, Transport for London made a series of trials of out-of-hours deliveries conducted in several London boroughs, and a range of businesses including supermarkets, pubs, and hotels highlighted the lack of complaints and summarized that off-peak deliveries is a viable option for businesses in wide areas. The transport companies reported a reduction of about 1 h per trip compared with daytime deliveries as well as noise reductions of about 8 to 10 dB, highlighting the effectiveness of the trial (2).

In a European-funded project in 2014, demonstrations of companies operating at night in Brussels, Belgium, and in Utrecht, Netherlands, revealed that the bigger the shift of deliveries away from daytime, the better the objectives of the various groups of stakeholders were served, although noise disturbances increased at night (16). From 2012 to 2016, off-peak delivery projects were performed in many areas in Denmark, with such results as an 8% to 10% reductions in vehicle kilometers traveled, about 15% overall time savings, and 7% reductions in CO2 emissions for beverage distribution (2). Such experiments were also conducted in other European countries, including the Netherlands and the United Kingdom, and generally concluded that off-peak deliveries provide major socioeconomic benefits.

Many places in North America and South America share the same attitude toward the off-peak delivery concept. In 2005, a long-running off-peak delivery program in Los Angeles, California, called PierPass, aimed to foster off-peak deliveries by providing incentives to industry to operate at night and on weekends, to reduce truck traffic and pollution during peak daytime traffic hours and to alleviate port congestion. According to PierPass (a not-for-profit company created by marine terminal operators at the ports of Los Angeles and Long Beach, California, in 2005), the project has achieved more than 30 million truck night trips since its inception in 2005.

One of the largest-scale, most ambitious, and most influential off-peak delivery projects was in New York City. Although it started as a small research project, the characteristics and figures of this metropolitan region [e.g., 20 million residents, more than 600,000 business establishments, more than 1.3 million registered trucks, more than 8.8 million employees, an average of 17,600 persons per square mile (4)] necessitated the expansion of the project, producing notable conclusions and findings for urban logistics. For instance, Holguín-Veras et al. estimated that if off-peak deliveries were in full operation in New York, there would be benefits to logistics and freight operators, in transport efficiency (with respect to travel times), and in sustainability (greener transport and environmental savings) for all road users corresponding to a benefit of $147 million to $193 million per year (17). A key conclusion from the New York pilot study was that the transition from daytime delivery to OPHD is becoming easier, because of the experience gained. For instance, in the first pilot, only 35 companies participated in the project, whereas the second round involved about 400 entities, highlighting the growing interest of the private sector in the OPHD concept (18).

In the same vein, from 2014 to 2016, Bogota, Colombia, implemented a regional logistics plan developed in 2007, including an off-hour delivery pilot, to assess the performance, competitiveness, mobility, security, and externalities of logistics operations at night, resulting in considerable benefits for logistics, with a decrease of 20% in operations time for loading and a 60% reduction for unloading, and for the environment, with a savings of 42% carbon monoxide, 8% CO2, and 1.4% particulate matter emissions; a 32% savings in travel cost between daytime and nighttime operations; higher speeds for trucks in off-peak hours; and no security or safety issues during the implementation (19). The pilot set in motion the implementation of such projects in urban logistics, stimulating more freight attractors and carriers to participate.

Recently, the Ontario, Canada, Ministry of Transportation, in cooperation with the municipality of Toronto and other entities at the regional level, organized an off-peak deliveries pilot within the framework of the Toronto 2015 Pan Am and Parapan Am Games (the largest international multisport games ever held in Canada) to reduce transportation demand at peak hours during the games.

Evaluation and key findings of pilot cases implemented all over the world show that there are potential benefits for both carriers and receivers in reduced operations time, improved vehicle handling, enhanced logistics planning, and improved customer satisfaction.
These findings have led other cities, such as the Colombian cities of Barranquilla, Cali, and Medellin, to begin tests of the off-peak delivery concept (18).

CASE STUDY

Background

Set in the heart of Scandinavia, Stockholm is among its largest and most rapidly expanding cities. Its strong economic growth attracts industrial partners to invest and generates opportunities for trade (20). With respect to congestion and traffic conditions, Stockholm is at the forefront of similar cities in Europe. The 47 loading bays for heavy vehicles in the inner city, the always-increasing number of service and craftsmanship vehicles, light vans, and trucks and the more than 10,000 heavy vehicles operating on the Stockholm urban road network highlight the significance of urban freight transport in Stockholm.

The identification and implementation of transport solutions that promote sustainability in the city centers is a priority for policy makers. To achieve a more efficient transport system in Stockholm within the next decade, in 2012 the City of Stockholm started preparing a freight plan (20), a holistic approach setting the priorities and goals for commercial freight traffic, taking into consideration related issues such as sustainability, safety and security, and equity.

The congested road network of Stockholm urged policy makers to come up with solutions for the existing transport system that will promote efficiency and sustainability. Off-peak deliveries are among the most challenging concepts in promoting sustainable urban logistics. Many cities have implemented nighttime deliveries and pilot cases within the past decade. Stockholm initialized nighttime freight delivery programs aimed at a more efficient, sustainable, and environmentally friendly delivery system within the urban area of the city. This policy is included as one of nine areas for action in the city’s freight plan for 2014 to 2017.

In contrast with other big cities all over the world, such as London or New York, in Stockholm trucks normally are not allowed to deliver goods between 10:00 p.m. and 6:00 a.m. in the city center. Nevertheless, there is high interest in a certification scheme for vehicles and equipment operating at night without causing noise disturbances (PIEK certification). Consequently, the Cities of Stockholm and Gothenburg, Sweden, agreed on a common definition of environmental trucks, namely, vehicles that fall into one of the following categories: (a) completely electric vehicles, (b) partly electric vehicles, and (c) vehicles that use other types of fuels that are environmentally friendly, such as biofuels.

The idea of delivering goods outside of peak hours is not new in Stockholm. The first attempt was during 2005 and 2006, when two grocery companies shifted their operations in the inner city of Stockholm, the Östermalm district, from morning to deliveries after 6:00 p.m. The goal for this pilot case was to identify the impacts of off-peak deliveries in distribution time, environmental aspects, capital utilization, and working environment. The pilot showed that there was a decrease in delivery times of about 20% to 25% when the goods were delivered in off-peak hours, as well as significant environmental benefits (3). However, working hours and wrongly placed deliveries were obstacles that had to be overcome.

Description of Pilot

The need for better organization of urban freight transport and reduction of traffic congestion prompted the City of Stockholm to organize a workshop in 2011. A wide range of stakeholders involved in logistics in the center of Stockholm were invited to express their views on the current situation, problems and inefficiencies, new ideas, and challenges for the future. On the basis of experiences in London and New York, a pilot project was initiated that focused on distribution of goods at night. The goal was to make deliveries more flexible, urging transport companies to invest in new, silent, environmentally friendly trucks and to use the infrastructure in a more efficient way for all modes of transport, like in Barcelona, to improve the safety and livability of the city for its inhabitants. In addition, the approach could generate a better working environment for drivers, since there would be less congestion, reliability in travel times, and less anxiety.

The pilot benefited from both manufacturers that were able to provide vehicles and equipment corresponding to the prerequisites for sustainable and quiet night deliveries and freight companies that had a preexisting interest in nighttime deliveries, leading the off-peak city logistics project to be initiated in 2014.

During two calendar years, 2015 and 2016, the project was to test nighttime distribution in the city center of Stockholm by using one hybrid and one biogas vehicle for delivering goods to three retail establishments and to a variety of hotels and restaurants. The outcomes would be analyzed for three aspects: transport efficiency, environmental impacts of noise, and policy measures and stakeholder perception. The last of these is the focus of this paper.

Participants

The pilot consortium consisted of a wide range of stakeholders. The municipality of Stockholm had a pivotal role in the project, finding companies, organizations, and entities interested in off-peak deliveries and organizing their actions so that they would not generate problems or inefficiencies affecting citizens.

The major producers of heavy trucks provided two state-of-the-art, environmentally friendly distribution trucks, one hybrid and one biogas powered, and a company expert in silent systems for distribution, for example, rolling cages, provided the necessary equipment.

Two of the biggest logistics companies in Sweden participated by delivering goods during the night to their customers, and an international retail company operating in off-peak hours in other countries tested that model in Stockholm.

The role of the Royal Institute of Technology in Stockholm was to assess the multidimensional aspects of shifting freight deliveries from daytime to off-peak hours through identification of the social costs and benefits and allocation to the various stakeholders.

Methodology

Data Collection

In qualitative research, the most common methods used for the collection of data are interviews and focus groups (21). According to Cannell and Kahn, a research interview could be defined as “a two person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused by him on content specified by research objectives of systematic description, prediction, or explanation” (22). From the types of interviews suggested by LeCompte and Preissle, in-depth interviews were selected for the collection of data in this research (23). The semi-structured format allows interviewees to feel more relaxed and comfortable, discussing in detail complex ideas and issues, especially when there are distinct sets of different opinions, as in off-peak deliveries.
The survey was conducted during February and March 2016, with the participation of all stakeholders involved in the nighttime deliveries pilot in Stockholm. The interview scheme consisted of two sections. The first was a set of open-ended questions focusing on the role of each stakeholder and their involvement in each stage; their views on opportunities, challenges, obstacles, or limitations of the expansion of night deliveries in Stockholm; and how they are interconnected in nighttime delivery operations. In the second part, stakeholders were asked to quantify the main costs and benefits of delivering goods at night in the inner city of Stockholm. Specifically, interviewees had to check from a list which parameters actually affect their operations and in which way—positive or negative, and to rate the importance of each parameter on a scale ranging from not at all important to very important. The parameters included in the list were selected according to a literature review of the effects of shifting deliveries from daytime to nighttime.

Analysis

After the survey was conducted, the data collected were inserted into a unified table for all interviewees, the questions categorized by the following groups:

1. Preparatory phase (role in the project, preparatory activities, expected outcomes, etc.),
2. Implementation phase (difficulties, problems, feedback, etc.),
3. Background on off-hour deliveries (legislation, experience, etc.), and
4. Expansion.

To facilitate the analysis and better represent the key findings, the stakeholders were divided into two main categories:

1. Public, comprising the City of Stockholm and the former vice mayor for transportation and environment, who initiated the off-peak pilot project, and
2. Private, including all the participating stakeholders from industry, divided into two main subcategories:
   – Carriers and receivers, comprising the two logistics companies and retail, and
   – Vehicle and equipment providers, including truck manufacturers and the equipment provider company.

FINDINGS

Incentives for Participation

The need for checking the transferability of business models in off-peak deliveries from other countries to Stockholm and the expansion to other Swedish cities such as Gothenburg was among the key incentives for participation of the stakeholders in the project. Thus, companies are in the forefront of technological, environmental, and innovative solutions. Promoting these values through a strong marketing strategy enables companies to gain new customers, establishing their dominant role in the market.

The participation of industrial partners in such pilot cases could be characterized as decisive in that the manufacturers could test new technologies to provide innovative solutions that meet the needs and requirements of society; set the standards, requirements, and specifications for nighttime deliveries in the future; understand the change in usage of their products in different markets; and improve communication and cooperation with their customers.

Preparatory Phase

The implementation of the project required preparatory activities by all stakeholders participating in the project. Apart from giving permission to companies operating at night with the two certified trucks, the municipality of Stockholm had to do some reconstruction on the existing infrastructure, such as changing the asphalt in specific parts of the road network so that delivery points would be smoother, or changing the height of sidewalks.

Manufacturers had to develop new prototypes. Similar technologies had been tested in other projects in the Netherlands, Germany, and Finland. Stockholm needed a different approach because of the existing legislation framework.

Carriers and receivers had to redefine their business models by analyzing the existing and additional costs (cost structure of the trucks, extra wages for personnel, and extra payments) and rescheduling their routes, in a way that would comply with the specifications and requirements for environmental friendliness and silence, for example. Most of the receivers did not have the experience, the trained staff, or the background on receiving goods at night.

Impact of Off-Peak Deliveries on Citizens’ Daily Routine

The implementation of the project brought to the surface issues that should be considered before delivering goods at night is allowed. Modification of the hours for loading zones in central streets generated issues with other users, such as taxis and private cars, that park in the loading bays. Additionally, when regulations for nighttime distribution are enacted, there should be a control mechanism for checking on adherence to these rules. These issues necessitated adoption of an extra surveillance system. Zone management, use of traffic congestion cameras (which are already used in Stockholm for congestion pricing), and other new technology could be used, but according to the interviewees the most effective solution is resident complaints to the municipality in case of noise and other disturbances.

According to Kowalski, “complaints are defined as expressions of dissatisfaction, whether subjectively experienced or not, for the purpose of venting emotions or achieving intrapsychic goals, interpersonal goals, or both” (24). Especially in the case of night deliveries, the shift from a common situation to a new environment could evoke complaints even when there is no actual disturbance, such as an increase in noise levels.

The difference between Stockholm and other cities that implemented off-peak delivery tests is that ensuring better living conditions for citizens in Stockholm was set as a priority, and there was sympathy for disturbances and complaints from citizens. Nevertheless, it was decided that there would be no official announcement to citizens about the testing, to avoid the situation of people standing by the road waiting for silent trucks, since the development of silent trucks is a beneficiary not only for entities related to off-peak deliveries but for everyone else as well. However, in the event of any disturbances or complaints from citizens, the city would address the problem and remedy the situation. Providing contact details on the trucks for citizens to use in the event of disturbance was considered but abandoned.

Although many complaints were expected during the testing period, there were just three cases, only one urging modification to
the infrastructure. Nevertheless, according to the interviewee, it is highly possible that people did not know how and where to express their dissatisfaction and state their problems. Even in the case of people who choose to live in a city center and accept a reasonable level of noise, there should be a guarantee that there will be no further disturbance if nighttime deliveries are expanded in the future.

Identification and Quantification of Cost and Benefits

The policy of shifting freight deliveries from daytime to off-peak hours generates a wide range of social benefits and costs (Figure 1).

Reduction of travel and delivery times is the main benefit for all stakeholders participating in nighttime distribution. The potential of mass expansion of off-peak deliveries raises the risk that other users will get this value of time gained by this switch, but this issue could be obviated by institutionalized standards, requirements, and certifications.

From the aspect of the public sector, reduced traffic congestion in the daytime and promotion of intelligent, innovative, communication technology solutions are considerable advantages when trucks are moved from peak hours to off-peak hours. Carriers and receivers believe that through off-peak deliveries, there is an increased frequency of route services, making deliveries more efficient. Better working conditions for people in logistics are also assessed as an important parameter. Among the most significant benefits are the environmental impacts according to the vehicle and equipment providers. Distribution of goods outside of peak hours produces less CO2 and other emissions, better air quality in the daytime, and a more environmentally friendly and sustainable distribution system.

It was observed that benefits that are considered of high importance for a specific group of stakeholders are not prioritized for another. For example, increased competitiveness for carriers and receivers is a key point for municipalities and politicians, whereas it is not a priority for manufacturers.

All stakeholders agree that the most important drawback for nighttime deliveries is the increased noise levels for residents. Although, because of technological development, trucks and equipment for distribution managed to achieve very low levels of noise, and Swedish national agencies fully agree, the generation of new traffic volumes unavoidably produces additional noise at night.

The extra costs for wages and equipment was not assessed as a crucial parameter because most of the interviewees claimed that they are in balance with the earnings gained by transport efficiency. The decrease in travel time and the avoidance of traffic congestion are also key factors that should be taken into consideration in that balance. In any case, the purchase of vehicles and equipment for nighttime deliveries could be translated into a considerable investment cost for companies. To avoid high risk, the municipality of Stockholm should provide assurances on continuation of the allowance to deliver at night, which would work also as an incentive for companies to continue to invest in innovative and sustainable urban logistics solutions.

What each stakeholder assesses as a significant cost or benefit is highly interconnected with his or her operations. For instance, for equipment providers, shorter travel times mean faster deliveries, so the loop time is shorter, and the need for equipment is less because the turnaround is faster. However, this has a marginal impact on the whole process.

Lessons Learned

Although the extent of the project was not wide (small coverage area, two trucks, and 10 to 15 delivery points), according to the
interviewees it was well defined and could be the basis for further steps in urban logistics in Stockholm. All of them expressed their satisfaction in the outcomes of off-peak deliveries so far, since they managed to fulfill the goals set in the beginning: to become more productive and efficient, attract more customers, and improve their position in the market share.

The project highlighted the complexity of the interaction and interconnection of all stakeholders participating in off-peak deliveries. Politicians and logistics operators are core to the process, since they interact with residents; the municipality of Stockholm; and shippers and receivers, vehicle providers, manufacturers, and civil servants. But residents are highly linked to civil servants and municipalities, resulting in a complex network in which all stakeholders cooperate and interact to make overnight deliveries in Stockholm more efficient, sustainable, and resilient. That most participants had cooperated with each other on past projects and activities encouraged better implementation of the pilot and achievement of the objectives set at the beginning.

Transport efficiency remains the key challenge for nighttime deliveries. According to the claims of a country’s logistics manager of a retailer company, driving at night in Stockholm reduces travel time by 25% to 30% compared with peak hours, making deliveries more efficient and promoting just-in-time flows. And it makes more sense for perishable products. Shifting one of five trucks to off-peak deliveries could maximize the profitability of carriers and logistics companies. Operating at night means that they will see higher utilization of their trucks, since the use of distribution vehicles in the daytime is about 20% to 25%. In the daytime, most of the time is spent either on loading and unloading or being stuck in traffic congestion in the city center, resulting in about 2 h of productivity for customers, issue that could be surmounted by distributing outside of peak hours. In addition, truck drivers are very satisfied, claiming better working conditions and working environment when they are working at night.

However, participation was a high risk for the industrial partners, since they spent a considerable amount of money both purchasing the necessary equipment and modifying their business models, and they did not have any reassurance or guarantee from the City of Stockholm about how long they would be allowed to have off-peak deliveries.

From a sociopolitical point of view, the policy of off-peak deliveries is inextricably linked to politicians’ priorities and convictions against private cars. Although urban freight transport was a crucial issue many years before, the political discussion on policies related to city logistics started many years later because of the lack of motivation from politicians.

The Stockholm demonstrated findings are similar to off-peak deliveries case studies all over the world, such as in New York; Sao Paolo, Brazil; and Bogota. In all cases, participants from industry expressed their satisfaction and the cost-effectiveness in their operations. Companies in Stockholm managed to reduce their operational costs to about 25%, which is similar to the 30% to 35% cost savings in cities in the United States (19). In another similarity, before implementation of the project, stakeholders were skeptical about the applicability and the effectiveness of the concept, an attitude that changed after the first outcomes. With respect to the expansion of off-peak deliveries, it is clear not only in Stockholm but in all other places as well that stakeholders from the private sector must feel more confident. There is a need for removing risks from their operations and provision of incentives to stimulate business involvement. These incentives in the case of Stockholm should focus on the productivity and efficiency of the companies themselves, whereas in the case of New York, subsidies are a key point. The cases of Bogota and Sao Paolo proved that off-peak deliveries could be beneficial even when there are no incentives but there are the same limitations (19).

Future Challenges

The off-peak deliveries concept is a challenging concept for urban freight transport in Stockholm since most participants claimed that they are willing to switch their operations partly or completely to nighttime according to the needs of their customers. But the key point for successful expansion of the concept is adaptation of the business models of the stakeholders. The new business models should be flexible and correspond to the trends and the needs of the market. For instance, for truck manufacturers, off-peak deliveries are intrinsically linked to the business models of selling their products, including sales of service contracts, efficiency, and integrated innovative solutions. Even if the sales of trucks are reduced, there is an opportunity for new markets, such as hybrid or electric trucks.

Standardization is another crucial issue for the expansion of the concept in the future. Certification of trucks (PIEK certified truck) and loading and unloading equipment, training schemes for drivers and workers during nighttime deliveries, and an effective surveillance system are some of the aspects of this parameter, the adoption and facilitation of which will stimulate more companies to deliver at night.

What most of the interviewees agreed on with respect to the expansion of off-peak deliveries is that it could be achieved not by imposing fines or penalties. Subsidies are not needed as long as stakeholders could realize by themselves the potential and the benefits of off-peak deliveries for their own business development.

Generally, a prerequisite for the successful expansion of such policies is that they be placed gradually; promoting best practices and successful examples from experience coordinated and controlled by an official body and in parallel will be regulations, standards, and certifications. The role of the city is to initiate such projects, giving the opportunity to companies to promote their innovative solutions.

CONCLUSIONS

Shifting urban freight delivery traffic to off-hours is said to contribute to efficient, sustainable, and resilient transport systems in urban areas. Stockholm is growing rapidly, pushing the need for such policies. Although congestion and problems in the distribution of goods in the city center had been identified many years before, there was no policy or action to remedy the situation before the establishment of off-peak logistics project in 2014. According to the former vice mayor for transportation in Stockholm, although urban logistics is an integral part of everyday life, freight transport is not an active area of political discussion, so in most case policies to address freight are not given attention by politicians. Such policies are highly accepted by industry since they create new challenges and opportunities for trade. Nevertheless, that policies in public transport do not affect directly the everyday lives of citizens makes them not a priority for policy makers.

The pilot case in Stockholm drew conclusions similar to those of other cities. The wide range of stakeholders from both private and public sectors interact in a complex and dynamic way, requiring closer cooperation and communication between them in their everyday operations. According to interviewee claims in the in-depth
interviews, although there are some drawbacks related to noise and additional costs and risks, off-peak deliveries are beneficial for almost all the stakeholders in the process, ensuring reductions in travel times, increased efficiency, higher productivity, and lower emissions. According to stakeholder claims, benefits exceed the costs, and since there will be an allowance for operating in off-peak hours, they are willing to shift part or all of their business from daytime to nighttime.

From the point of view of the municipality of Stockholm, the project has been perceived so successfully that several expansions are planned: extending permission to additional companies to make nighttime deliveries and testing a new model of plug-in electric lorry.

The expansion of such a policy is not a simple decision but a complex procedure since it requires a modification of business models for companies. To stimulate business involvement, there is a need for outreach and incentives, making participating stakeholders, especially from the public sector, feel more confident. Outreach should focus on the positive aspects of shifting operations to off-peak hours, such as increasing transport efficiency rather than restrictions, fines, or penalties. Subsidies are not seen as an option because in the long run, the municipality of Stockholm expects companies to voluntarily participate because of the direct benefits of efficiency of operating in off-peak hours.

Certification and standardization of the operations and the vehicles and equipment used for nighttime deliveries not only at the national but also the international level is another challenge. In Sweden, there is a definition for environmental trucks, but it is vague and must be further specified. Additionally, issues related to infrastructure such as road load limits or crossing points of distribution of goods with other road users of other modes of transport, such as cycling lanes or pavements, should be taken into consideration for promotion of nighttime operations.

However, the expansion of off-peak deliveries should be supported by additional research and testing with respect to new technologies in vehicles and equipment and an increase in participation and commitment by stakeholders, especially in the private sector, and a wider test area should be applied, covering all the center of the city of Stockholm, to fully understand the steps required, the benefits, the costs, and the challenges.

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