THE MULTI-ACTOR, MULTI-CRITERIA ANALYSIS (MAMCA) FOR THE EVALUATION OF "DIFFICULT" TRANSPORT PROJECTS:
THE CASE OF THE OOSTERWEEL CONNECTION

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ABSTRACT

Implementing transport projects leads quite often to controversies. Often there are winners and losers involved when implementing a new transport project. Simply neglecting these stakeholders will not help in implementing faster the proposed solutions as more and more often these people will organize in action groups which can prove to have quite important (legal and media) power. In Flanders, for more than two years on a row, the mobility problems in Antwerp have resulted in a major debate. Several possible solutions and even so different actors were placed against each other.
In this paper we show how the Multi Actor, Multi Criteria Analysis (MAMCA, developed by Macharis, 2004) methodology can help in structuring the debate and help to come to good compromises. The MAMCA is a methodology to evaluate different policy options whereby different stakeholders' opinions are explicitly taken into account.

Keywords: Multi Actor, Multi Criteria Analysis, Evaluation of transport projects.

1. INTRODUCTION

The Oosterweel connection is the largest infrastructure project ever in Flanders. It has been a point of discussion for several years, especially during the last 2.

The Ring Road in Antwerp is the busiest highway in Belgium. International and port – related traffic are the reason why the Ring Road is congested. This congestion means a high cost for the economy , especially the Port, where thousands of trucks a day enter of leave the port.

The plan to close the Ring Road, and therefore create extra capacity, is a plan that has been developed in 1995. Now, 15 years later, the project is still in a preparatory phase due to a lot of discussions and conflicts of interests.

The current project, the BAM route, consists of a tunnel under the Scheldt and a two – decks bridge (the "Lange Wapper"). This 150m high bridge will be built right in the centre of Antwerp, which is unacceptable for people living in the surroundings. During the last 2 years, the social basis for this project decreased rapidly. The absolute point of depth was the referendum in October 2009 where 60% voted against this proposal.

The BAM route is not the only way to close the Ring Road. Several action committees and study bureaus came up with their own alternative to complete this project which lead to extra delays in the decision making process. The involvement of these external parties also indicates that there are different stakeholders with different points of interest.

The Oosterweel connection is a perfect example of how difficult it is for the government to implement mega projects. As the discussion above shows, this decision problem needs an approach that takes the different points of view the different stakeholders explicitly into account. Also different criteria have to be taken into account. A new methodology that makes this possible is the Multi actor, multi-criteria approach, or short MAMCA methodology. It is an extension of the traditional multi criteria decision analysis (MCDA) above which a layer is put to take the different stakeholders into account. It has been developed by Macharis (2000 and 2004).. The MAMCA is able to support the decision maker in his final decision as the inclusion of the different points of view leads to a general prioritization of proposed policy measures and gives insights in the possible barriers to implement certain decisions. In the next section the methodology will be explained. In section 3 it will be applied to the case of the Oosterweel connection and in section 4 our conclusions can be found.

Throughout the whole study and this paper, our focus is on two main research questions:

- Can the Multi – Actor, Multi – Criteria Analysis or MAMCA provide added value to the analysis of the Oosterweel connection?
- Which alternative will be the most suiting outcome, according to the MAMCA, taken into account the different stakeholders and their criteria?

2. THE MULTI ACTOR MULTI CRITERIA ANALYSIS

The Multi Actor Multi Criteria Analysis (MAMCA) allows to evaluate different alternatives (policy measures, scenario's, technologies,…) on the objectives of the different stakeholders that are involved. Unlike a conventional multi-criteria analysis where alternatives are evaluated on several criteria, the MAMCA methodology explicitly includes the points of view of the different stakeholders. It has been developed by Macharis (2000 and 2004) and has been applied for several transport related decision problems (see Macharis et al., 2009 for an overview). The methodology consists of 7 steps (see Figure 1). The first step is the definition of the problem and the identification of the alternatives. These alternatives can take different forms according to the problem situation. They can be different technological solutions, different policy measures, long term strategic options, etc. Next, the relevant stakeholders are identified (step 2). Stakeholders are people who have an interest, financial or otherwise, in the consequences of any decisions taken. Thirdly, the key objectives of the stakeholders are identified and given a relative importance or priority (weights) (step 3). Fourthly, for each

criterion, one or more indicators are constructed (e.g. direct quantitative indicators such as money spent, number of lives saved, reductions in CO2 emissions achieved, etc. or scores on an ordinal indicator such as high/medium/low for criteria with values that are difficult to express in quantitative terms etc.) (step 4). The measurement method for each indicator is also made explicit (for instance willingness to pay, quantitative scores based on macroscopic computer simulation etc.). This permits measuring each alternative performance in terms of its contribution to the objectives of specific stakeholder groups. Steps 1 to 4 can be considered as mainly analytical, and they precede the "overall analysis", which takes into account the objectives of all stakeholder groups simultaneously and is more "synthetic" in nature. The fifth step is the construction of the evaluation matrix. The alternatives are further described and translated into scenarios which also describe the contexts in which the policy options will be implemented. The different scenarios are then scored on the objectives of each stakeholder group. For each stakeholder a MCDA is being performed. The different points of view are brought together in a multi actor view. This multi actor, multi-criteria analysis yields a ranking of the various alternatives and reveals their strengths and weaknesses (step 6). The stability of the ranking can be assessed through a sensitivity analysis. The last stage of the methodology (step 7) includes the actual implementation. Based on the insights of the analysis an implementation can be developed, taking the wishes of the different actors into account.

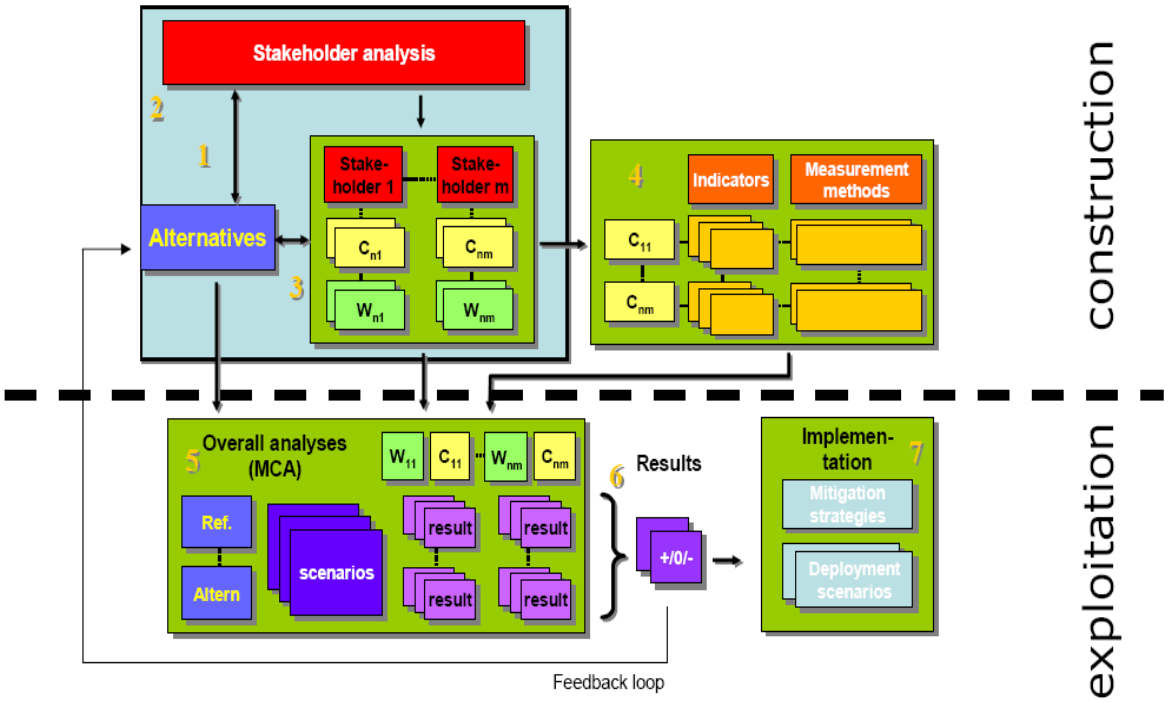

Figure 1 : the MAMCA methodology (Macharis, 2008)

The MAMCA methodology has already proven its usefulness for several transport related decision problems. It was used to cope with an intermodal terminal location decision problem (Macharis, 2000), for a study on the choice between waste transport alternatives in the Brussels region (Macharis & Boel, 2004), for the location choices of a new high speed train terminal (Meeus, Macharis, & Dooms, 2004), for the evaluation of DHL's hub strategy at Brussels airport (Dooms et al., 2006; Dooms & Macharis, 2005), in the project 'Night Deli' for the evaluation of different night distribution scenarios (Verlinde et al., 2009) and in the Flanders in Action Process to structure the discussions on how to turn Flanders into a top region by 2020 in terms of logistics and mobility (Macharis, De Witte, & Turcksin, 2010). For

a complete overview of theory and applications of the MAMCA methodology, see (Macharis, De Witte& Ampe, 2009a)

3. THE APPLICATION OF THE MAMCA ON THE "OOSTERWEEL"CONNECTION

As said above, the MAMCA methodology consists of 7 steps. We will go through the different steps in order to show how they can be performed and how they were performed in this particular case. The Decision Support Software used for this analysis is Expert Choice. This software uses the Analytical Hierarchy Process method (Saaty, 1982) as MCDA - technique en provides the advantage that the outcomes can be visualized and allows an extra layer to include the stakeholders (Macharis, 2005).

Step 1: Define the alternatives

The first step of the methodology consists of identifying and classifying the possible alternatives submitted for evaluation. In this case, 5 alternatives will be evaluated. The first alternative is the BAM route. This alternative is the initial alternative suggested by the Flemish Government with the contested "Lange Wapper" bridge. The second project is the ArupSum – alternative or AS route. This was a voluntary proposal made by the investigation bureau ArupUK/SUMResearch during their independent analysis of the Oosterweel connection. The third and fourth alternative respectively is the optimization of the Liefkenshoek tunnel and the optimization of the road tax in the Kennedy tunnel. Finally, the going concern scenario is the continuation of the current situation. The different alternatives will be described more in detail below.

The BAM route

This alternative is a part of a much larger plan to solve the mobility problems in Antwerp: The Masterplan. It closes the R1 – Ring, making it a full worthy ring road around Antwerp (Figure 1). The total distance of this road will be about 10 kilometers. The connection is made between the R1 (Kennedy tunnel) – E17 – E34 (Left Bank) and the R1 (Merksem Viaduct) – E19 – A12 (Right Bank).

Figure 1: The BAM – trace: Source:http://upload.wikimedia.org/wikipedia/commons/thumb/d/dd/Ring_Antwerpen_-_Oosterweelverbinding.PNG/270px-Ring_Antwerpen_-_Oosterweelverbinding.PNG

The first part of the Oosterweel connection is a sunk tunnel (1,5 km) under the river Scheldt which will consist of 9 components (Figure 2), 2 x 3 lanes and two separate tunnels

for pedestrians and for safety reasons (Figure 3).[1] This tunnel does fully conform to the Tunnel guideline 2004/54/EG by the European Union.[2]

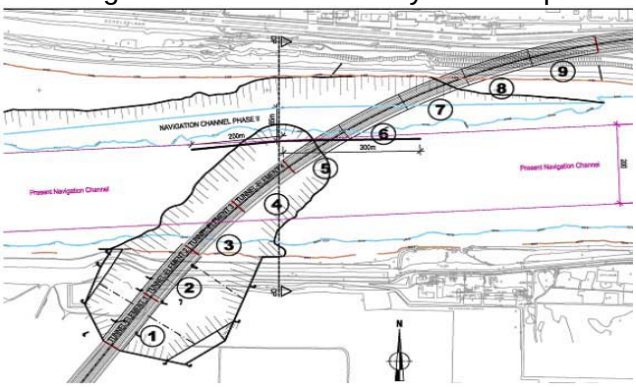

Figure 2: Sunk tunnel of the BAM – trace for crossing the Scheldt . Source: VAN DONINCK, N. 2007. Environmental effect report Oosterweel connection: Non – technical summary. By order of Beheersmaatschappij Antwerpen Mobiel (BAM)

Figure 3: 2x3 tunnel with separate safety tunnels. Source: http://www.natuurlijktrace.be/juiste_antwoorden.aspx

On the Right Bank, a traffic node (the Oosterweel node) will be built, giving the Port of Antwerp and the North part of the city a direct disclosure (Figure 4).

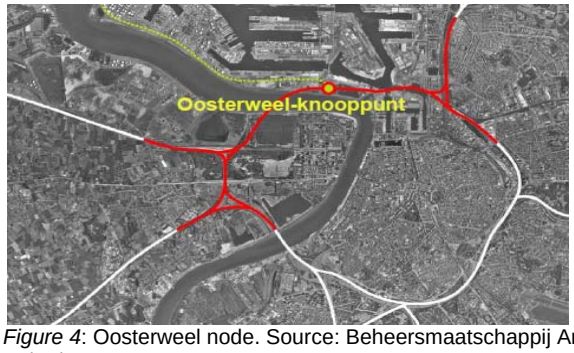

Figure 4: Oosterweel node. Source: Beheersmaatschappij Antwerpen Mobiel. 2007. Presentation: Masterplan Mobility Antwerp. 18/06/2007.

The next part of the connection is a double – deck viaduct (2,4 km) with 2 x 3 lanes (Figure 5). This viaduct closes the Ring at the Merksem viaduct. The BAM – trace will be charged for road tax, together with a truck ban in the Kennedy tunnel.[3]

[1] VAN DONINCK, N. 2007. Environmental effect report Oosterweel connection: Non – technical summary. In order of Beheersmaatschappij Antwerpen Mobiel (BAM)

[2] ARUPUK/SUMRESEARCH, 2009. Evaluation study new Scheldt crossing in Antwerp.

[3] XXX. 2009. Oosterweel: transport federations warn for delays." De Morgen. http://www.demorgen.be/dm/nl/989/Binnenland/article/detail/922532/2009/07/09/Oosterweel-transportfederaties-waarschuwen-voor-vertragingen.dhtml (Consulted 24/02/2010)

Figure 5: The "Lange Wapper"- viaduct. Source: http://vbv.be/Nieuwsbrief/september09/langewapper.jpg

The ArupSum route

This alternative was developed by the British bureau of study ArupUK/SumResearch and consists of a drilled tunnel (4,3 km), 2 x 3 lanes, going from Left Bank to the A12 in Ekeren, where a new traffic complex will be built to manage the new traffic flows. (Figure 6).

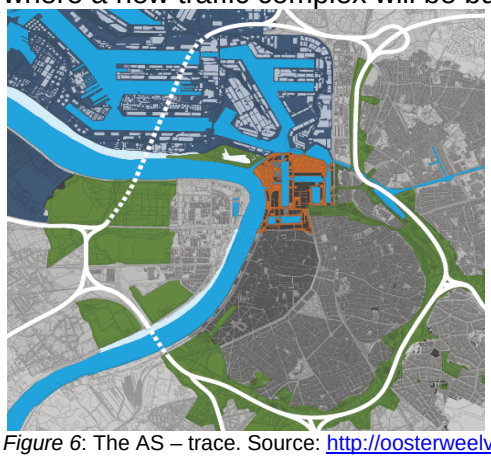

Figure 6: The AS – trace. Source: http://oosterweelverbinding.webs.com/Red090711_ARUP-SUM.gif

The optimization of the Liefkenshoek tunnel

This proposal was launched by Ivan Sabbe, member of the Flemish Parliament for Lijst Dedecker. Sabbe suggests that the existing Liefkenshoek tunnel should be optimized so that it can act as a full worthy alternative for the current R1 (Figure 7). Sabbe emphasizes that this optimization can happen with relatively small changes to the current infrastructure and that his proposal has a short to medium term perspective. [4] [5]

[4] XXX. 2009. "Don't Forget the Liefkenshoek tunnel." De Standaard. http://www.standaard.be/artikel/detail.aspx?artikelid=OL2G3HTR (Consulted 25/02/2010)

[5] XXX. 2009. "Ivan Sabbe (LDD) proposes 'Eg of Columbus' in Oosterweel connection dossier." Knack. http://knack.rnews.be/nieuws/belgie/ivan-sabbe--ldd--stelt--ei-van-columbus--voor-in-dossier-oosterweelverbinding/site72-section24-article38708.html (Consulted 25/02/2010)

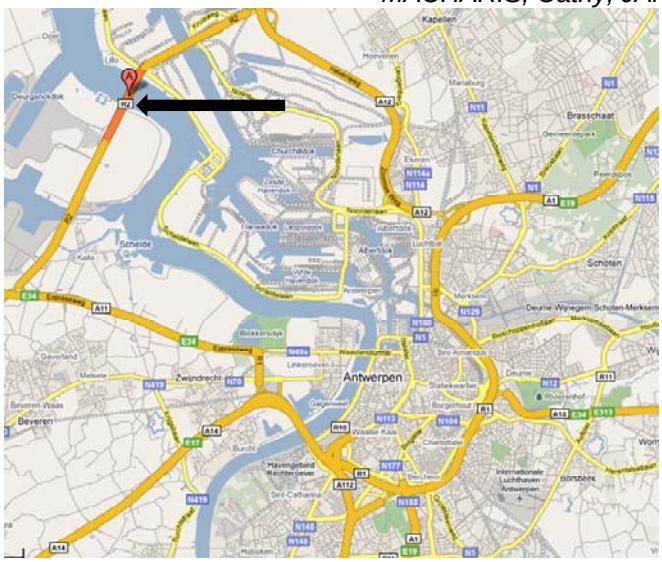

Figure 7: The Liefkenshoek tunnel: Source: Google Maps.

The optimization of road taxes in the Kennedy tunnel

This alternative was introduced by Bruno De Borger (University of Antwerp) and Stef Proost (Catholic University of Leuven) by the end of 2009. De Borger and Proost (2009) suggest that the current infrastructure (The Kennedy tunnel: see the marked area in Figure 8) should be put into better use by variable road taxes in order to partly solve the traffic problems in the short term.

Figure 8: The Kennedy tunnel. Source: Google Earth

The going concern

The Going Concern is being used as a benchmark for the other alternatives.

Step 2: Define the stakeholders

The second step in the MAMCA method is to identify the relevant stakeholders in the decision making process. For the Oosterweel connection, 4 stakeholders have been identified.

The construction firms

The bid rigging for a project like the Oosterweel connection has to run through a certain number of stages. Currently, the syndicate THV Noriant has been appointed as preferred

bidder.[6] The syndicate will act as the private partner in the Public Private Partnership (PPP) for this project and therefore will have to guarantee 20% of the financing. On top of that, the private partner is faced with the building and exploitation risks. In this analysis, not only Noriant, but the construction firms in general are considered.

The Flemish Government

The second actor is the Flemish Government, who is the decision maker in the project. The Masterplan Mobility Antwerp was designed to solve the traffic problems in and around Antwerp. The plan involves other companies and public authorities like the Belgian Railways, Public transport company De Lijn and other regional authorities.

The Flemish Government set up a public company, the BAM, to realize its goals concerning the Masterplan so that the projects of the Masterplan could also be financed with private investments. In the PPP, BAM would act as the public partner.[7]

The city of Antwerp

The third stakeholder in the analysis is de city of Antwerp, which clearly stated its involvement and importance in the referendum of 18/10/2009. This referendum had only one single question: "Should the city of Antwerp give a positive opinion concerning the building permit of the Oosterweel connection on the anticipated trace between Left Bank and Merksem/Deurne? Yes or no?" Almost 60% voted against the BAM route.[8]

The port community of Antwerp

The Port of Antwerp is important for the economic development of Flanders and Belgium. Being the 2nd largest port in Europe, it is one of the gates into the continent. Currently, 31% of the total transshipment (157,8 million tons in 2009) is being transported via trucks.[9] This puts a lot of pressure on the road infrastructure of Antwerp. Then again, only one fifth of the total truck transport on the Ring Road is port related. It also acts as a node in the international truck transport (Januarius, 2009). The port community not only covers the Port Authority, but also all the companies that are located in and close to the Port and the different trade associations The stake of the port community is clear in this transport project: The need for adequate transport infrastructure is crucial for the Port in order to stay competitive and to develop economically.

Step 3: Determine the criteria and their weights

The third step of the analysis determines the criteria per stakeholder and their importance. A predetermined list of criteria was set up by the authors of this paper to be validated by the stakeholders. The interaction with these stakeholders gave a definitive list of criteria with

[6] THV Noriant is a temporary company formed by CFE, Besix, Cordeel, Dredging, Van Wellen, Victor Buyck, Fabricom GTI and Vinci

[7] BAM, 2009. Masterplan Antwerp: History and current situation.

[8] XXX. 2009. "Antwerp clearly says no to the 'Lange Wapper'." Het Laatste Nieuws. http://www.hln.be/hln/nl/5256/Lange-Wapper/article/detail/1017259/2009/10/18/Antwerpen-zegt-duidelijk-nee-tegen-Lange-Wapper.dhtml (Consulted 03/03/2010)

[9] PORT OF ANTWERP, 2009. Statistics: History: Overall maritime cargo traffic. http://www.havenvanantwerpen.be/portal/page/portal/POA_NL/Focus%20op%20de%20haven/Kerncijfers (Consulted 25/03/2010)

their weights. The people that were interviewed are given in Table 1. Note that 134.861 habitants (34.75% of the total population) of the city of Antwerp voted in this referendum, which made it valid.

Table 1. List of the interviewed people per stakeholder group

Stakeholder	Function	Date
Construction Firms	Project manager THV Noriant Project manager THV Noriant Director Engineering Besix	14/12/2009 17/12/2009 20/12/2009
Flemish Government	Chief – of – staff Minister President	22/12/2009
City of Antwerp	Referendum concerning the BAM – tracé President vzw Ademloos StRatenGeneraal	18/10/2009 8/03/2010 29/03/2010
Port Community	General Manager Westerlund Distribution Director Policy and Communication Alfaport	15/12/2009 17/12/2009

The validation of the criteria consisted of two parts. First, it was to test the predetermined list of criteria. Secondly, the stakeholders had to give weights by assigning 100 points over the different criteria. The result is a complete list of criteria per stakeholder, showed in a "*hierarchical tree*" (see Figure 9).

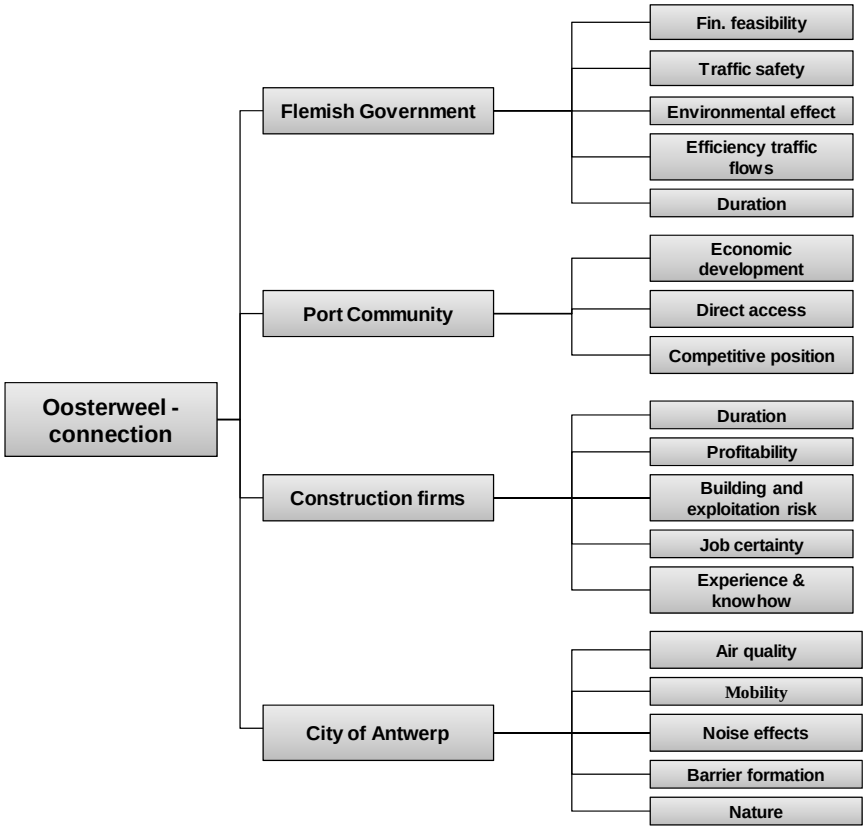

Figure 9. Decision tree of the Oosterweel connection. Source: own setup.

Criteria and weights of the Construction firms

The people that were interviewed in this stakeholder group put forward 5 criteria and gave it a weight (see Table 2). :

Table 2. Weights construction firms	
Criteria	**Weights (in %)**
Profitability	50
Experience & Knowhow	23,33
Building and exploitation risk	16,66
Job certainty	6,66
Duration	3,33
Total	**100**

Criteria and weights of the Flemish Government

For this stakeholder, 5 criteria were determined for the analysis.

These criteria were assigned with their corresponding weights. The results are shown in Table 3.

Table 3. Weights of the Flemish Government	
Criteria	**Weights (in %)**
Financial feasibility	35
Environmental impact	10
Efficiency traffic flows	35
Traffic safety	10
Duration	10
Total	**100**

Criteria and weights of the city of Antwerp

The criteria and their weights are given in Table 4.

Table 4. Weights of the city of Antwerp	
Criteria	**Weights (in %)**
Air quality	20
Mobility	15
Noise effects	20
Barrier formation and visual hindrance	27,5
Nature	20,5
Total	**100**

Criteria and weights of the port community

The port community put forward 3 criteria they find to be relevant for the Oosterweel project.

The weights for the port community are given in Table 5.

Table 5. Weights of the port community	
Criteria	**Weights (in %)**
Economic development	32,50
Direct access	27,50
Competitive position	40
Total	**100**

Step 4: Allocation of indicators and measurement methods

At this stage, the previously identified stakeholder criteria are 'operationalized' by constructing indicators (also called metrics or variables) that can be used to measure whether, or to what extent, an alternative contributes to each individual criterion. Indicators provide a 'scale' against which a project's contribution to the criteria can be judged. Indicators are usually, but not always, quantitative in nature. More than one indicator may be required to measure a project's contribution to a criterion and indicators themselves may measure contributions to multiple criteria. The result for this analysis is shown in Table 6.

Table 6. Indicator(s) per criterion	
Criterion	**Indicator(s)**
Construction firms	
Profitability	Money, percentage
Experience & Knowhow	Ordinal scale
Building and exploitation risk	Money, share (in %)
Job certainty	Ordinal scale
Duration	Time
Flemish Government	
Financial feasibility	Money, IRR
Environmental impact	Particulates (PM2,5), NO_x, decibel
Efficiency traffic flows	Passenger car equivalent, time gains, vehicle kilometers, traffic intensity
Traffic safety	Accidents with personal injuries per year, money, traffic intensity
Duration	Time
City of Antwerp	
Air quality	Particulates (PM2,5), NO_x
Mobility	Passenger car equivalent, time gains, vehicle kilometers, traffic intensity
Noise effects	Decibel
Barrier formation and visual hindrance	Height, integration in the city image
Nature	Hectare
Port community	
Economic development	Capacity, traffic intensity
Direct access	Number of vehicles per time unit, passenger car equivalent, traffic intensity
Competitive position	Time gains, vehicle kilometers, money

Source: own setup

Step 5: Analysis and ranking

The alternatives were evaluated through pair wise comparisons via the decision support software Expert Choice. The comparisons were made on the basis of several studies available. These studies are mainly the Environmental Effect Reports[10] and the independent evaluation study made by ArupSum.[11] [12] The results will first be discussed per stakeholder, followed by a multi actor view. The weight of each stakeholder is supposed to be equal in the first analysis in order to get an idea of the point of view of each stakeholder and to take them equally into account.

Analysis for the Construction firms

Figure 10 provides the result in Expert Choice for this stakeholder. On the horizontal axis, the different criteria/objectives of this actor are displayed. The rectangular bars at the bottom and the corresponding values on the left axis indicate the weights these criteria were given. The values on the right axis represent the scores of the different alternatives under consideration. On the 'OVERALL' axis, a general prioritization of the proposed alternatives is given for all criteria.

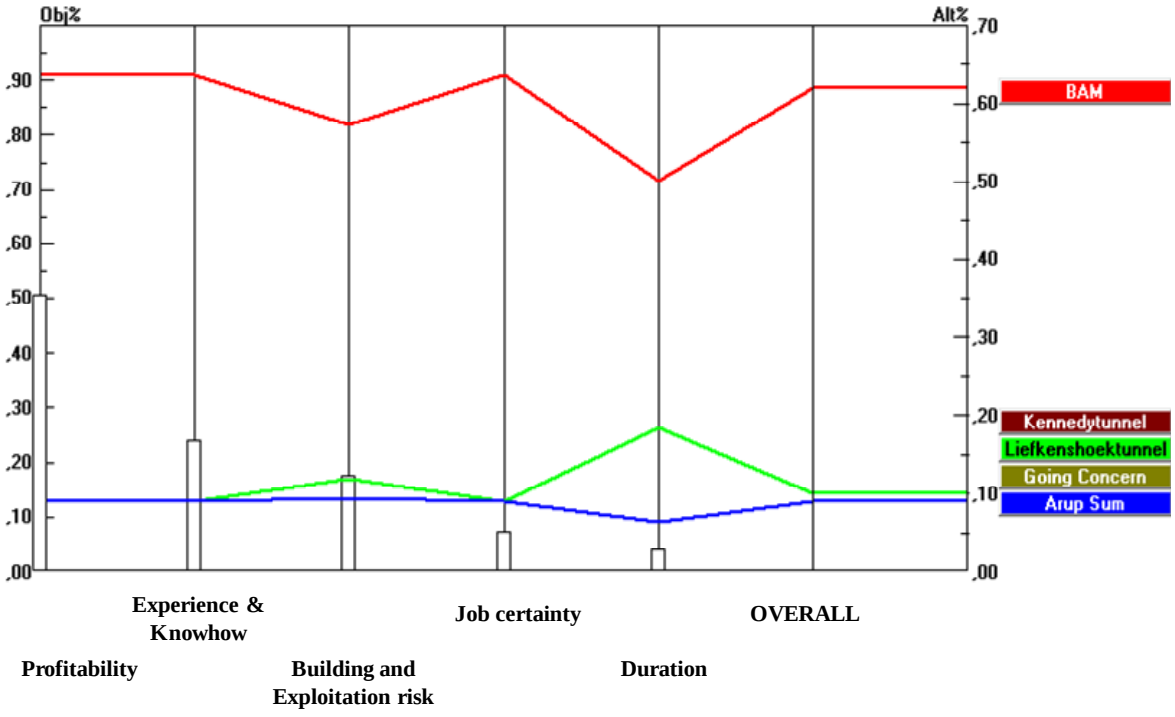

Figure 10. Sensitivity Graph for the Construction firms. Source: own setup in Expert Choice.

[10] BAM, 2005. Plan Environmental Effect Report: Main report. In order of the Flemish Government.

[11] ARUPUK/SUMRESEARCH, 2009. Evaluation study new Scheldt crossing in Antwerp.

[12] ARUPUK/SUMRESEARCH, 2009a. Second study new Scheldt crossing in Antwerp.

The BAM route clearly seems to be the best alternative for this stakeholder, which is not surprising since this has been the most investigated and most developed alternative.

The other 4 alternatives are clearly less preferred. The two short term solutions, the Kennedy tunnel and the Liefkenshoek tunnel have a slightly better score because they represent relatively small adaptations of the current infrastructure and they do not jeopardize the realization of the BAM route.

An important remark concerning this stakeholder is its relative position in the decision making process. Noriant is appointed preferred bidder, which means that the contact between BAM and Noriant is a pre – agreement (Design Sign – Off). In other words, their legal position is relatively weak. This implies that the strength of this stakeholder should be considered to be less than the others in this analysis. This will be discussed in step 6.

Analysis for the Flemish Government

The sensitivity graph in Figure 11 shows the results for this stakeholder.

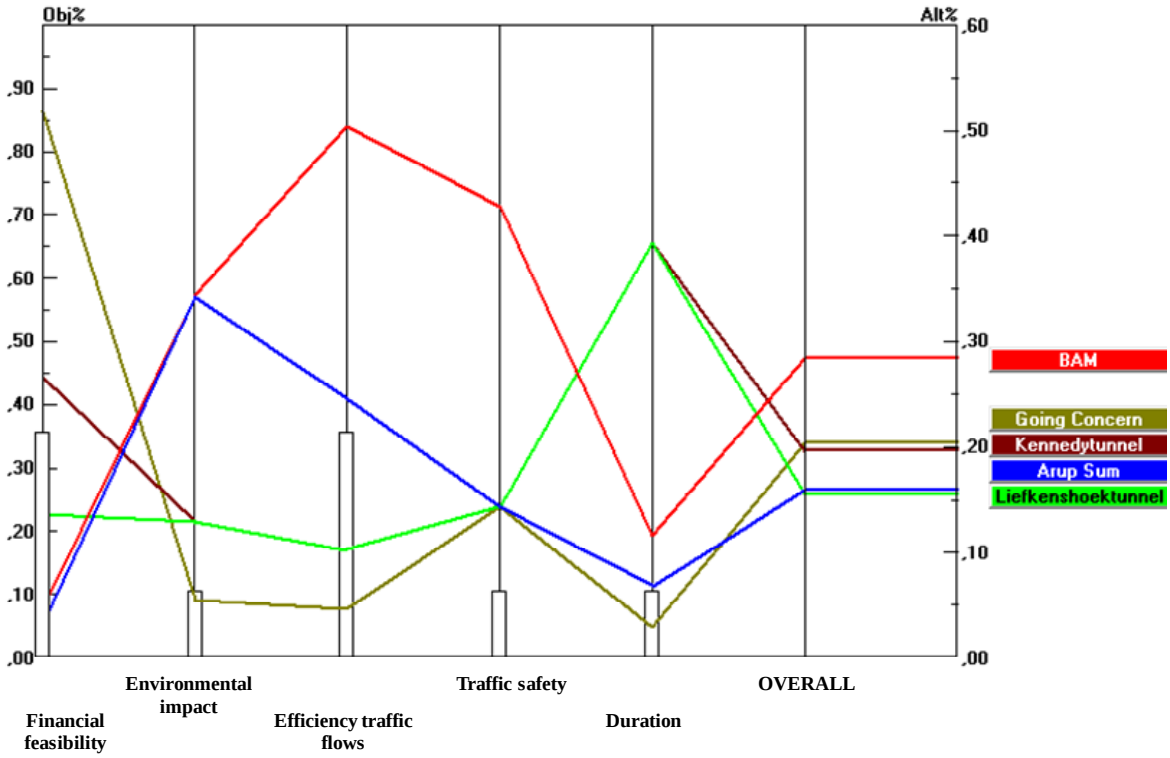

Figure 11. Sensitivity Graph for the Flemish Government. Source: own setup in Expert Choice.

The BAM route prevails, due to a better score on traffic safety and the efficiency of the traffic flows. Especially the latter plays an important role in the analysis, given its high weight.

The Going Concern gets a high score as well, due to its performance on financial feasibility. The scenario performs much less on the other criteria, which indicates that this alternative is not an option for the Flemish Government.

The AS route shows similar results as the BAM route for the first 2 criteria, but performs less on the remaining criteria. The Kennedy tunnel even performs better overall than the AS route, but this result is due to a better performance on duration and financial feasibility. This reasoning is similar for the Liefkenshoek tunnel, that results right under the AS route.

The overall conclusion of the analysis for this stakeholder is that the BAM route provides the best solution for the traffic problems in Antwerp because it provides better traffic flows on the R1 and it is the safest solution to close the Ring Road. The environmental impact of the alternative is also limited to a minimum (together with the AS route) compared to the other alternatives. It also is part of the much larger Masterplan which indicates that this project is just a (large) piece of the puzzle to solve Antwerp's mobility problems.

Analysis for the City of Antwerp

Figure 12 gives the results of the analysis for the City of Antwerp.

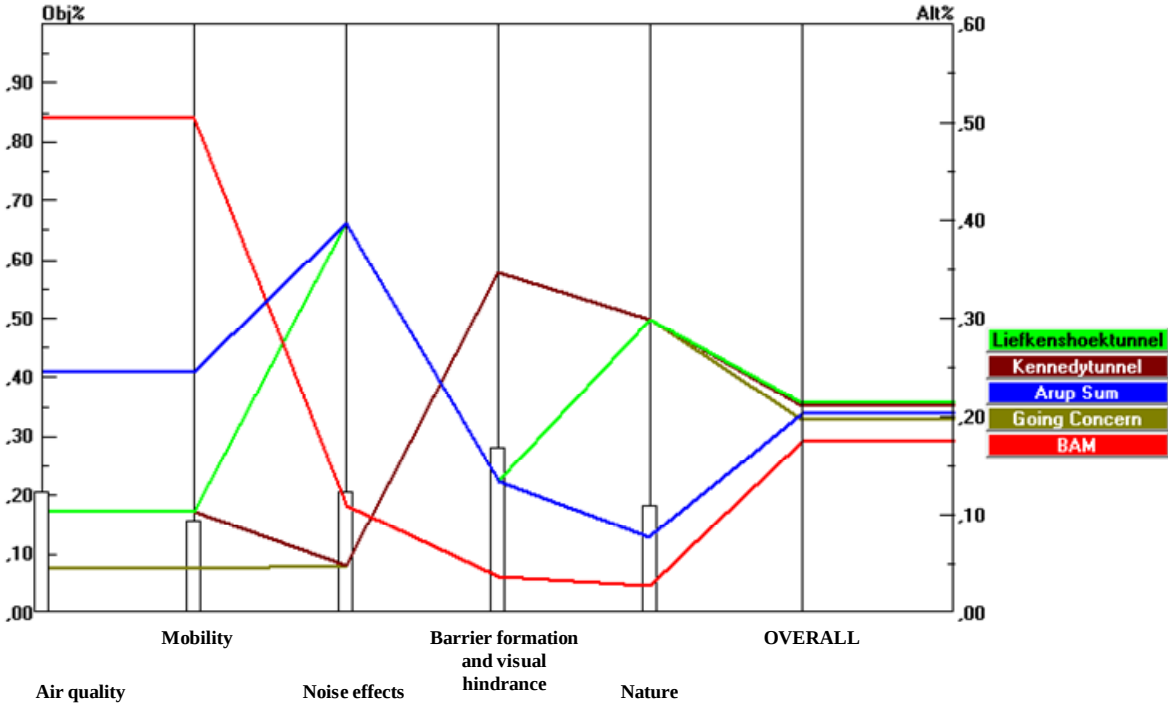

Figure 12 Sensitivity Graph for the City of Antwerp. Source: own setup in Expert Choice.

The overall classification is a close tie which indicates why this project was such a rough decision to make for the Antwerp community. In the results per criterion, there are nonetheless major differences between the different scenarios.

The BAM route results as the least preferred alternative due to its performance on barrier formation and nature. On the other hand, this alternative is the best solution for the Antwerp mobility situation. This result shows that the residents of Antwerp have a lot of interest in the ecological and town – planning effects. These effects were made clear to the community by intensive communication campaign by action committees and the residents of risk areas like Deurne and Merksem for which the BAM route would have very bad effects. The BAM neglected this aspect of their task which resulted in a decreasing social support.[13]

[13] ADEMLOOS, 2009. Lange Wapper (3): Why no support for the project? http://www.gva.be/nieuws/binnenland/video/extern-lange-wapper-3-waarom-geen-draagvlak-voor-project.aspx (Consulted 30/03/2010)

The 2 short term proposals, the Kennedy and Liefkenshoek tunnel, appear to be the best alternatives for the city. The Liefkenshoek tunnel performs well on noise effects and nature, while the Kennedy tunnel has no effect on barrier formation and visual hindrance. This criterion was determined to be the most important, but it is clear that a good performance on mobility and ecological effects (noise and air quality) and a weak performance on barrier formation go hand in hand. This comparison will be discussed in step 6. The reason why these 2 short term alternatives perform well is due to their time perspective. A short term impact is not of the same magnitude than a long term impact. These proposals appear to be a part of the overall solution, but nothing more.

The AS route achieves good results on noise effects and a medium result on the rest of the criteria. It shows that this alternative is far from complete in its development process. Many aspects need to be further documented and investigated.

The Going Concern performs better than the BAM route, but this alternative performs the worst on mobility, air quality and noise. This alternative is not an option for Antwerp if the city and the Port want to continue to grow.

A very important remark in this analysis is the result of the referendum (October 2009). 1/3 of the Antwerp population voted against the BAM route, making this result difficult to ignore in the decision making process.

Analysis for the port community

The results of the analysis for this stakeholder are illustrated in Figure 13.

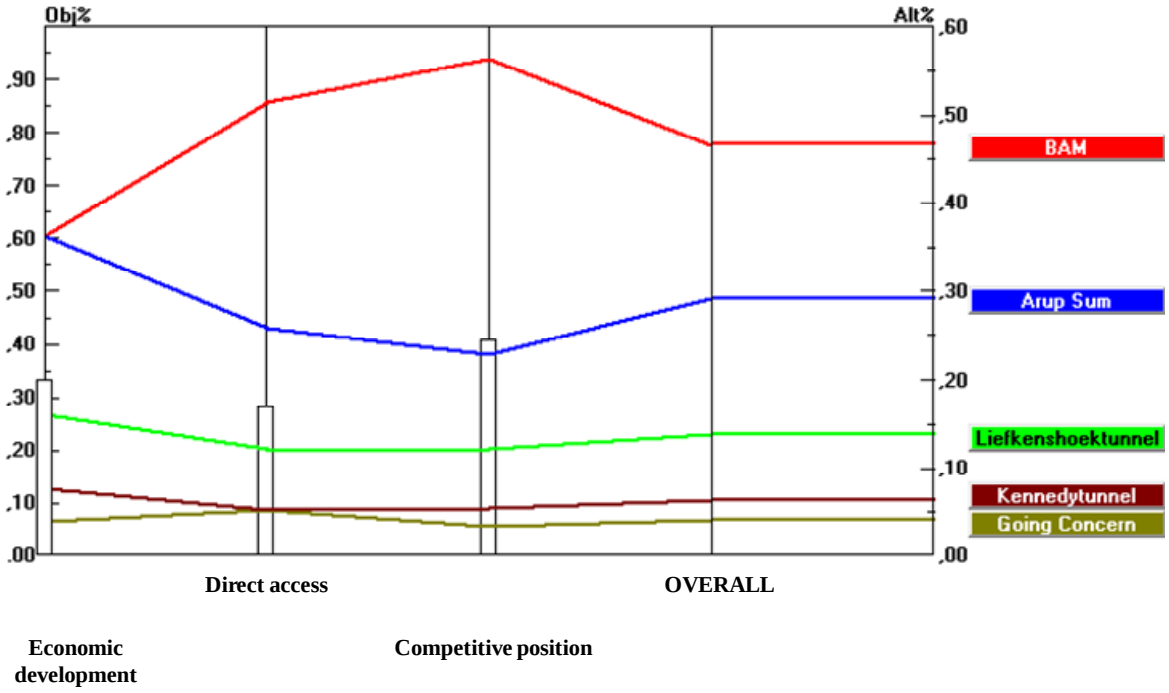

Figure 13. Sensitivity Graph for the port community. Source: own setup in Expert Choice.

The BAM alternative clearly is the most preferred one, with the AS route and Liefkenshoek tunnel as 2nd and 3rd. This result is fully conform to reality. The Port community always stated

that its position towards the Oosterweel connection was pro BAM route, because this alternative is the most advanced and it can be implemented right away.[14] However, due to the outcome of the referendum, it was clear that this proposal had limited chances for survival. A group of eminent industrials and experts got together and formed the Forum 2020 in the end of 2009. This group developed a new alternative, the so called Mecanno alternative.[15] This shows that the port community is pro – actively joining the debate concerning this decision problem.

The results of the Kennedy and Liefkenshoek tunnel are also within expectations. A better connection between the E17 and the Liefkenshoek tunnel provides a better access to the Waasland Port. This again states that the Liefkenshoek tunnel is a part of the solution. The Kennedy tunnel, however, has no plans for a better access of the Port, giving this proposal a weaker score in the overall result.

Multi – actor view of the Oosterweelconnection

The overall result of the MAMCA is presented in Figure 14. The analysis indicates that the BAM route is the best alternative for the Oosterweel project, followed by the AS route. The short term alternatives (Liefkenshoek and Kennedy tunnel) are respectively 3rd and 4th and the Going Concern ends up being the worst case scenario.

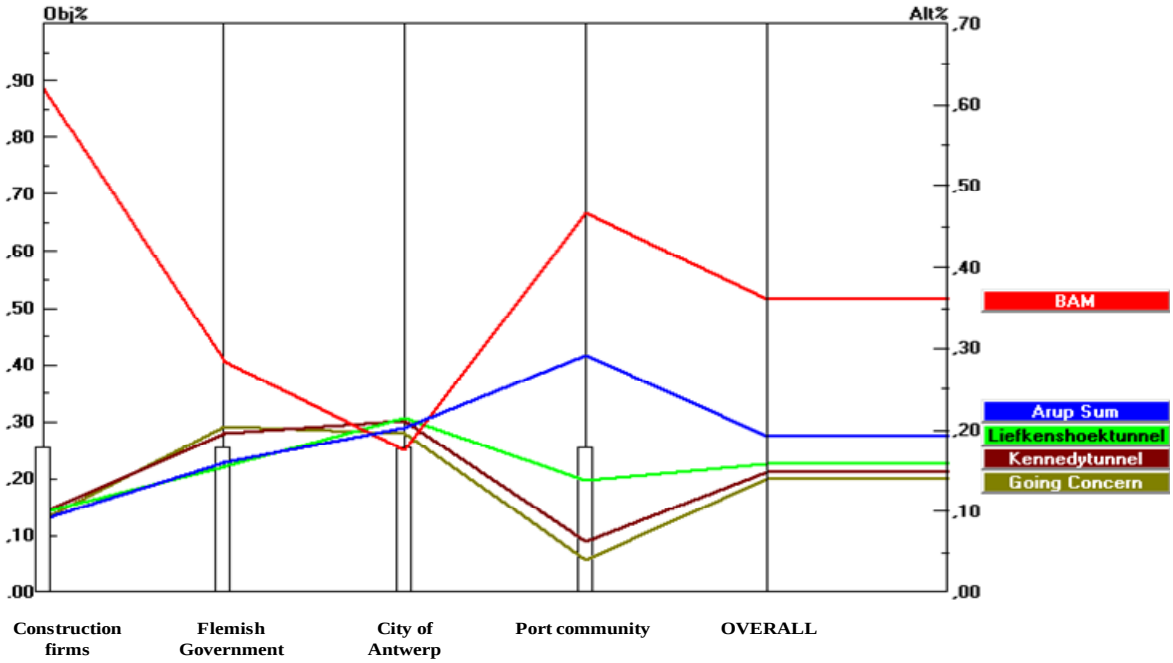

Figure 14. Multi – actor view of the Oosterweelconnection. Source: own setup in Expert Choice.

[14] XXX, 2009. "Antwerps Port federation behind BAM." De Tijd. http://www.tijd.be/nieuws/binnenland/Antwerpse_havenfederatie_achter_BAM.8243232-438.art (Consulted 26/03/2010)

[15] XXX, 2010. "Forum 2020 has 4th Oosterweel scenario." De Redactie. http://www.deredactie.be/cm/vrtnieuws/regio/antwerpen/1.723525 (Consulted 19/04/2010)

The BAM route is the best alternative for all the stakeholders, except for the City of Antwerp. The reason for this has been explained in the analysis of this stakeholder. This result lies within expectations. The 2 most studied and developed alternatives are also the ones that provide the best answer to the traffic problems in Antwerp. The sole question now is how deep the ecological and town – planning impact weighs on deciding which alternative should be chosen.

Step 6: Analysis of the results

The MAMCA allows performing a sensitivity analysis. Certainly when there is a doubt in the stability of the results and some doubts on the weights that were given this kind of analysis will allow to see how robust the results are.

As discussed above, there are two areas where some uncertainty exists about the weights that were given.. First, the position of the Construction firms might be overrated in the analysis. As explained above, Noriant and other building firms are tied by the agreements made before and as such have little negotiation power. Second, the City of Antwerp stated that barrier formation and visual hindrance was the most important criterion for them. The BAM route did not perform well on this criterion. However, it performed well on mobility. The question that rises is what would happen if the importance of these two criteria changed. These 2 remarks will be the subject of step 6 in which a sensitivity analysis will be performed.

Sensitivity analysis of the Construction firms

One of the main assumptions of the analysis was an equal importance for all the stakeholders. However, the analysis showed that the position of the Construction firms might be inferior to the other stakeholders. In this sensitivity analysis, the importance of the Construction firms will decrease to 10% instead of 25%, giving the other stakeholders an importance of 30% instead of 25%. Figure 15 shows the result of these changed weights for the different actors (at the left side) in the end scores of the alternatives (right side).

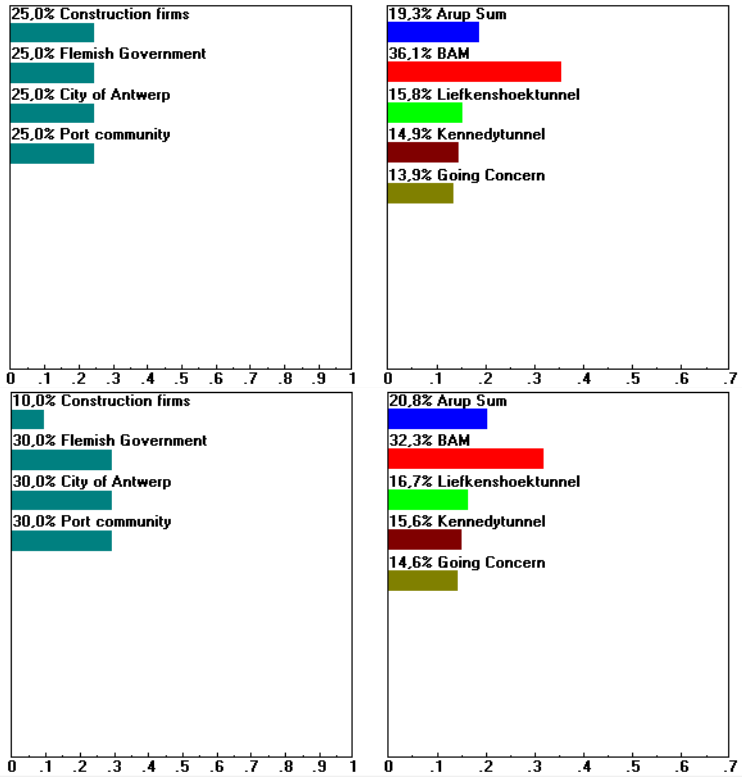

Figure 15. Sensitivity analysis of the Construction firms. Source: own setup in Expert Choice

The result shows a change in scores of the different alternatives, but the overall classification remains the same, with the BAM route as the best alternative.

Sensitivity analysis of the City of Antwerp

A main issue in the discussion on the BAM alternative is that it foresees a huge bridge very close to the city centre which has an impact of the viability of the neighborhoods and which separates the city centre and the North part of Antwerp by an unnatural barrier. On the other hand, the alternative achieves the best score on mobility. The analysis showed that these 2 aspect are difficult to unite in the decision making process.

The sensitivity analysis will investigate a change in weights for these two criteria. Mobility will have a score of 27,5% instead of 15% and barrier formation gets a weight of 15% instead of 27,5%; the result is illustrated in Figure 16.

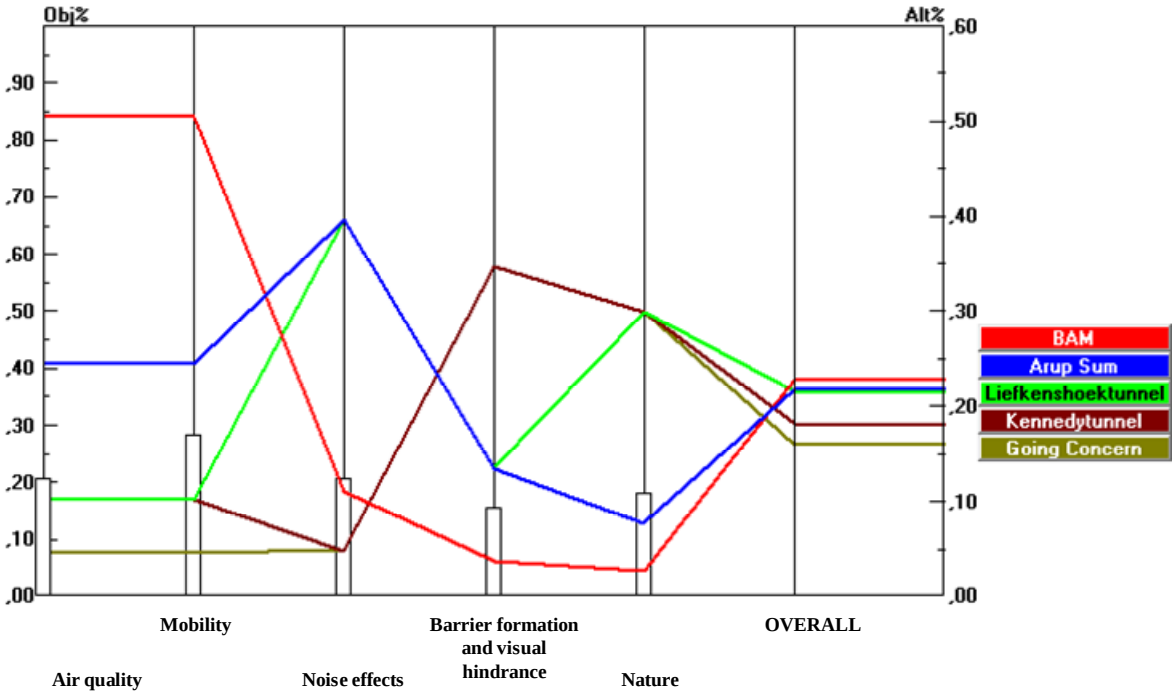

Figure 16. Sensitivity Analysis of the City of Antwerp: The effect of a change in the weights of Mobility and Barrier formation. Source: own setup in Expert Choice.

Due to an increased importance of the criterion mobility, the BAM route ends up at the top of the rank. The conclusion of this analysis is that these 2 criteria are very difficult to fulfill in this project. Given the boundary conditions and the urban characteristics of Antwerp, it is very difficult to find a trajectory that is optimal for everyone.

Step 7: Implementation

The goal of the last step in the MAMCA is to find implementation paths that help implement decisions, taking the possible disadvantages for some stakeholders into account.

As this MAMCA study was not formally in the decision process we can only guess how it could have influenced the process. However, in the mean time the Flemish Government had to take a decision concerning the Oosterweel connection at the end of March 2010.

The final decision was the following: The BAM trajectory is kept, but instead of a bridge, the new crossing of the Scheldt will be followed by 4 drilled tunnels that will connect to the Ring Road in Merksem.[16] This solution has 3 important demands, however. It has to be conform to the Tunnel guideline 2004/54/EG by the European Union, it cannot be more expensive than the Lange Wapper bridge and the time to build the project cannot take longer than the initial BAM alternative.[17]

With this decision, the Flemish government was able to solve an important issue without losing face. The trajectory that was developed by BAM and Noriant is kept, because it is the best solution for the mobility problems in Antwerp. And the city is provided with a solution that can be united with the current development plans. The positive characteristics of the BAM route remain and the negative ones are neutralized. This was shown in the MAMCA, where the BAM route was the best solution, but could not be accepted due to a certain number of aspects by certain stakeholders.

4. CONCLUSIONS

The Multi – Actor, Multi – Criteria Analysis (MAMCA) of the Oosterweel connection lead to a number of insights that will be discussed briefly in this section.

The MAMCA helped as an evaluation tool to investigate the interests of each stakeholder in an objective way. This lead to a classification of the 5 proposed alternatives: the BAM route, the AS route, the optimization of the Kennedy tunnel, the optimization of the Liefkenshoek tunnel and the Going concern.

The overall result suggested the BAM route as the best alternative for this decision problem. The analysis per stakeholder indicated this scenario as the best, aside from the City of Antwerp.

The Construction firms are most in favor of the BAM route due to a high score on the criteria of this stakeholder.

The BAM alternative is also the best alternative for the Flemish Government. The scenario performed well on an increased efficiency of the traffic flows, which was the most important criterion for this stakeholder.

The results for the City of Antwerp were somewhat different. The Liefkenshoek and Kennedy tunnel came out as the best scenarios due to their low impact on the current city image and the city's development plans which was the most important aspect for the city citizens. However, these alternatives performed less on a better mobility. The sensitivity analysis showed that a change in the weights of the criteria mobility and barrier formation resulted in a higher score for the BAM route.

The Port community wants to see the economic development of the Port supported by an adequate road infrastructure because road transport remains a large part of the modal split for the Port. The BAM route appears to be the best solution for this stakeholder.

[16] JUSTAERT, M., 2010. "Een Masterplan of 5 billion." De Morgen.

[17] JUSTAERT, M., VERELST, J. 2010."Tunnel under conditions, bridge only emergency scenario." De Morgen.

This decision problem was mainly confronted with the following issue: despite the fact that there are several alternatives for the same problem, the MAMCA showed the critical criteria, namely a better mobility and a low impact on the city image. A compromise was found by putting the bridge in the ground which solved the major critics on the BAM route.

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