NIGHT-TIME DELIVERY AS A POTENTIAL OPTION IN BELGIAN URBAN DISTRIBUTION: A STAKEHOLDER APPROACH

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ABSTRACT

This paper investigates the public support for night-time delivery in Belgian cities. Encouraging, or even imposing night-time deliveries are possible measures for governments in order that urban traffic does not get jammed completely and that goods still can be delivered efficiently. But there are also some downsides to delivering at night such as noise nuisance caused by loading and unloading trucks, the need for an increased availability of the receiver and some liability issues. Therefore assessing the attitude of all stakeholders involved towards shifting urban deliveries to the off-peak hours is useful in order for the policy-makers to decide what position to take in respect to night deliveries.

This paper presents the multi-actor multi-criteria analysis (MAMCA) (Macharis, 2004) as the appropriate tool for measuring public support for night-time delivery in urban surroundings as it enables to incorporate the views of different stakeholders, in this case the receiver, the transport sector, society as a whole and the employee, and their criteria. These stakeholders were interviewed on their attitude towards five different scenarios in which the time periods for deliveries and/or the accompanying measures differ. The findings suggest that the public support for an overall implementation of night-time deliveries is rather low. But at the same time, the research shows there is some room for implementation in Belgian cities, but only if the time period, the type of business and the accompanying measures are carefully selected.

Keywords: night-time deliveries, off-peak deliveries, urban freight, city logistics, stakeholder approach, multi-criteria analysis, multi-actor multi-criteria analysis.

INTRODUCTION

The lack of suitable infrastructure for deliveries, noise emissions, conflicts with other road users during delivery operations, jammed trucks in pedestrian zones or historic centres, traffic disruption in the inner city, and environmental pollution. According to 43 European urban governments, these are the main problems concerning urban freight transport in their cities (Ruesch and Glücker, 2001). Despite the fact that these problems are well-established, they are very difficult to resolve because having goods delivered frequently and efficiently is essential for a liveable city. A liveable city is more than just a place to live. It has to accommodate several other functions, such as working, public services, shopping, entertainment, education and tourism (De Munck and Vannieuwenhuyse, 2008; Witlox, 2006). For each of these functions, tons of goods have to be brought into the city. But the way these deliveries are done nowadays puts a strain on the quality of life because of the negative impact on the environment, on traffic safety and on urban mobility.

In the literature on urban logistics, introducing night-time deliveries, also called off-peak or off-hour deliveries, is often cited as a possible solution. The concept is rather straightforward: deliveries take place in the off-peak hours, thus reducing congestion during rush hours. However there are also a number of potential stumbling blocks such as the noise pollution during the 'quiet' hours, the more expensive labour costs, and liability issues. Balancing the pros and cons against each other is all the more complicated because one should take into account the often conflicting interests of the different stakeholders involved. For example, some retailers prefer to be delivered in the early morning because they want to have their merchandise in their shops before they open up. But local residents do not want noisy trucks in their streets during the night, and commuters and other residents do not like trucks blocking the road when they have to travel to work.

In Belgium the Federal Science Policy Administration issued a research project on evaluating how night-time deliveries can be considered as a potential option for (partly) solving the problems concerning freight transport in Belgian cities. The ultimate aim of the program is to reconcile the different stakeholder demands and to assess the overall socio-economic impact of night-time deliveries. As part of this project, the public support for night-time deliveries in Belgian cities was measured, making use of a multi-actor multi-criteria analysis (MAMCA), which, as a stakeholder oriented tool to evaluate transport projects, was developed at the department of MOSI-Transport and Logistics of the Vrije Universiteit Brussel (VUB) (Macharis et al., 2007). This paper presents both the MAMCA-approach, which allows the points of view of several stakeholders and their quantitative and qualitative criteria to be incorporated in one analysis, and the results of the analysis. These aspects are dealt with in sections 3 and 4 of this paper. In section 2, we focus on some relevant findings of earlier research on night-time deliveries, whereas in section 5, our conclusions are summarized.

NIGHT-TIME DELIVERIES AS A POSSIBLE SOLUTION FOR URBAN FREIGHT TRANSPORT PROBLEMS

One option to optimize the economic life and the urban distribution, while decreasing the negative effects of urban freight traffic, is to switch to night-time deliveries. In this policy measure no goods vehicles are permitted to enter a specified geographical area within the inner urban area to make collections and deliveries during a large period of the working day (Allen et al., 2004). Currently, in Belgium, like in most countries, deliveries are usually carried out by day. To our knowledge, there are no general statistics on delivery times, but some city administrations map their distribution patterns. In 2004, the city of Ghent studied the feasibility of an urban distribution centre and interviewed 215 traders within the city centre (Stad Gent, 2004). Twenty-eight percent of the respondents were owners of bars, restaurants and hotels, 18 percent traded in fashion and accessories, 17 percent provided other services, 14 percent were other retailers and only two percent were supermarkets. They were all asked at what time of the day their two main suppliers deliver their goods. The results of the inquiry are shown in Table 1.

Table 1- Delivery Times in Ghent. Source: Stad Gent, 2004

DELIVERY TIMES IN GHENT		
Time of day	abs	%
Before 9 am	34	9%
9 am – 11 am	118	32%
11 am – 2 pm	62	17%
2 pm – 6 pm	29	8%
After 6 pm	14	4%
Highly varying	101	28%
Does not know	6	2%
Total	364	100%

Nearly half of the deliveries take place between 9 am and 2 pm. Only a minority, nine percent, is made before 9 am, and even less, only four percent, is carried out after 6 pm. In other European countries such as the Netherlands and Great Britain, we notice a same pattern (Schoemaker et al., 2006; Allen et al., 2000). The majority of deliveries occur in the morning, only a negligible percentage is carried out during the off-peak hours. The small share of night deliveries in Ghent is even more striking because there is a time window between 6 pm and 11 am. This time window is government-imposed to increase traffic safety and liveability and to create an attractive urban shopping environment. Obviously, in this case, many exceptions were granted because at least 25 percent of the deliveries took place outside the set timeframe.

The literature on the (theoretical) advantages and disadvantages of night deliveries is extensive. Table 2 summarises the findings of earlier research. It shows the impact of night

deliveries on five points of interest for urban distribution: congestion, road safety, the environment, social vitality, economic viability, and on the logistics chain. The conclusion is that shifting deliveries to the off-peak hours is a measure with positive social and economic consequences, which is also feasible provided that the government sets up the right framework to keep any negative effects under control. These possible negative effects are: noise, safety, both for the driver and the goods, liability issues and extra costs to the receiver.

In the Netherlands, SenterNovem which is an agency for sustainability and innovation thought it would be interesting not only to sum up the pros and cons of night-time deliveries, but also to really calculate the impact of a possible shift. In 2008 they studied whether the benefits would compensate the extra costs if all Dutch supermarkets were delivered in the off-peak, provided the implementation of an adjusted policy to keep the above-mentioned negative effects under control (Dassen et al., 2008). The model is based on a qualitative analysis of the impact of night distribution from which the quantifiable effects (i.e. energy consumption, transport costs, emission of pollutants and number of traffic victims) were calculated. Six retail chains cooperated. They provided the researchers with data on their delivery operations such as the average distance travelled, the actual driving time, the fuel consumption, the average fuel price, etc. SenterNovem used these numbers to determine through projection the total financial and environmental impact of night deliveries both on the micro and the macro level.

Table 2 - The Impact of Night Deliveries. Source: De Munck and Vannieuwenhuyse, 2008

THE IMPACT OF NIGHT DELIVERIES			
		Impact	
Points of interest for urban distribution	Congestion	+	Shifting deliveries to the off-peak hours decreases congestion.
	Traffic safety	+	Decreasing the number of trucks and vans during the off-peak-hours diminishes the risk of casualties.
	Environment	+	Even when trucks do not change their itinerary, not standing still in traffic jams with running engines will reduce their emission of pollutants dramatically.
	Social vitality	±	Liveability by day will ameliorate because trucks will not populate the streets. At night, on the other hand, noise levels might exceed the acceptable, which can be countered by firm noise standards.
	Economic viability	+	Drivers do not lose time in traffic jams, which allows them to deliver more in less time.
Logistics chain	Total logistics cost	±	It is uncertain what the impact of night deliveries on the total logistics cost would be, since the wages of the drivers would raise, but the gain of time would cut costs.
	Reliability	+	The risk of delays is much lower when delivering at night because there is no congestion.
	Flexibility		No impact
	Safety	-	When delivering at night, truck drivers often get unguarded access to a shop which hampers security. There are technical solutions such as delivery boxes, but they imply extra costs. There is also a liability issue when goods are damaged or lost during delivery operations because usually there is no staff present to accept the delivery. The presence of night security might solve this problem, but it also implies an extra cost.
	Speed		No impact
	Image		No impact
Subsidies necessary?		N	No subsidies are necessary; this policy might even be cost-cutting.
Initiator			Government (legal framework) and supplier (agreement on delivery times with the receiver)
Social effect		+/ ++	The impact of night deliveries is very positive. Attention should be paid to the noise levels of both truck and driver.
Economic effect		+/ ++	Night deliveries are more expensive because of the night work needed, but then again transport becomes more efficient and reliable. Attention should be paid to the safety of the goods.
Feasibility		~/ +	Night deliveries are feasible in certain logistic chains, when the safety of goods is not an issue, or for retail chains who organize their own logistical arrangements.

The calculations show, for example, that a national operating retail chain could save ten percent on fuel by switching to night deliveries. On a national level, that could mean an annual saving of fourteen million litres fuel. It was also found that a regional operating chain could save up to 858.000 Euros a year; whereas for a national operating chain, this could lead up to almost five million Euros. The possible environmental consequences are even more striking. The emission of soot and fine dust could be reduced with forty-two to forty-four percent. SenterNovem concludes that there are great benefits in using the early mornings and late evenings to supply retail chains. It will lead to less pressure on our road network and to an improved use of its capacity. It will also reduce costs, energy use and emissions of pollutants.

Although this Dutch project is an indicator of the possible scale of the positive effects of a shift to off-peak deliveries, the ease with which it assumes that the negative effects can be easily overcome might not be very realistic. In most urban settings, there is a spatial integration of the different qualities city life incorporates. This is often encouraged by local governments because these hybrid neighbourhoods generate a vibrant, attractive and safer city (Vannieuwenhuyse and De Munck, 2008). Therefore, in addition to the 'economic' stakeholders, one should also take into account the needs of the different 'social' stakeholders. Broadly speaking, there are three groups of stakeholders: (i) trade and industry, (ii) society, and (iii) public policy-makers (Witlox, 2006). Trade and industry include suppliers, carriers, receivers, wholesalers and distribution companies. Society consists of inhabitants, employees, commuters, consumers, and tourists. Public policy-makers are local, regional and national governments. All these stakeholders, each with their own often conflicting interests, take measures to mitigate the adverse effects of urban distribution to them personally (or as a group) which in turn often cause additional nuisance to the other stakeholders. Therefore, governments aim for a sustainable urban distribution which means that they want to establish a framework within which the various aims and objectives of the stakeholders are reconciled as much as possible.

HOW TO MEASURE PUBLIC SUPPORT FOR NIGHT-TIME DELIVERIES IN BELGIAN CITIES?

Methodology

Evaluating (new) transport projects (either new infrastructure or new initiatives) implies having a method that is able to take into account different conflicting objectives and can reconcile tangible and intangible criteria. Today, five commonly used methods exist: the private investment analysis (PIA), the cost effectiveness analysis (CEA), the economic-effects analysis (EEA), the social cost benefit analysis (SCBA) and the multi-criteria analysis (MCA) (Macharis et al., 2007). The latter two are the most frequently used. Recently, however, both in management literature and practice, the concept of stakeholder and

stakeholder management has become a very important issue. A technique that combines the MCA technique with the notions of stakeholder and stakeholder management in an explicit way is the so-called multi-actor multi-criteria analysis (MAMCA) (developed by Macharis, 2004). This approach takes the advantages of a MCA (namely the fact that effects may be expressed in different units and that trade-offs become more explicit) and those of stakeholder management (the fact that stakeholders are crucial actors in contributing to the success or failure of the implementation of a policy). In the context of the evaluation of night-time distribution, the participation of stakeholders is vitally important. As explained above, the urban setting involves many different interests, which makes the decision on whether or not to deliver in the off-peak highly controversial. MAMCA provides a comparison of different strategic alternatives by pointing out its advantages and disadvantages for all stakeholder groups.

The MAMCA-methodology consists of seven steps, and is depicted in Figure 1:

The definition of the problem and the identification of the alternatives: The first stage of the methodology consists of defining the alternatives. These alternatives can represent different policy options or actions to be taken.

The identification of stakeholders and their key objectives: In this step the stakeholders are identified and asked for their goals/aims concerning the decision problem at hand.

The objectives are translated into criteria and a weight is allocated to each of them: The choice and definition of evaluation criteria are based primarily on the identified stakeholder objectives and in order the assign a weight to these objectives the AHP method is used. The Analytic Hierarchy Process (AHP) (Saaty, 1986) is a frequently used MCA-method. By means of pair wise comparisons the priority of each objective for the stakeholders is determined.

For each criterion, one or more indicators are constructed: In this stage, the previously identified criteria are translated into variables that can be used to measure (quantitatively or qualitatively) to what extent an alternative contributes to each individual criteria.

An evaluation matrix is constructed which aggregates each alternative contribution to the objectives of each stakeholder group.

The multi-criteria analysis provides a ranking of the various alternatives and shows their weak and strong points: The multi-actor multi-criteria analysis provides a comparison of different strategic alternatives and supports the decision maker in making his final decision by pointing out for each stakeholder which elements have a clearly positive or a clearly negative impact on the sustainability of the considered alternatives.

The actual implementation: Sensitivity analysis shows how consistent the judgments are: When the decision is made, steps have to be taken to implement the chosen alternative by creating deployment schemes. As the method proves insights in the advantages of each alternative for each stakeholder group, this information can be explicitly taken into account while developing the mitigation strategies.

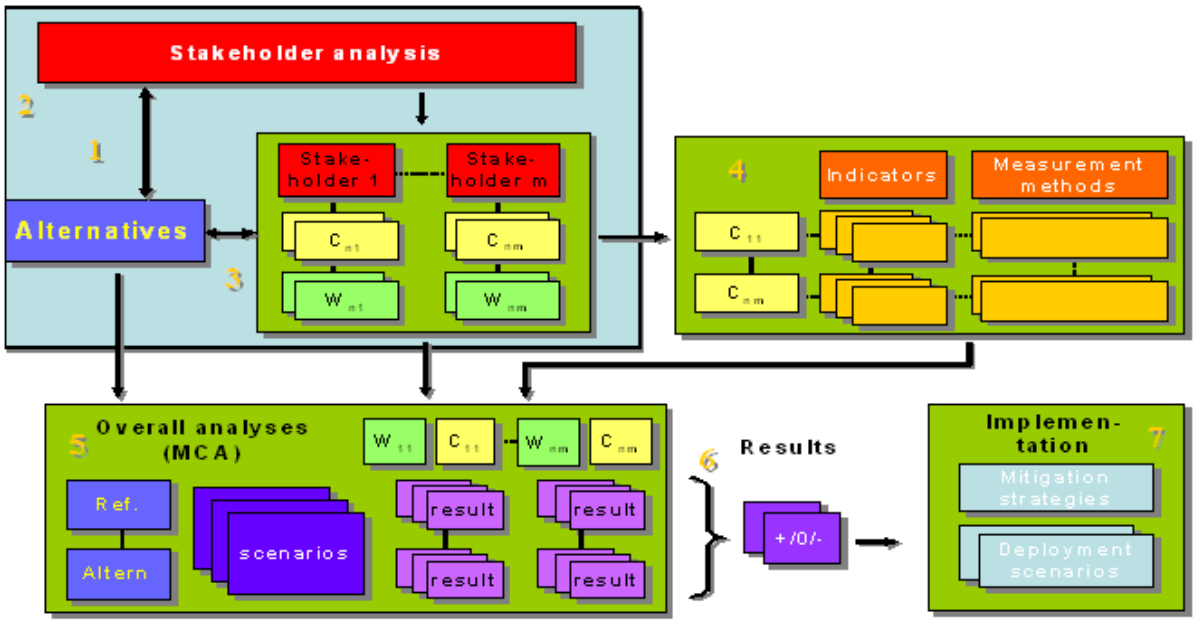

Figure 1 – Methodology for a multi-actor multi-criteria analysis. Source: Macharis, 2004

The different steps of the Multi Actor Multi Criteria Analysis in the case of off-peak deliveries

In the following section the different steps of the methodology of the MAMCA will be explained for the specific case of off-peak deliveries. Through this analysis the support for a possible shift to off-peak deliveries can be assessed for each of the stakeholder groups as the end result is a ranking of the previously defined scenarios.

Step 1: Defining the alternatives

The first step consists of identifying and classifying the possible alternatives submitted for evaluation. In this case, there are two alternatives: delivering businesses in cities during daytime or at night. Based on these alternatives and on a profound study of the problems of urban distribution and of the typical characteristics of night deliveries, five possible scenarios were defined. They differ as to when deliveries are made and which accompanying measures have been taken.

Scenario 1: Day deliveries

Scenario 1 assumes that deliveries in cities are made during the day in compliance with currently imposed time windows. The actual practice shows it would be mainly between 9 am and noon (Stad Gent, 2004; Schoemaker et al., 2006; Allen et al., 2000).This scenario can be seen as the reference scenario.

Scenario 2: Night deliveries between 7 pm and 7 am

In scenario 2 all deliveries are shifted to the late evenings, nights and early mornings when the demand for transport is low. At these times commuter traffic virtually stops. Most commuters leave their homes between 6:30 am and 8:45am, with a peak between 7 am and 8:15 am (Verhetsel et al., 2007). Statistics on everyday congestion in Belgium point out in the same direction: the earliest traffic-jams appear at 6:30 am and end around 9:15am (www.touring.be, 12th of March 2009). They are at their longest at 8:35 am. The evening rush hour is more spread. People arrive home between 4:30 pm and 8 pm, with an early peak between 4:30 pm and 6 pm. As from 7 pm the number of commuters still on the way drops dramatically. According to Touring Mobilis the evening traffic jams reach their peak between 6 pm and 6:30 pm. This shows that in Belgium the hours between 7 pm and 7 am can be considered as off-peak.

Scenario 3: Off-peak deliveries between 7 pm and 11 pm

As previously mentioned, off-peak deliveries have several undesirable side effects. They are generally directly linked to the nocturnal time of delivery, for example the higher nuisance caused by loading and unloading trucks and the higher wages for drivers and workers. To find out whether a well thought-out partial use of the off-peak hours to deliver goods might mitigate these side effects, two alternative scenarios were introduced.

In scenario 3, deliveries are only allowed between 7 pm and 11 pm, based on the following:

At 9:30 pm only 9% of the Belgians already went to bed (Glorieux et al., 2008). Another 3,5% is getting ready to do the same.

At 11 pm more than half of the population is asleep (56%). One hour later, already 83% is sleeping and at two o'clock, nearly everybody went to bed (96,1%).

Labour legislation is less strict on companies introducing night work when it is performed before midnight. (http://www.belgium.be, 12th of March 2009).

Scenario 4: Off-peak deliveries between 3 am and 7 am

In scenario 4 deliveries can only be carried out between 3 am and 7 am. We can assume that some stakeholders might prefer these hours because they are the off-peak hours closest to the 'normal' delivery hours in the morning.

Scenario 5: Night deliveries between 7pm and 7 am, combined with noise standards and a subsidy scheme

Literature on night-time deliveries and pilots show that the noise nuisance caused by trucks driving, loading and unloading is an important obstacle for introducing off-peak deliveries in cities (Dassen et al., 2008). Therefore, in this scenario, as in scenario 2, all deliveries are shifted to the late evenings, nights and early mornings. But this time, this shift is combined with a specific set of measures aimed at mitigating the nuisance. The scenario refers to the Dutch Piek-programme. At the end of 1998 the renewed "Decree Retail Trade Environmental Protection" came into force (www.piek.org, 12th of March 2009). It stipulated that the noise emission generated when loading and unloading goods between 7 pm and 7 am must comply with strict peak noise standards. Given the products that were used at that time, industry and commerce could not comply with these strict standards. They were forced to come up with innovative measures. The Dutch government supported the implementation of these new products with a long-term subsidy scheme, also called the Piek-programme.

Step 2: Defining the stakeholders and their objectives

The second step consists of identifying all relevant stakeholders and their objectives. As mentioned earlier, concerning urban distribution there are three main groups of stakeholders. When evaluating night-time distribution, this general categorization is still valid, although the subcategories should be slightly rearranged according to the mutually different or coinciding objectives within or between the different groups. This leads to four separate stakeholders: the receiver, the transport sector, society as a whole, and the employee.

The receiver

The attitude of the receiver is a very decisive success factor (Holguín-Veras et al., 2005). They determine the delivery time and usually prefer to be delivered in the morning right before or right after opening up. In spite of them being mutually very divergent, the different types of receivers are considered to be one group due to their common objectives concerning deliveries which are:

- Competitiveness
- Customer satisfaction
- Smooth delivery (just in time deliveries, without delays, right in front of the shop, at a convenient time)
- Attractive urban shopping environment
- Goods safety (both the delivered goods and the stocks)
- Motivated employees

The transport sector

The second group of stakeholders is the transport sector. This group comprises carriers, but also logistic suppliers, the distribution sector and other related stakeholders, for example suppliers and harbours. These are the objectives that the transport sector uses to evaluate every possible change in their delivery operations:

- Delivery cost
- Customer satisfaction
- Technical feasibility
- Organizational feasibility
- Motivated employees

Society

The third stakeholder is society as a whole. Since the users of the urban space (inhabitants, commuters, tourists, shoppers) and the government have the same objectives regarding urban distribution, they are considered as one group for this analysis. Their objectives are as follows:

- Efficient urban distribution
- Cost-efficient accompanying measures
- Attractive urban environment
    - Smooth traffic
    - Traffic safety

- Limited noise nuisance
- Limited emissions of pollutants

The employee

The fourth group of stakeholders are the employees. It concerns all the employees, truck drivers, employees working in the stores, at the port, etc. Their objectives for their work environment are:

- Health
- Safety
- Wage
- Flexibility
- Social life
- Stress

Steps 3 & 4: Translate the objectives into criteria and indicators and allocate a weight to each criterion

After identifying the alternatives and the different stakeholders with their key objectives, the next five steps of the MAMCA-methodology aim to obtain and to process information on the impact of the different alternatives on the stakeholders' objectives. When analysing the advantages and disadvantages of night-time deliveries, most of the defined criteria cannot be expressed in numbers or are not the subject of existing statistics, for example an attractive shopping environment or motivation of the employee. Therefore this information was gathered through 18 interviews with representatives of the different stakeholder groups.

The interviews were held on established lines and included three phases. First of all, the above defined objectives were presented while asking for possible gaps. Secondly, the interviewee could indicate the importance of each of the objectives by assigning points. A total of 100 points had to be spread over the different objectives. Finally, a score between -2 and +2 had to be given to each scenario for the different objectives. Afterwards, the different scores for objectives were transformed in order to get pair wise comparisons which are used to establish the weights for the criteria. Furthermore, an evaluation matrix was constructed which aggregates each alternative contribution to the objectives of each stakeholder group.

Step 5: Overall analysis and ranking

In order to carry out the overall analysis and ranking we use Expert ChoiceTM, specialized software that makes use of the AHP method. The results of this analysis are shown in the next section.

Results

Employee

Figure 2 below shows the results for the stakeholder 'employee'. The figure can be interpreted as following: the objectives are represented by vertical bars and the alternatives (scenarios) are displayed as horizontal line graphs. The intersection of the alternative line graphs with the vertical objective lines shows the priority of the alternative for the given objective, as read from the right axis labelled Alt%. The objective's priority is represented by the height of its bar as read from the left axis labelled Obj%.

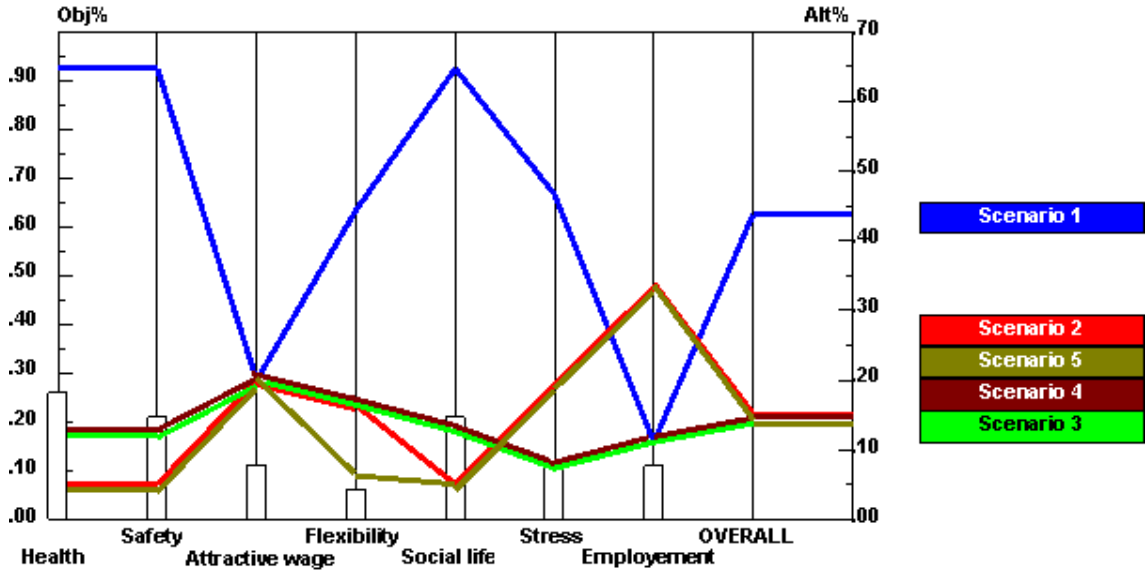

Figure 2 – Results stakeholder 'employee'. Source: MOSI-T, VUB

For the stakeholder 'employee', the overall best scenario is scenario 1. The second best is scenario 2, followed by scenarios 5, 3 and 4. It means that the stakeholder 'employee' prefers day deliveries and considers them as the best alternative. The figure also shows that scenario 1 has the highest scores for the three most important objectives, being 'health', 'safety' and 'social life' which is easily explained as working at night is more dangerous, less healthy and very disturbing for your social life. Only for the objective 'employment' scenario 1 does not have the highest score, but scenarios 2 and 5 do. These are the scenarios with night deliveries between 7 pm and 7 am, with or without a subsidy scheme and noise standards.

Receiver

The results for the stakeholder 'receiver' are shown below in Figure 3. Again, scenario 1 comes out as the overall best alternative. Subsequently, we have the four other scenarios with very close scores. Scenario 1 obtains a high score for the objectives 'low delivery price', 'goods safety' and 'motivated employees'. When we look at the objective 'attractive urban environment', scenario 5 is seen as the best alternative as delivering at night with a subsidy scheme and noise standards results in a truck free urban environment during the day and is not disturbing at night. The most important objectives for this stakeholder group are 'customer satisfaction', 'low delivery price' and 'smooth delivery'. For the objective 'customer satisfaction' scenario 4 is the best alternative, for the other two objectives scenario 1 scores best.

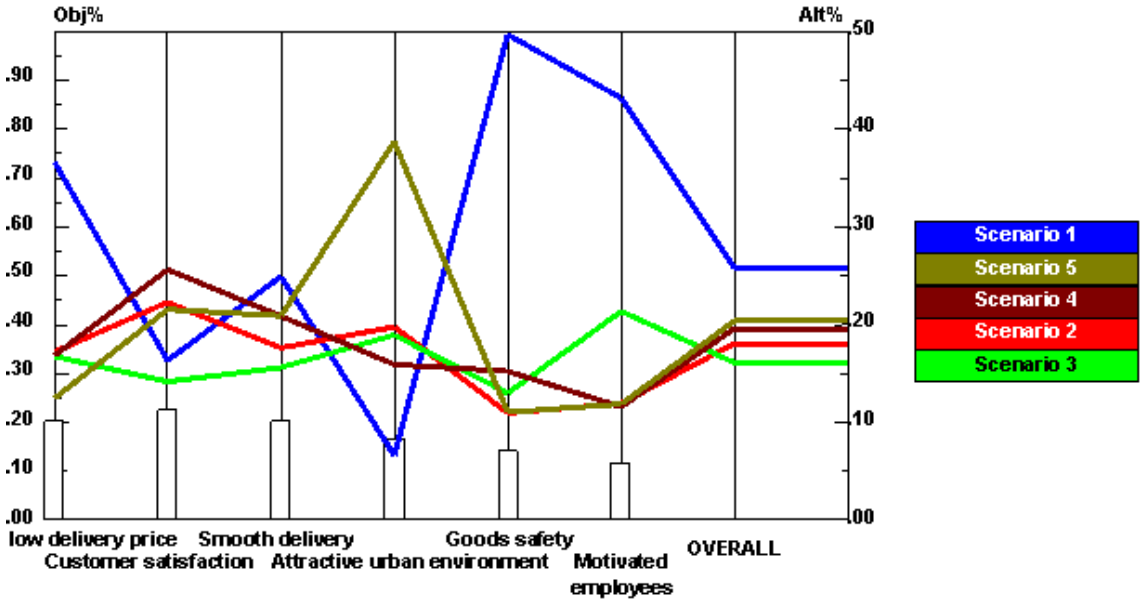

Figure 3: Results stakeholder 'receiver'. Source: MOSI-T, VUB

Transport sector

The model seen from the perspective of the stakeholder 'transport sector' is shown in Figure 4. The results are remarkably different from those of the previously discussed stakeholders. Scenario 2 (night deliveries between 7 pm and 7 am) is overall perceived as the best option. Subsequently scenario 3 (off-peak deliveries between 7pm and 11pm) and scenario 4 (off-peak deliveries between 3 am and 7 am) are good alternatives. With regard to the less important objectives 'technical feasibility' and 'organizational feasibility', scenario 1 (day deliveries) scores best. As for the most important objective, being 'competitive delivery price', scenario 2 offers the best alternative. The transport sector thinks that they would be able to lower transport costs when delivering in the off-peak hours, which would lead to more competitive delivery prices. The second important objective is 'motivated employees' which,

according to the transport sector, could be reached best through night deliveries coupled with a subsidy scheme and noise standards.

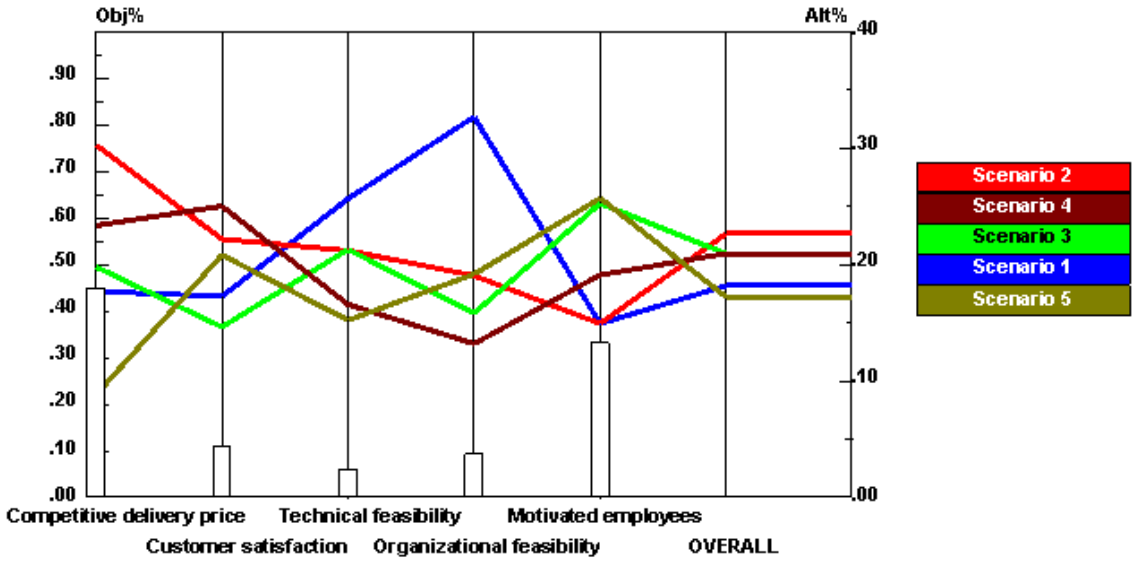

Figure 4: Results analysis stakeholder 'transport sector'. Source: MOSI-T, VUB

Society

With regard to urban deliveries, the stakeholder 'society' aims for three objectives, namely efficient urban distribution, cost efficient accompanying measures and an attractive urban environment. For these three objectives scenario 5 receives the best score, followed by scenario 2 and scenario 4. Strikingly, scenario 1 (day deliveries) is not considered as the best alternative. The objective with the highest weight is 'an attractive urban environment. It attains the highest score for scenario 4. This scenario is also the best option for the objective 'cost efficient accompanying measures'. As for the objective 'efficient urban distribution', scenario 5 (night deliveries between 7 pm and 7 am with a subsidy scheme and noise standards) has got the highest preference (Figure 5).

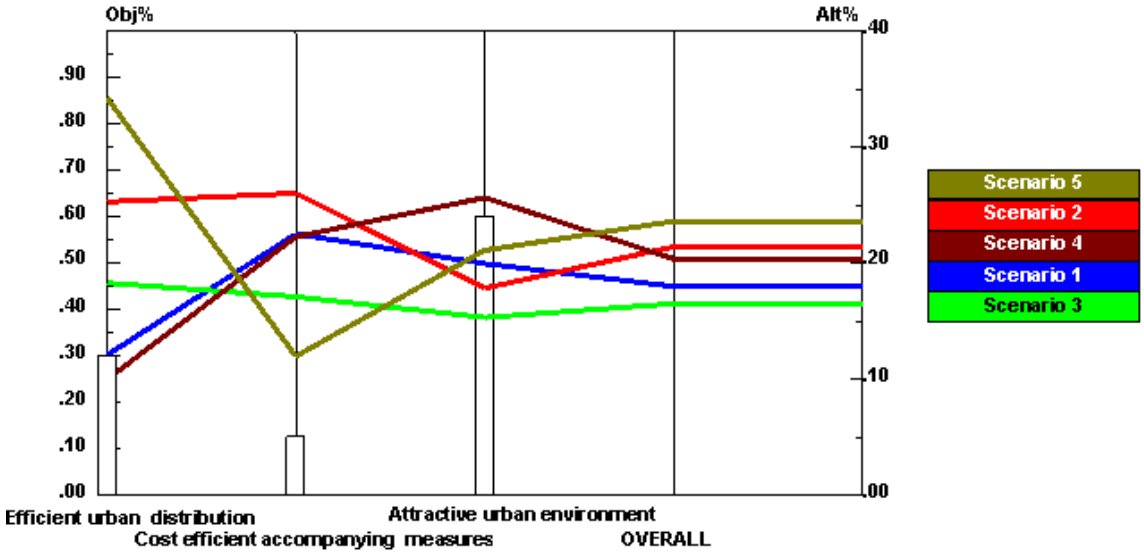

Figure 5: Results stakeholder 'society'. Source: MOSI-T, VUB

Subcriteria within society

According to the interviewed representatives of the stakeholder group 'society', the objective 'attractive urban environment' is defined by 6 sub criteria, being 'transport safety', 'limited emissions of pollutants', 'noise nuisance', 'smooth traffic flow', 'visual nuisance' and the question whether it is desirable to shift to a 24-hour economy, called the 'social component'. The results of the analysis for these sub criteria are shown in Figure 6. Overall, the best scenario is scenario 4 (off-peak deliveries between 3 am and 7 am). Notable in Figure 6 is that when scenario 4 attains a high score, scenario 1 has got a very low score and vice versa. With regard to the objectives 'noice nuisance' and 'social component', day deliveries are preferred because of the noise caused by the loading and unloading operations and the issue whether a further shift to a 24-hour economy is desirable. As far as the other objectives are concerned, society prefers scenario 4.

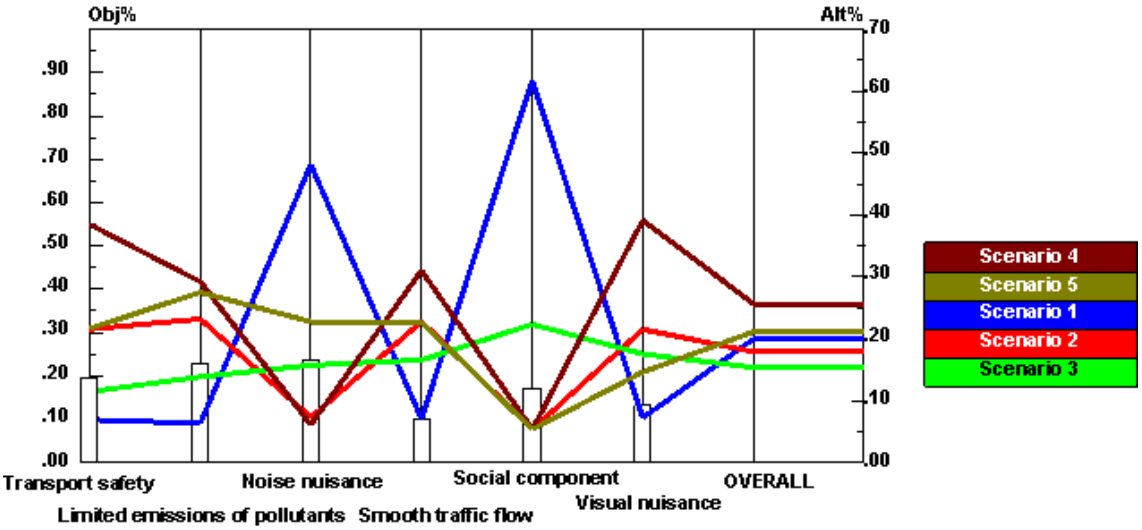

Figure 6: Results stakeholder society, sub criteria. Source: MOSI-T, VUB

Overall optimal scenario

Figure 7 shows that the optimal scenario, considering the preferences of all stakeholder groups which were considered to be of equal importance, is scenario 1 (day deliveries), followed by scenario 4 and scenario 2 respectively. As mentioned before, scenario 1 is the optimal scenario for the stakeholders 'employee' and 'receiver'. Scenario 3 is the scenario with the highest score for the stakeholder 'transport sector' and scenario 5 for 'society'.

The analysis of these results shows clearly the conflicting interests of the different stakeholder groups. Employees prefer day deliveries, since here 'health', 'social life' and 'safety' prevail. Receivers choose day deliveries as well, because the primary objectives here are 'smooth delivery' and a 'low delivery cost'. In contrast, for the stakeholder 'transport sector', totally different results were observed. Day deliveries are only ranked at place four and instead scenario 2 is considered as the best alternative. This can be explained by the fact that a 'competitive delivery price' is very important for this stakeholder group and therefore. Also striking is the fact that the 'transport sector' considers scenario 5 to be the most appealing one to its employees, as the stakeholder group 'employee' indicates to prefer scenario 1. Like the 'transport sector', 'society' does not choose day deliveries as the best option. They do consider scenario 2, scenario 4 and scenario 5 to be optimal which can be explained by the fact that for 'society' the objectives 'efficient urban distribution', 'cost efficient accompanying measures' and an 'attractive urban environment' are the most important objectives. It is very obvious that day deliveries have a low score for these objectives.

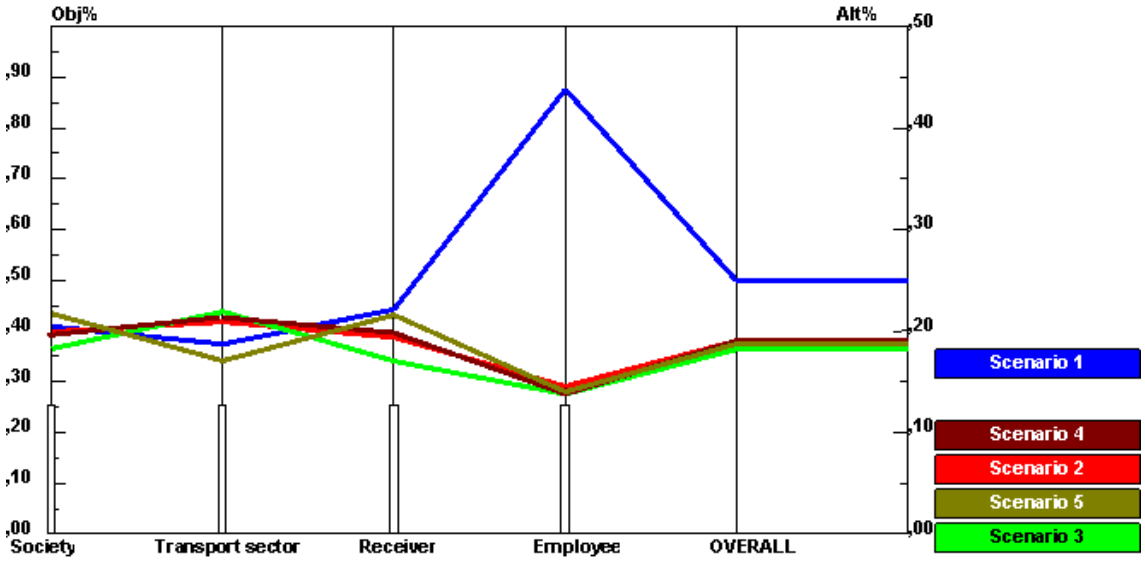

Figure 7: Sensitivity analysis for all stakeholder groups. Source: MOSI-T, VUB

CONCLUSION

Night-time deliveries might be an answer to some of the problems in Belgian cities, such as congestion, pollution and inefficient delivery operations. As the contribution of freight traffic to these problems is rather unclear and as there are both advantages and disadvantages to shifting deliveries to the off-peak hours, it would be interesting for urban government to assess the public support for a similar shift. The most appropriate methodology consists in a multi-actor multi-criteria analysis (MAMCA), which enables to incorporate the often conflicting interests of the different stakeholders in one comprehensive analysis.

The executed MAMCA on night-time deliveries gave the following results: two of the four stakeholder groups, 'employee' and 'receiver', prefer deliveries to be carried out as they are today, namely by day. The opinion of the stakeholder group 'transport sector' is completely opposite, as they prefer to deliver between 7 pm and 7 am. The fourth stakeholder group, 'society', prefers night-deliveries as well, but only when accompanied by a subsidy scheme and noise standards. These findings suggest that the public support for an overall implementation of night-time deliveries is rather low. But at the same time, the research shows there is some room for implementation in Belgian cities, but only if the time period, the type of business and the accompanying measures are carefully selected.

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