

BARRIERS AND OPPORTUNITIES FOR NIGHT TIME DELIVERIES IN URBAN CONTEXT: A FRENCH CASE STUDY

Loïc Delaître

MINES ParisTech, CAOR- Centre de robotique, mathématiques et systèmes,

60 Bd St Michel 75272 Paris Cedex 06, France

[*loic.delaitre@mines-paristech.fr*](mailto:loic.delaitre@mines-paristech.fr)

ABSTRACT

In supply chain management, the last miles are pointed out because they represent one of the most critical part of the whole chain regarding costs, times, quality of service and overall performances. City logistic is different from general logistics because of unique characteristics and constraints which creates a complex system.

The resulting problems, such as emissions of pollutants, greenhouse gasses, noise and congestion, are the consequences of the interaction of each actor. Within this framework, local authorities, with their role of project catalyst, begin to integrate urban freight transport in the global urban mobility strategy. To optimize the development of urban traffic, it is necessary to integrate all various ways of freight transportation. The objectives generally identified are:

- To reduce congestion and increase mobility;
- To reduce pollution and noise levels to contribute towards reaching the Kyoto targets, and improve the life conditions of the city inhabitants;
- To favor the development of city centre activities.

From a stakeholder point of view, one way to improve the global system of transport in city is to deliver the goods during the night to avoid the lost of time due to congestion and more precisely during the peak hours.

Few experiments in this field have been conducted and night time deliveries seem to be efficient but still require a change in the organization at warehouse, retailers and carriers levels. These changes have supplementary costs which have to be evaluated in order to check the profitability of night time deliveries not only from a stakeholder point of view, but also from local authorities point of view.

In this paper, we propose an overview and an analysis of the main projects of night time deliveries in Europe and in the United States. From this point, we highlight the barriers and the opportunities and provide some key factors to implement this kind of organization. We focus then on a concrete case in France and evaluate the gains on economic and environmental aspects before and after the tests launched in Paris. Finally, regards to the results in Paris, we give some recommendations to implement night time deliveries.¹

Keywords: city logistics, night deliveries, urban freight movements, mass marketing

¹ *The present work is based on the study done by Vincent Bilbeissi during his internship.*

1. INTRODUCTION

Contractors, logistics providers and simply actors who want to transport goods to urban sectors must face congestion, differing from a city to another.

Such actors are aware with the fact that they waste time, and in order to improve the time of transport and by the way save gas and staff-related charges, a solution can be brought up which consists in operating deliveries between the daily peaks of congestion. The following sketch gives an example about the Ile-de-France area where the plurality of congestion in real time (the blue-filled curve) and the marks through annual averages for this particular given day are to be pointed out (i.e. on Wednesdays).

The red curve accounts for the average evolution noticed on Wednesdays (entire year).
The orange curve accounts for the average evolution noticed on Wednesdays in February.

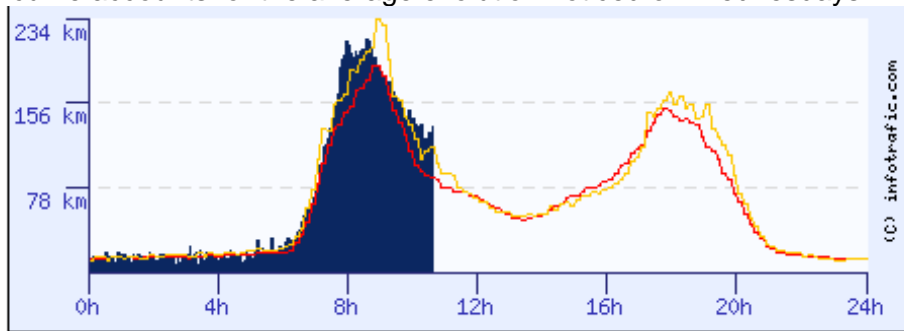
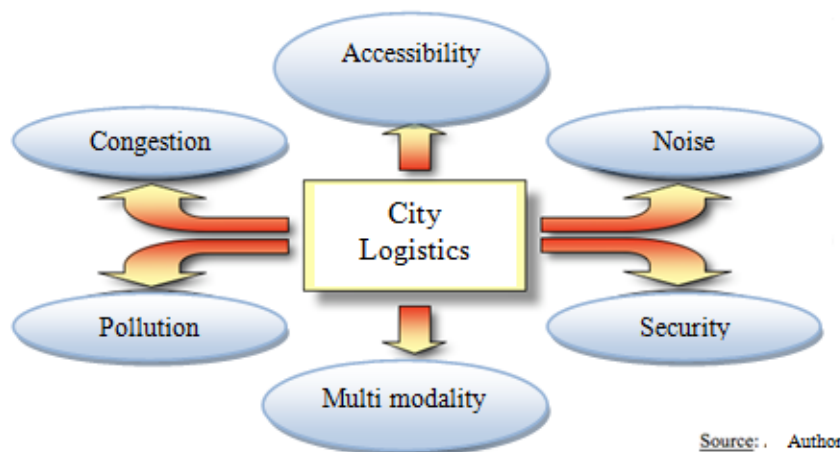


Figure 1 – The congestion in Ile-de-France

One should notice that the right period of time for a low congestion is to be found between 2100 hours and 0600 hours.

Thus, if private contractors' major interest consists in reducing transport costs, local authorities will obviously be also interested in containing congestion. The problem is indeed to reduce congestion, pollutant and noise emissions, insecurity and the development of accessible areas (the putting in of delivering areas) and this in time (a logical organization of timetable in relation with concerned contractors' way of processing) as featured in Figure 2.



Source: . Author

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Figure 2 – The transport of goods in town problematic

Working on reducing congestion might, by the way, also reduce noise, pollution and insecurity. Delivering at night, during a low peak congestion, would result in delaying the vehicles usually on the road during daytime. Yet, this does not go without consequences toward urban logistics contractors.

The night supply problem is different from one contractor to another. As a result, local authorities give their support in the organization of passengers and goods urban influx. They set rules, restrictions, prohibitions or authorized delivery timetables. They thus establish a context of development for all industrial contractors who have any kind of relation with urban goods flows. In most cases, local authorities restrain access to vehicles of a certain kind according to their gauge (size, weight, ground surface, environmental parameter: criteria are numerous as indicated in the study carried out by Interface Transport about France's fifty largest cities [Interface Transport, 2008]).

Local residents play quite a sensitive role though they indirectly share in making night deliveries possible. The problem is simple for local residents, night deliveries must be clear, thus they do not aim at increasing the already existing noise, i.e. streets noise. Otherwise, local authorities will register complaints and act in consequence (as a result of new laws about sound levels or gauges which provide a new labor frame for industrial contractors and the buckle is curled.

The night delivery problem for industrial contractors is twofold:

- the aspect of technology
- the aspect of organization

A sine qua none condition for night deliveries to be possible is to keep sound level as low as possible. If a part of the noise due to deliveries can be avoided thanks to an adequate behavior from the part of truck drivers, then remains the not negligible other part generated by equipment. As a consequence, the possibility of this type of delivery first focuses on the technology of the equipment used, i.e. it is a matter of answering the following questions: must vehicles be replaced for less noise nuisance? What further equipment could be added so as to significantly reduce noise emission? Must such gear be added? etc...

Then, industrial contractors' main problem is to find some economic prospects throughout this mechanism. One can intuitively identify the winnings, for instance, for the identical distance covered, the time of transport will be reduced at night, saving time and consumption (and by the way pollution and staff). Yet, some barriers can also be identified, such as the social chapter (night deliveries might deteriorate truck drivers' living conditions), law enforcement (truck drivers can not be on their own for deliveries any more), reception in sales outlets (sales outlets are closed at night, more staff is necessary in order to be delivered the goods, who will by the way receive raises in their salaries according to law).

Measuring the difference between additional costs and earnings generated is at stake for industrial contractors.

In order to grasp night deliveries, several experiences occurred in Europe and we suggest to describe them through the following paragraph.

2. SEVERAL EXPERIENCES

The experiences described in this part follow a chronological order.

The MERCADONA CONDIS project

Within the context of the will of the Barcelona town council to improve urban mobility in the city and its suburbs, the objective of the study was to set a flexible delivery organization of goods and products [Valtech, 2008]. Mercadona and Condis, two firms of the Spanish mass marketing integrated in the CIVITAS European program, set up the first night deliveries in 2003 and kept some from time to time throughout 2006. This was an exploratory experience and its vital lead was to set up different technologies so as to test and compare them.

Noise emissions during night deliveries could be compared thanks to a preliminary study of Barcelona's ambient noise. The three key hours of this experience were 2300, 0300 and 0500 hours when respectively delivering fresh and dry produce, fruits and vegetables when the "night" idea takes full meaning.

The formation of truck drivers to right practice was already effective in this experience, and a local residents' complaints receiver system was set up so as to get a feedback of the neighborhood, when locals were warned about night deliveries through an advertising campaign.

The main results showed that this type of delivery allowed to replace seven trips usually operated by goods vehicles by two rounds using trailer trucks. Moreover, such trips took three times less than deliveries at usual time. Even though delivering with trailer trucks, this experience tested night deliveries through goods vehicles using GNV (Renault 12T Midlum Truck) and electronic engineering thus reducing the noise emission by 6 dB, which corresponds to a four times less important noise!

Moreover, some sources for sound optimization were identified at the equipment level such as the "rice aluminum" coating of the rag or the pallet truck used like the YALE MP16S which has joints that deaden mechanical noise, the engine hood and the hydraulic pump, new noiseless tires, extra tires so as to cope with pavement irregularity.

Here again, the rigorous methodology allows one to associate the noise of each operation during night deliveries, i.e. truck arrivals (66.8 dB (A)), cart movements (56 dB (A)). However, the chosen fineness was not important enough in order to estimate the noise on the pavement for example, which would give an interesting way toward reducing (or not) noise by pavement development.

On the whole, the average level was registered at 52.2 dB (A) for an average ambient noise of 52.1 dB (A). On average, the noise generated by night deliveries was widely acceptable. Other analyses showed that 62% of the cases exceeding the ambient noise (i.e. 55% of cases), were due to truck arrivals.

This first example shows the technical and organizational possibility of night deliveries about a Spanish case, the information about costs have not been gathered for this experience.

However, earnings might exceed costs for this experience has now expanded to the cities of Valencia and Madrid where it features a strategic axis for the firm which may be competitive. Nevertheless, one should mind life styles, i.e. in Spain, inhabitants are less sensitive to noise at 2300 hours than in Nordic countries at the same hour of the night.

The Framtida Handel project

The main goal of the study led by the Framtida Handel lab was to assess the effects of night deliveries in downtown Stockholm. The study was also to evaluate the possible change of the delivery system so as to reduce environmental pollution and the time of transport, extend the delivery of consumer goods on 24 hours and by the way optimize the use of the funds invested (especially vehicles).

The work group, run by Framtida Handel, is a group of contractors (industrials, local, regional or governmental authorities) whose goal is to study possible improvements about marketing and production in accordance with an environmental-friendly policy.

Delivery schedule was at "night" in this project in Stockholm since they were originally to take place between 1800 and 2000 hours. The lack of staff in stores so as to be delivered the goods led to, in many cases, an earlier delivery schedule between 1600 and 1800 hours, during the highest peak of congestion. This experience did not study night but late afternoon deliveries, yet we deemed necessary to put it in this research because as opposed to the former example which showed us that transferring night deliveries in another city was possible; this project highlights the fact that transferability is not to take for granted. As a consequence, this study leads us to point out the factors of failure.

On the one hand, the social chapter in order to be delivered the goods is a major element in night deliveries. On the other hand, the final results are widely debatable since the time of transport was assessed using cars and at night which might differ from trucks. Delays were pointed out at the beginning of the tests because one of the concerned delivery groups knew problems with trade-unions (due to timetable) as long as low rates of truck loading, which delayed the assessment for a few months.

Eventually, the consumption of gas was not assessed, but only computed thanks to the history of rounds, making it the last major element. Qualitative results are yet very useful and one can keep in mind the following points:

- The 1800-2000 hours rounds save fifteen minutes compared to afternoon rounds (1400-1800 hours) and were more reliable. They leverage peaks of orders from stores, provide more flexible deliveries and optimize the use of the resources (trucks).
- The strong will of store owners so as to change their organization as well as the timetable including night rounds was a key factor.
- Loading and unloading the goods was disturbed by cars that parked on delivery areas.
- Drivers' pressure has been significantly reduced compared to usual rounds.
- The change of employees' and drivers' timetables is a key element as well as the difficult change of minds.

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- Errors in orders are hard to fix because of the absence of the staff in delivery centers during delivery hours and the impossibility to delay them so as not to make the store staff stay after closure.
- Budget must be dynamic, taking all the unknown factors into account.

This experience can be qualified a semi-failure, because even though “night” deliveries did not know a favorable outcome, major lessons were drawn which were apparently used for the following experiences.

The PIEK project

The group led by SenterNovem and Albert Heijn in the Netherlands wanted to test the possibility of night deliveries and appropriate solutions. SenterNovem, the agency between the Dutch government and firms carried out the PIEK project and the experimentations working with the Treasury Department, the Environmental Protection Agency and the Department of Transportation [Goevaers, 2008] and [Wandsworth, 2009].

Lab measures were led by SenterNovem on quiet equipment (tractors, goods vehicles, trailers, cooling, containers, handling equipment) between 2001 and 2004. Such tests showed noise levels under 60 Db (A) at 7.5 yards from the sound emissions. The key idea of the project was born in that time, the PIEK project was an experience of those tests which only began by 2007.

The tests lasted three months, in ten stores of nine cities and deliveries were operated early in the morning between 0500 and 0700 hours, and late at night between 1900 and 0200 hours, backed by noise measurements.

Equipment and quiet vehicles were used to fix the noise level previously measured on basic products. The trucks used were geared with speed reducers so as to control this parameter and reduce the consumption of gas.

The aspect of methodology is something recurrent in this project, in which indicators were devised so as to make a comparison between the usual and night deliveries:

- Sound levels
- The number of trucks and the type of vehicles used (goods vehicles or trailer trucks)
- The distance covered
- The average delivery time
- The consumption of gas
- Drivers' costs
- The costs of vehicles
- The quality of air and the emissions of CO₂, HC, Nox, PM (particles).

The constraints identified were the following:

- The noise and local residents' complaints
- The geographical situation of delivery centers and stores
- Urban congestion
- City circulation law
- Drivers' and staff employees' formations to right practice

The PIEK study highlights the advantages in terms of noise level reduction (after the vehicles and the handling equipment were adapted). The tests registered but a single complaint (in 1,000 deliveries operated) on behalf of local residents.

It clearly appears that exploitation additional costs (equipment and store human resources) are compensated by productivity gains. Indeed, late hours (or advanced ones) of deliveries resulting in the absence of congestion, saving time in the access to stores as well as the possibility (urban law enforcement) to replace goods vehicles (sixteen pallets) by trailer trucks (thirty-three pallets) which allows to reduce the number of drivers. Such improvements were directly translated into a drop in drivers' and gas costs.

Working conditions helped to reduce drivers' stress and improve their security and the number of incidents during deliveries. From an environment point of view, the quality of air improved compared to usual daytime deliveries.

The following lessons were drawn from this experience:

- The additional cost for the buying of vehicles (15%) and quiet equipment.

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- The accessibility to town for some stores (dimensions of streets) is sometimes hard and thus compels to use smaller trucks (goods vehicles and non-trailer trucks)
- Finally, implicating all participants (drivers and store staff) in this project is crucial to its success.

In the end, Albert Heijn decided to extend this project to all stores in the Netherlands (90% of the country's stores) as well as to all (abroad) stores of the group. The firm is, in a first time, to call for contractors who have PIEK "certified" trailers, then replace a part of its vehicles by PIEK certified trucks (2010).

The Sainsbury's project

The project aimed at leveraging night deliveries restrictions of Sainsbury's of Wandsworth by testing night deliveries for six months, in order to show that such deliveries did not impact on the urban community [FTA, 2008].

The study involved a group of Sainsbury (specialized in mass marketing in the UK), the town council of Wandsworth (suburb of London), the Noise Abatement Society organism (NAS) that aimed at reducing noise and the Freight Transport Association (FTA), an association that worked on transport-related topics for firms.

The study had to prove that night deliveries would reduce noise and the time of transport, improve the rotation stock, sales and stock availability rates, drop in gas costs and improve the quality of air and gas emissions.

This pilot drew its inspiration from the PIEK project, aforementioned. It started after the FTA (Freight Transport Association) had devised a tool that described the methodology so as to set night deliveries.

Store delivery hours were set for 0130 and 0300 hours.

The tests were made on a single Sainsbury's store in Wandsworth and such a choice was justified by the fact that the site is particularly sensitive:

- In 2001, the NAS forbade the store to be delivered goods between midnight and 0600 hours, after problems with noise emissions.
- The store manager was very motivated by this project.
- Should the project succeed, then surrounding cities were to consider such solutions and relations with the town council as well as with the NAS would improve.

Once more, one can notice a part of the common-core syllabus, the instructions for drivers' and store staff's right practice in order to reduce noise (trucks are turned off when parked, no loading with empty carts, no door banging, radios are turned off when arrived, call of stores when trucks have left and arrival time expectation). A complaint receiver system was also set.

No quiet equipment was used, apart from rubber mattings put in key places so as to reduce the noise made by carts.

Noise measures were made before and during the pilot in order to make the comparison.

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Noise was reduced by 8 to 10 dB (A) for highest levels (goods unloading). This can be explained by the putting in of an isolating curtain where trucks unload the goods.

An average round was reduced to thirty minutes the outward journey (a total of sixty minutes for round-trips), which allowed to save two daily hours of work for drivers.

This can save 20,000e, or 700 hours of work, after a year. The first use of a TMS software in this project was crucial to make such earnings.

The pilot led to put off what can be two rounds during high peak congestion, the equivalent of seven hundred annual rounds.

Night deliveries would reduce by sixty-eight tons of CO₂ or some 6,250 gallons of gas.

Consumers' feedbacks were significantly positive since such deliveries allow to supply stores before they open and no local residents complained during the tests.

The improvement of the productivity by 15% is also to be expectable, this adding two extra employees each night for dry produce and three for fresh produce. However, contracts are to be rehandled if the project was granted.

The tests were successfully carried out and showed that night deliveries, by using a noise surveillance policy, were not linked with noise pollution.

However, no information about the long-term spreading of this type of deliveries was disclosed.

The DIT project

The "Low Noise Solutions For Night Deliveries" project aimed at encouraging Irish firms to develop products and equipment and operate night deliveries in urban areas. It took place in Dublin, Northern Ireland, and involved the DIT (Dublin Institute of Technology, Department of Transport Engineering), Musgrave (ensign of mass marketing) and Arnotts (large stores in Dublin), contractors such as Thermoking and DAF, as well as the town council of Dublin.

Night deliveries tests started in 2008 on Arnotts and Musgrave stores of downtown Dublin. A theoretical study showed that five vehicles operating 636 deliveries by departing from the same warehouse during a six-day week, managed to save 80,000e per year if such deliveries occurred at night.

Deliveries were operated by quiet trailer trucks, whose 70% were loaded with dry and 30% with fresh. Rounds were computerized (TMS) and trucks were located through GPS which ensured secure routes. Noise measures were made and compared to ambient noise.

So far, new quiet equipment had focused on pallet trucks, truck container, the rag and the new thing in this project was to put a screen in front of stores in order to soften the noise made by trucks and take into account the surrounding housing. Yet this new element was not exclusive and a set of quiet technological solutions was also tested (rag, truck container or isolated reception wharf).

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The signal was split up into events and timetables (carts shocks, displacement of carts in the street, return of empty carts, loading boxes in trucks) and compared to a referencial level of 66 dB (A). The detail of the delivery process is more important in this project and thus allows one to assess the noise of each operation. And the staff was formed to right practice.

Experimentations showed that an 10% additional cost was necessary for quiet equipment. They were worth between 10,000 and 12,000e for the quiet putting in on the different sites. A formation and financial bonuses were necessary in order to motivate drivers to take the tests.

The vehicles of both firms, dating back to less than five years, were not to be transformed into quiet vehicles soon.

The firms concerned by this project decided not to keep up with night deliveries.

The Club Demeter project

The Club Demeter project is a copy of the PIEK project applied to the Parisian context [Demeter, 2009a] and [Demeter, 2009b].

Experimentations lasted a week and began in February 2009.

Noise measures were led for deliveries with two types of low noise vehicles, with two different contractors, on two different marketing chains (Carrefour group and Casino group).

Sonometers were hung to store windows at different heights and the recorded data was gathered and analysed by the town council of Paris only at the end of the test.

Local inhabitants were proposed to fill surveys and comparative economic analyses were made so as to get a balance on economic, social/societal (noise/congestion) and environmental factors.

A Champion store (Carrefour) and four Géant/Casino were delivered goods in Paris.

All deliveries took place between 2200 and 0600 hours, with either goods vehicles (lent by Petit Forestier/Lecapitaine) or trailer trucks (rented by GT at DHL).

The study showed that the longer the delivery slots were, the less noise pollution was and the better residents' living conditions were.

The traffic reduction saved time as well as the replacement of deliveries operated by goods vehicles by deliveries thanks to trailer trucks (1 trailer truck against 2 goods vehicles). The actual economic gain is to be found here, i.e. replacing two goods vehicles by one trailer truck that only costs 10% more than a goods vehicle but can load twice as much.

The additional cost of (quiet) equipment was compensated by the number of vehicles rotations and low traffic timetables. Moreover, this project highlights the importance of the additional costs for equipment maintenance in the economic model (6 to 10%) which had not been studied so far.

Drivers' and store staff's involvement was crucial. Such people also must be formed to quiet deliveries as well as forms in order to get feedbacks of the deliveries operated.

Nevertheless, such deliveries knew strong reluctance about noise on behalf of local inhabitants, because goods vehicles deliveries used to be operated in premises big enough to let the entire truck drive in, i.e. noise was thus very low. When goods vehicles were replaced, the same premises could not let trailer trucks in, as a result, trucks had to park in the street making more noise, prejudicing residents.

Noise measures were not entirely made use of because of the absence of equivalence between noise curves gathered and the different actions operated by drivers or the store staff.

Since the putting in of sonometers is variable, the different measures could not be compared one to another.

Measures were also disturbed by the surrounding noise (police sirens, passers-by) and must be completed with lab measures in order to get the actual level of noise emissions.

The interest of delivery areas was born during this experience because the areas in front of stores were scarcely accessible when unloading pallets, which resulted in double-parked trucks.

Night deliveries have not been regularized by Carrefour and Casino groups alike so far. The short time of experimentation due to the one-week rental of the PIEK certified trailer does not lead to a satisfactory statistical extrapolation. Furthermore, the type of product concerned consists in fresh which needs more quiet equipment especially about cool group.

3. TEACHINGS FOR NIGHT DELIVERIES

Through such experimentations, the key parameters of success for the putting in of night deliveries are getting clearer. One can file the key factors according to the following categories:

- Regulations
- Noise
- Involvement of contractors
- Communication sensitivity
- Gains
- Improvements

In a first time, we suggest to detail the aforementioned categories.

Regulations

Some projects did not take into account the upcoming regulations as an element of discrimination. However, if contractors are looking for solutions for urban freight, it is partly because regulations evolve along with a policy like, for example, on euro norms of vehicles driving in town according to the period of the day.

It is also a matter of knowing to the detail the regulations linked with night delivery (threshold of noise tolerance, type of vehicles authorized, etc...). One can nowadays notice that such regulations do not exist or are completely disproportionate. For instance, the maximum threshold for authorized noise, at night and in Paris, is 25 dB (A), which is quite less important than opening the door of a car, since it is equivalent to whispers.

Noise

Noise is linked with the notion of regulations. Indeed, the threshold should not be, a priori, set on an absolute manner. The disturbing noise is the noise perceived by residents. Such noise is perceived when it exceeds the ambient noise of streets. The ambient noise differs according to the period of the year (summer is more vivid than winter, thus noise is more important during summer and is generally better tolerated), and such noise varies all day long. As a result, setting a threshold of tolerance does not make any sense.

The criterion for noise is critical for night deliveries. Thus, experiences showed that the success of the project also comes from the fact that noise was not perceived, i.e. that noise generated by night deliveries was not more important than ambient noise.

Involvement of actors

Some projects indeed resulted in failures because the staff was not motivated by the experience. It seems that the motivation and the involvement of the industrial actors are necessary but not sufficient conditions. So are the motivation and the involvement of local authorities.

Communication sensitiveness

One of the parameters to make such night practice possible is the number of complaints of the surrounding area. Some projects deemed fair to warn the residents about the night experience, when others did not. It clearly appears that when residents are not the targets of a communication campaign, negative feedbacks are more secretive.

Gains

Identifying the economic gains is the fundamental criterion for industrial contractors. Assessing gains is a hard task. Assessing environmental gains is even more ambitious. Indeed, the use of a model is often the done thing to do since the data about pollutant emissions are not always known (especially when tonnage or weight differ).

Improvements

Eventually, improvements are not always easy to prove. The state of art shows us that when a variable improves, another deteriorates. The quality of the service and especially the drop in delays linked with a better reliability of the time of transport is a major source of improvement. The flexibility such a mechanism proposes is also an improvement for peaks of demand are more easily lopped.

4. THE FRANPRIX LEADER PRICE TEST

Franprix Leader Price wanted to test the possibility of night deliveries so as to supply all enclaves of Ile-de-France.

The study was twofold:

- Possibility test with a few stores
- Analysis of impacts generalizing deliveries to all stores.

Characteristic of the test

The test was led in June 2009 and for four weeks in a row. Sixteen stores were asked to take part in the experience, which represented more than fifty deliveries. Two forms were devised so as to guarantee delivery tracking: one for drivers, the other for store managers. Every day, so-called “night” rounds were twofold: one beginning by 1900 hours, the other by 2100 hours. The departure time was adjusted during the test so as to determine the departure time that minimized the time of transport and allowed to deliver stores at the right moment.

Noise emissions were measured during the test. It was necessary to characterize the delivery process as indicated in Figure 3 in order to have a correspondence between noise and the task operated.

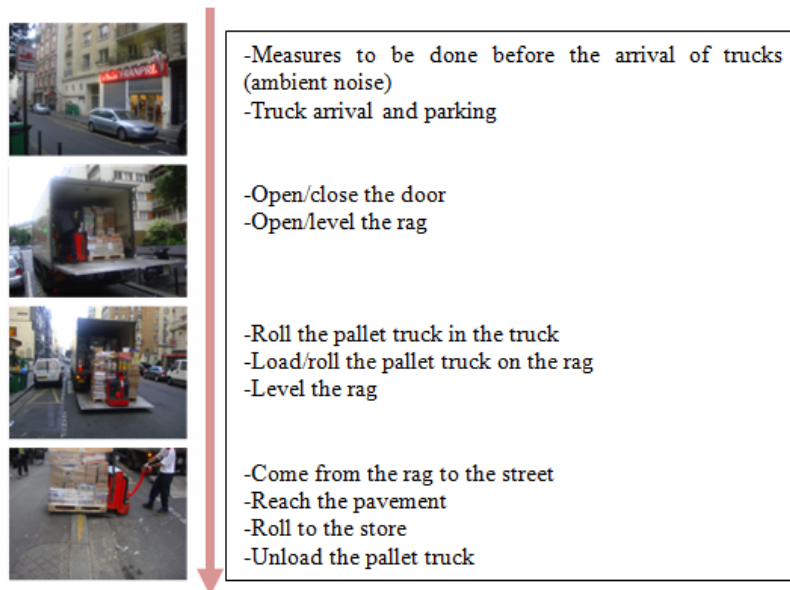


Figure 3 – The delivery process

Each step was measured according to the methodology used during the PIEK project (fixed points located seven yards away from the sound source); we measured five times each step of the process of each delivery so as to get more stable measures.

Outcome of the test

On average, we related the noise emitted to the ambient noise which depended on the hour of the day. Generally speaking, as Figure 4 shows it, the noise exceeded the ambient noise with the vehicles used by the firm.

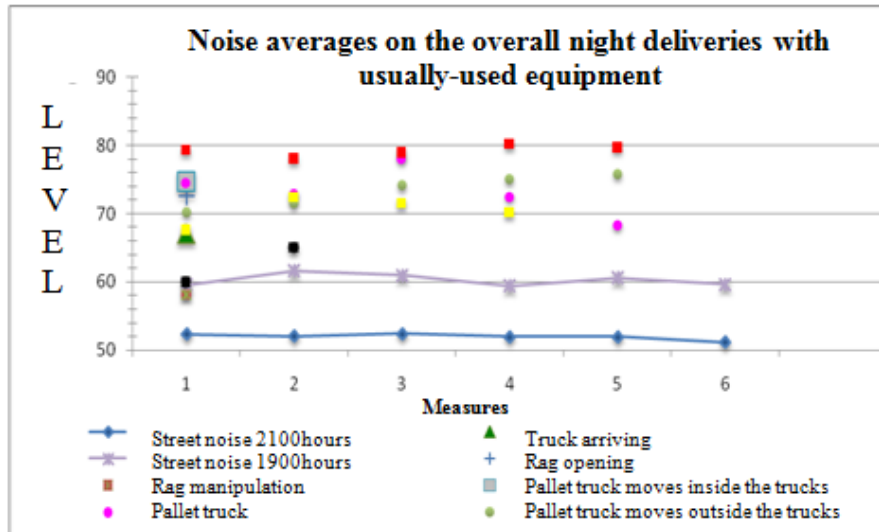


Figure 4 – Noise emitted during deliveries

This graph highlights the critical part of the steps whose noise outmatched the ambient noise (street noise) like opening and leveling the rag, moving the pallet truck on the rag and on the pavement. Solutions still have to be found to reduce noise at least during those steps. The first elements for solutions were gathered during a driven study, which we are not to tackle in this paper, about the coating of the truck container and the rag, quiet pallet trucks and loading ramp with suppliers. The study was by the way supported by putting some identified quiet equipment in real-life situations. This study ended by stating that reducing noise emissions was possible for euro 3 goods vehicles used by Franprix.

Rounds noticeably evolved during the test. Indicators of change tracked are departure and round time, the distance covered, consumption, CO₂ (carbone dioxyde), Nox (nitrogen oxides) and PM (suspended particles) emissions. An example is given through the following grid:

	Current delivery	Night delivery							
Departure time	7h22	21h23	<table border="1"> <thead> <tr> <th>Gains</th> </tr> </thead> <tbody> <tr> <td>21 %</td> </tr> <tr> <td>10 %</td> </tr> <tr> <td>17 %</td> </tr> <tr> <td>22 %</td> </tr> <tr> <td>25 %</td> </tr> </tbody> </table>	Gains	21 %	10 %	17 %	22 %	25 %
Gains									
21 %									
10 %									
17 %									
22 %									
25 %									
Kilometers	41,0 km	40,5 km							
Duration	2h03	1h37							
Fuel consumption	32,4 l/100 km*	27,5 l/100 km							
CO ₂ emission	1137,2 g/km*	938,4 g/km*							
Nox emission	4,9 g/km*	3,8 g/km*							
PM emission	0,22 g/km*	0,17 g/km*							

* Data from the ADEME IMPACT software calculated based on speed averages

Figure 5 – Example of the evolution of a round (Magasin Pyrénées)

Gains are significant with more than 20% of the round time saved for a store located in the 20th district of Paris. Gains differ according to the location of stores. A rule depending on the

distance to the warehouse and on accessibility (inner Paris, small crown, large crown) must be devised if one wants to generalize the results of the test.

Methodology

One would agree on generalizing on the entire number of Franprix Leader Price stores, using the test. To do so, we followed the device illustrated by Figure 6.

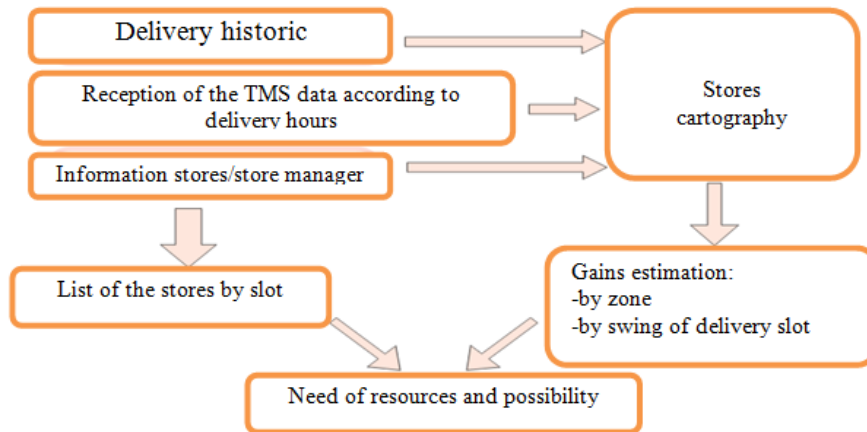


Figure 6 – Methodology used during the deployment of all stores

A stores cartography is devised according to the geographical location, deliveries and the time of transport (given by a Transport Management System software). Stores are classified according to store managers’ preferences and to store swings for deliveries (for example: a store can swing deliveries between 0500 and 0545 hours, usually at 1000 hours). We proceeded through slots as indicated in the following figure:

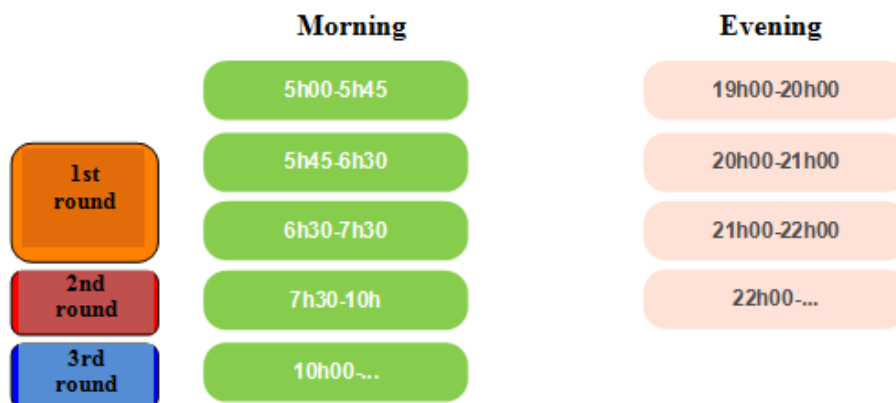


Figure 7 – Delivery slots

A list of stores is sorted and features former and new slots of stores based on preferences. Gains generated in transport can be estimated thanks to such information and according to the area in which stores are located. The needs of resources can be identified (number of drivers and necessary vehicles) by meeting the will of stores to be supplied.

Cartography

Stores are grouped together in zones. Such zones are defined by the history of deliveries. Limits are established in the way that when a store is supplied in a given zone, in 80% of

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cases, the same vehicle supplies another store of the same zone. Figure 8 illustrates the cartography.

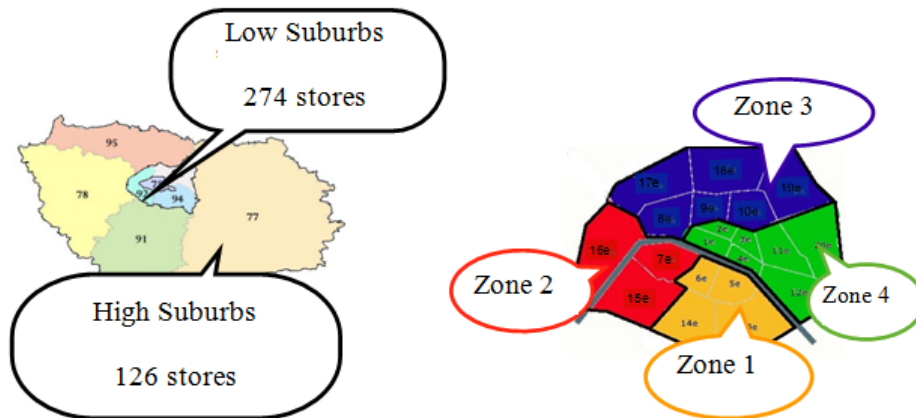


Figure 8 – Stores cartography

For each zone, we calculate the reduction or degradation of the time of transport departing from the warehouse in Chenvières (94) when a store swings from a slot to another. The following figure shows the average on the four zones of inner Paris.

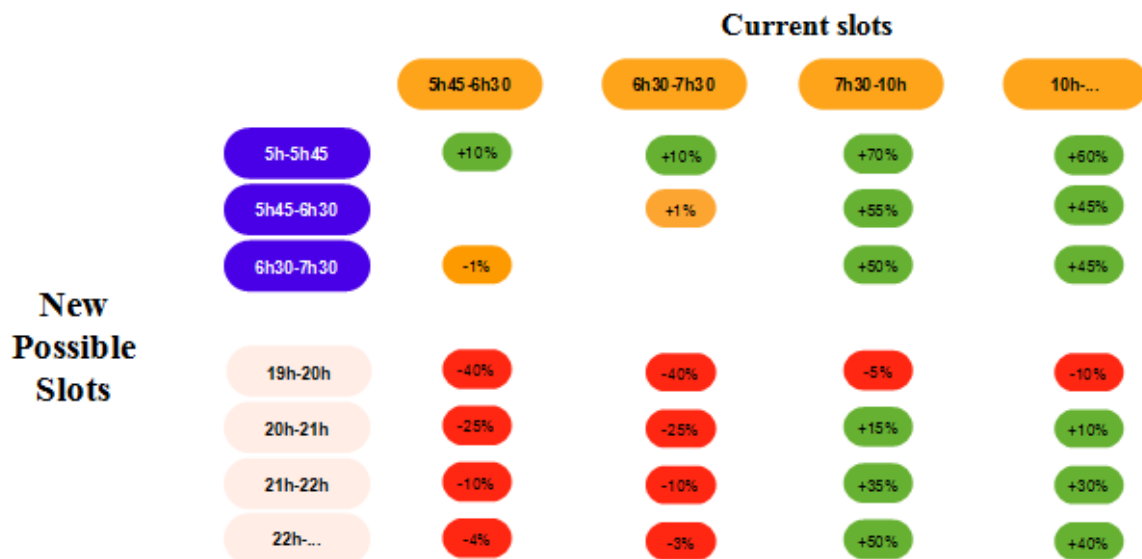


Figure 9 – Paris transport reduction matrix

A similar matrix exists for each zone, i.e. eleven were accounted for. Each coefficient of the matrix represents the percentage of reduction (if positive be), increase (if negative be) of the time of transport when a store swings from a slot to another. For instance, the time of transport is divided by two on average for a store in Paris if it goes past 0730-1000 hours (hours of high peak congestion) to 0630-0730 hours.

Identified gains

Gains are obviously made by the time saved which is generated by the swing in relation with congestion and the gain of drivers' time and gas,... Another gain is the one of productivity in stores. Then, those two types of gain come in a variety of forms for very early and late deliveries (from 1900 hours).

Gains of transport

Early and late deliveries would reduce the impacts of congestion on deliveries, save some of the time of transport and optimize drivers' working time, reduce gas consumption (important during hours of congestion), reduce pollutant emissions (important during hours of congestion) and improve customer service by reducing delays due to congestion.

Logistics gains of stores

Early and night deliveries would bring forward the unloading time and the products storage in the morning when the staff arrives at the store, have more specific hours for deliveries, optimizing the time when the staff is present at the store and improve the availability of products for each department when opening the store (possible reduction of broken products).

Gains could not be explicit in this paper for obvious confidential reasons. However, gains in productivity were five times as large as gains in transport.

5. CONCLUSION

Evidently speaking, the night deliveries mechanism is successful, be it economic or especially in showing them possible given the fact that technology is now ready to drastically reduce sound emissions. Gains are obviously generated by the drop in round time, they are especially important for the store logistics which benefit from an unloading pallet apart from customers, thus increasing each employee's productivity. In the Franprix Leader Price case, we thought that such gain corresponded to five times the one of transport, which remained unsuspected by the time the project was launched. Rentability is also guaranteed by the fact that mass marketing generates flows that are important and massive in most cases. The network of stores is such in the Parisian region that demand kept on being present each day of the test and might correspond to an average. The constitution of a network remains a critical weight in making such a supply organization possible when a somewhat critical mass is essential so as to guarantee night delivery services. What are the types of industries that might swing to night deliveries? What type of goods can fall in (frequency of delivery, organization of transport, volumetry, preparation mode, reception capacity, delivery points density)? We will provide a few elements to answer such questions by characterizing customers for night deliveries in upcoming papers.

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