Changes in the DSS of the Polis-project

Research for IWT-project 060872

"*Ontwikkeling van model voor de evaluatie van de toegankelijkheid, brandveiligheid en evacuatie voor personen met beperkingen in de horeca*"

ERIK NUYTS, LENNERT LAMBRIGHS

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University College Limburg

INHOUD

1. Summary

In a European project, the Decision Support System (DSS) of the Polis-model was made to calculate the accessibility of a building. This model was used in a Flemish project as the basis of an extended model. Some improvements were made to the original DSS.

(1) Some properties of the Polis-DSS that were included in the manual on the internet did not work as described, or they were absent. In these cases the underlying programs were improved or expanded.

(2) The input of the model was difficult. Some facilities of the DSS were extended.

(3) Interpretation of the result was not easy. The output of the model was changed to facilitate the interpretation.

(4) Some output results seemed unrealistic. The calculation of the results was changed. These changes were done after discussion with one of the researchers who was involved in the model-building of the original DSS

Due to a lack of time, only those changes were done that were essential to make the DSS useable for a non-specialist end-user.

2. Introduction

In a European project, the Decision Support System (DSS) of the Polis-model was made to calculate the accessibility of a building. This model was used in a Flemish project as the basis of an extended model. This extended model does not only calculate the accessibility of a building, but evaluates also the fire safety and the evacuation possibilities of the building.

In a first step of this project, the Polis-model was downloaded from the internet and tested on some real existing buildings. Access to the internet was become by contacting polis@sociale.it. It turned out that the model had several drawbacks. There were four kinds of problems.

(5) Properties of the Polis-DSS that were included in the manual on the internet did not work as described, or they were completely absent. In these cases we improved or expanded the underlying programs.

(6) The input of the DSS was in agreement with the manual, but the input of the model was difficult. In some cases we extended the facilities of the model.

(7) The calculation of the DSS was in agreement with the manual, but the interpretation of the result was not easy. In some cases we improved the output of the model to facilitate the interpretation.

(8) The calculation of the DSS was in agreement with the manual, the results were interpretable, but the results seemed unrealistic. In some cases, we changed the calculation of the results.

As in the situation of the developers of the original DSS of the Polis-model, this project was constrained in time. Hence, we improved the DSS where we thought it was most necessary. There are still many things that could be improved, but we think that the changes we've made were the most essential to make the model useable for a normal use by a non-specialist.

3. Correcting wrong programs and adding non-existent properties

3.1 Technical errors

Background + present situation:

- When downloading the original DSS from the internet, there were some problems to get the DSS working. All the underlying problems / errors were solved, and a Dutch manual was written how the DSS can be installed. At first the software was installed on both a Windows and a Linux server. Severe technical issues on the Windows machine pointed out that the software can only be used on a Linux server (Lambrighs, 2007). At a given level, “appliance” was a property of “appliance”, resulting in an eternal loop. The second ‘appliance’ has been removed.
- Saving sometimes resulted in a crash of the program. The problem was solved.
- Some properties should be slightly reformulated (e.g. fully glazed ‘door shutters’, should have been ‘door leafs’)
- An error message was shown when a project was initiated. The message was correct (it said that nothing could be done) since there were no data in the project yet. This was confusing for the end-users, hence this error message has been removed.
- Some services were intended to be used for some types of building, but one level deeper in the DSS they do not have any properties. We did not try to make a consistent set of properties for these services, but decided to delete the link between these types of buildings and the services without properties. In this way, we made the services invisible for the end-users. This has been done for:
    - Restaurant in a stadium
    - Bar service area in a airport terminal, bar/pub, parks and gardens, port, railway station, stadium, theatre

Changes made:

Errors mentioned have been solved or avoided.

Present situation:

Active.

3.2 At least two calculations: one based on common sense and one on a specific legislation

Background:

According to the DSS-manual (Perez et al, 2005) it is possible to calculate the accessibility of a building according to several different legal systems. In reality, this property of the DSS was not elaborated.

Changes made:

Unknowing of the fact that it was initially included in the DSS, also the support-commission of the Belgian project asked for different calculations for the same building. Since the same property is asked for independently a second time, this property seems to be really important for end-users.

Therefore, the DSS is extended with a second calculation. The first calculation is the calculation of the present tool, mainly based on common sense and international agreement. In the second calculation, every property that does not meet the standards according to the Belgian legislation is set to zero. The Belgian legislation also puts standards for some variables that are not in the present DSS. We did not add variables; hence these Belgian aspects are not included in the second calculation neither.

Present situation:

The second calculation is made possible.

A Dutch manual is written to explain the assumptions and consequences of several new formulas.

3.3 From route to building: a missing calculation

Background:

The accessibility for a building is defined as (Perez et al. 2005:30):

$$RA_{l_b} = \prod_{c \in C} b_c \sum_{k \in K} g_k A_{k,lb}$$

Figure 5.10: Accessibility of the building

RA_{lb} = accessibility level of the accessibility solution for the disability (l_b).
K = set of all services in the building.
C = set of all critical services in the building (C is a subset of K).
b_c = binary value for the critical service (c) (b=0 or b=1)
g_k = service relevance of the service (k).
$A_{k,lb}$ = accessibility of the service path that ends in service (k) for disability (l_b).

The formula was in the programs, but the result did not appear on the screen.

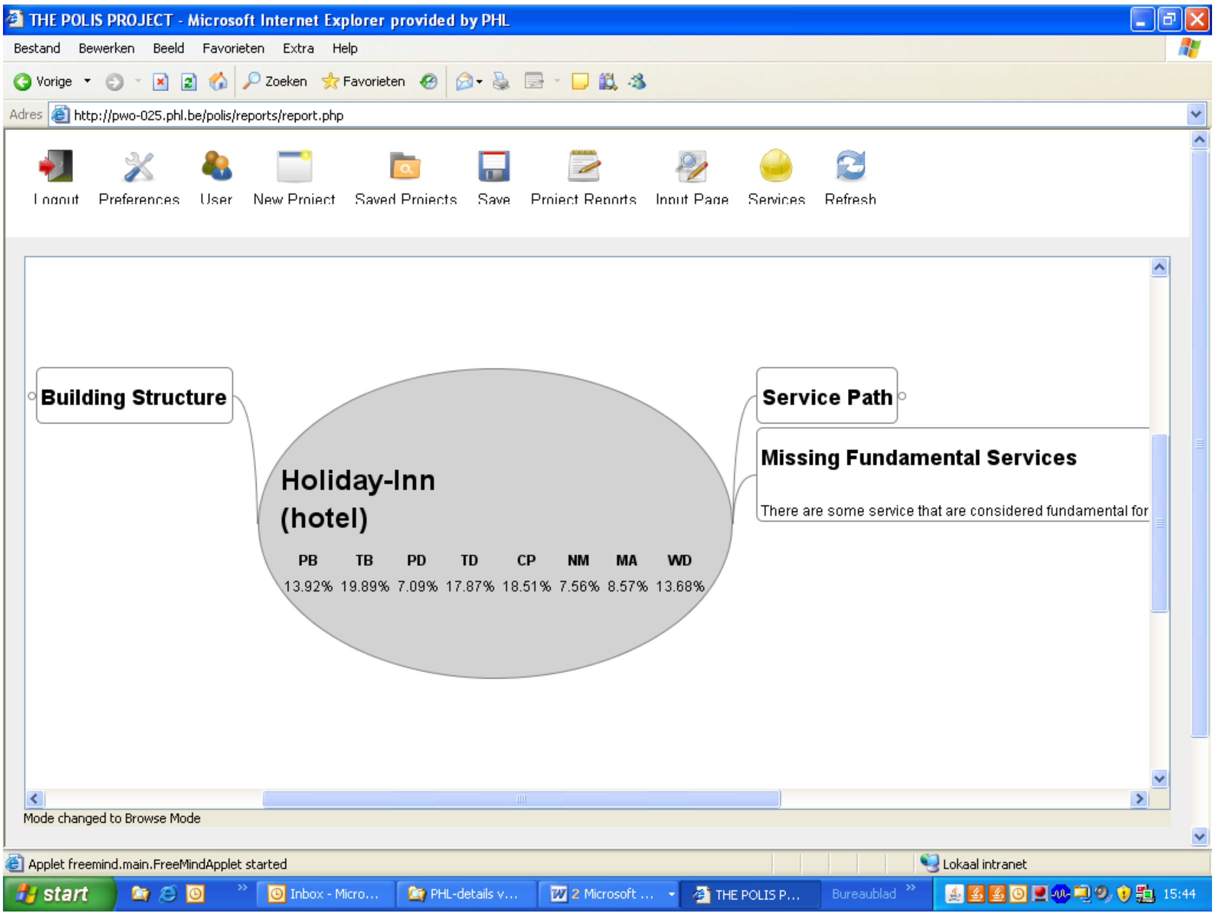
Changes made:

Initially we intended to include this formula as it was presented. But the tables of the binary values b_c of the critical values are not found in the DSS. Hence, all b_c are put equal to 1. But this makes the calculation of the products of the b_c useless, since it equals always 1.

Therefore, the implemented formula equals:

$$RA_{lb} = \sum_{k \in K} g_k A_{k,lb} \, .$$

Figure 1. Accessibility is calculated on the level of the building



Present situation:

The formula is including also weights for the services for which no routes were put in.

One can argue if this is the best choice. At the one hand, it seems evident that, if a service is given in in the Polis DSS, there should be a route to this service. If not, it seems as if this service is unreachable. Hence, its weight is used in the calculation mentioned above, but the ASR equals 0%.

On the other hand, one could argue that the DSS should only take care of routes that have been filled in. If the user wanted to evaluate the route between two services, one can suppose that he will put it in the DSS.

Moreover, in the present DSS only the end-service of the route between two services is taken into account in the calculation. The origin service is not in the calculation (for details see 6.4). If the reception is always entered in the DSS as the origin service, and never as the arrival-service of a route, this decreases with the present calculation the overall accessibility of the building.

3.4 Accessibility of doors for persons with hearing problems

Background:

No property of an internal or external door differs between good hearing and bad hearing people. Therefore, For PD and TD there were no percentages to add, and hence every door had an accessibility of 0%.

Changes made:

For every door width (door width > 0.00m) an accessibility of 100% on 100% is given for PD and TD for the property door width. Hence, the result adds up to 100%, which implies no difference between people with and without hearing problems.

Present situation:

100% accessibility is added for PD and TD for the Polis legislation.

4. Improving the input of the model

4.1 Edit service paths

Background:

The facility 'edit service paths' was shown, but it mentioned that it still had bugs. We checked it, and there were bugs in it indeed. At the other hand, since it does not seem very important, we decided not to solve the problems

Changes made:

"Edit service paths" has been made invisible for end-users.

Present situation:

Invisible.

4.2 Adding and deleting services

Background:

In the original DSS there was only one chance to include all the services of a building. After the initial saving, it was not possible to add services. In real situations, this caused some troubles since end-users often forgot some services.

At the other hand, the original DSS also did not allow to delete a service. Yet, under time-constraints it can be handy to ignore some rooms, especially when they are very comparable to other services that are already put into the model. This could be the case with a hotel with 50 bedrooms. If the properties of these 50 bedrooms are not all filled in, this could result in a low accessibility since empty variables can result in 0% accessibility.

Changes made:

A button is added to add services to an existing project.

Every service has also a button to delete the service.

Present situation:

Active.

5. Improving the output of the model (interpretation of the results)

5.1 Accessibility percentage compared with the maximal accessibility percentage

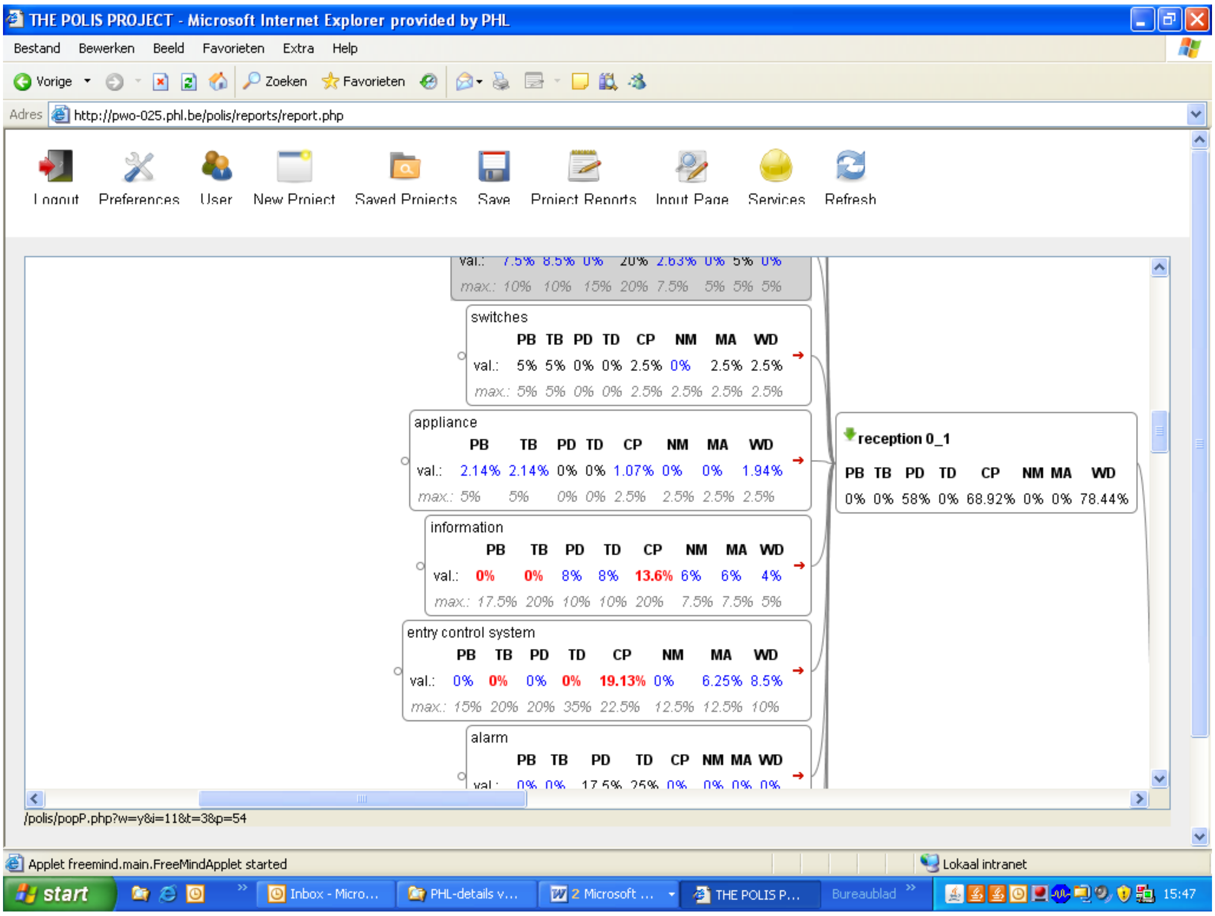
Background:

In the original DSS red numbers appeared when the accessibility equalled 0% and the maximal percentage for that property was greater than 0%. This was true for every property, critical or not. All other results were shown in black. The maximal percentage that a property could add to a higher level was not shown. Hence, a property with a shown result of 5% could be very bad, if it could add 50% to the accessibility of a higher level, or it could be very good if it could add only 5% to a higher level.

Changes made:

Under the percentage calculated is also shown in grey the maximal percentage that the given property can add to the higher level. In this way, in Figure 2 it is clear for the end-user that the 0% of switches for PD is no problem, since the maximum it can add to the next level is 0%. I.e., it is not included in the calculations for PD. Comparably, it can be seen that for the switches the 2.5% for MA is equally good as the 5% for PB. In both cases, it is the maximal value that switches can add to the next level.

Figure 2. Accessibility percentages (val:) can be compared with the maximal percentage that the given property can add to the higher level (max:)



Problems are made visible in colours. Accessibility values lower than the maximal value are shown in blue. The switches are only not perfect for NM: 0% with a maximum of 2.5%.

Critical properties are shown in bold. Values of critical properties lower than the maximum are shown in red and in bold. A critical value that does not fit for a group, and results in 0% for that property, should always result in 0% on the higher level. See e.g. the effect of the entry control system fro TB and TD. The bold red zeros result in 0% on the higher level, i.e the reception.

Present situation:

Active.

6. Changes in the calculations of the model

6.1 The calculation of an Actual Service Route (Ar,lb) differs between papers

Background:

The calculation of the formula $A_{r,\,lb}$ is described in Deliverable D1.1 (Pérez et al,. 2005:26) as

$$A_{r,lb} = Min\left(q_{k,lb}, \underset{w\in W_r}{Max}\left[Q_{w,lb}\left(\frac{d_w}{\underset{w'\in W_r}{\min}(d_{w'})} \right)^{-c_{lb}} \right] \right) \qquad \text{eq. (1)}$$

The same formula, using the minimum of {$q_{k,lb}$ and the maximum of the corrected $Q_{w,\,lb}$ } is used in Mediavilla et al. 2006:16.

At the other hand, Pérez and Mediavilla (2005: 7) report a product of both factors:

$$A_{r,lb} = q_{k,lb} * \underset{w\in W_r}{Max}\left[Q_{w,lb}\left(\frac{d_w}{\underset{w'\in W_r}{\min}(d_{w'})} \right)^{-c_{lb}} \right] \qquad \text{eq. (2)}$$

This is also the formula that we find in the programs of the DSS. Yet, equation (2) is systematically smaller than equation (1).

Equation (1) is the result of the final fine tuning of POLIS, based on the case studies. However, equation (2) was the initial definition, which was used as specification of the DSS tool (Juan Pérez, personal communication).

Changes made:

Equation (1) is implemented in the DSS-tool.

Present situation:

Formulas are changed.

6.2 The c-factor in equations 1 and 2

Background:

Whatever the calculation of $A_{r,\,lb}$ (equation 1 or equation 2) the effect of the factor C_{lb} is sometimes very pronounced. Actually, in some cases the punishment of a longer distance, due to the factor C_{lb} is completely exaggerated.

In the following table, C_{lb} varies between 1 and 6 (as we found them in the DSS), depending on the disability. In the other columns, we show some percentages of decrease in accessibility as a consequence of using a longer path.

Correction factor		**Longer Distance compared to distance of people without disabilities**				
Disability	**C_{lb}**	**1,2**	**1,3**	**1,4**	**1,5**	**2**
partial deafness	**1**	83%	77%	71%	67%	50%
total deafness	**1**	83%	77%	71%	67%	50%

cognitive problems	**2**	69%	59%	51%	44%	25%
partial blindness	**3**	58%	46%	36%	30%	13%
total blindness	**4**	48%	35%	26%	20%	6%
no mobility in legs and arms	**5**	40%	27%	19%	13%	3%
mobility only in arms	**5**	40%	27%	19%	13%	3%
walking difficulties	**6**	33%	21%	13%	9%	2%

E.g., if a blind person has to take a route of 18m in stead of 15m, i.e. 1/5th longer, the accessibility decreases to 48%. These 3m extra have an extreme effect on the accessibility.

Even more extreme is the use of a ramp from the car-parking to the reception. Assume that the parking space for people with a disability is near the income of the hotel (20m). Assume also that there is a ramp of 10 m, in order to avoid the use of some steep steps to the entrance. Hence, the better route is 30m in stead of 20m. The detour equals 1/3. Assume finally that all other details of the route are completely made on Universal Design principles. Yet, this concept being completely Universal Design will have an accessibility percentage of only 21% for people with walking problems.

Also Pérez and Mediavilla (2005: 31-32) state that the c-factor can have very restrictive effects on accessibility in real situations.

In the case studies, other c-factors seem to be used. Sakkas and Pérez (2006) do not use a factor equal to 5 or 6 for their calculations of the university on Crete. They use a factor equal to 1. Unless for a climbing path when used by people with only mobility in arms. But even then they use only a factor C_{lb} equal to 2, not to 5 or 6.

In some cases the problem seems to be avoided, by assuming that the distances by stairs or by the platform are the same (Pérez & Mediavilla 2005: 21; Mediavilla et al. 2006: 16-17). The main argument is "*The distances are referred from the surrounding to the reception. The surrounding is not a fixed point, but a wide area (a park with its pavements). So depending on where the user comes from the distance ratio will be different." (*Pérez & Mediavilla 2005: 21). This is true, but it does not fit the idea behind severe punishments for some longer distances. On whichever point of the surrounding one starts, the route by the ramp will be the longest one.

Also for paths comparing elevators and stairs Pérez and Mediavilla (2005: 25) seem to use a c-factor equal to 1 for partial and complete blindness, which does not coincide with the tables in the DSS

It turned out that there was an initial definition of "c" factors that was fixed by experts on accessibility and was used as DSS specification. However, fine tuning of the methodology with the cases studies showed us that this factors was too severe and it was more accurate the use of lower values. (Juan Pérez, pers. comm.). Numbers that were suggested, but not yet implemented after this fine-tuning are given in Table 1 in the 3rd column. These numbers are extrapolated for implementation in the Polis model to the numbers in the last column.

Table 1. Correction factors for long distances, used in several drafts of the DSS

Correction factor			
Disability	Original value	Value suggested after first reality checks	Value implemented in present draft of the Polis model
partial deafness	**1**		1
total deafness	**1**		1
cognitive problems	**2**		1,2
partial blindness	**3**		1,3
total blindness	**4**		1,4
no mobility in legs and arms	**5**	1,5	1,5
mobility only in arms	**5**	1,5	1,5
walking difficulties	**6**	1,6	1,6

Changes made:

The C-factors in the model are changed into:

Correction factor	
Disability	Clb
partial deafness	1
total deafness	1
cognitive problems	1,2
partial blindness	1,3
total blindness	1,4
no mobility in legs and arms	1,5
mobility only in arms	1,5
walking difficulties	1,6

Present situation:

Formulas are changed.

6.3 When do empty fields result in 0%, and when are empty fields ignored ?

The calculation when an empty field results in 0%, or when an empty field is ignored, was not always uniform. The system worked as follows:

- Almost always, empty fields are ignored, and the percentages are calculated on the properties that are filled in. The sum of the weights of the properties that are filled in, sums up to 100%

- But properties that have properties, which on their turn have deeper properties -hence three levels deep, e.g.: a button of a telephone of an office)- result in 0% accessibility. Hence, leaving a field unanswered on this level, results in a lower accessibility.

An example: percentages office for no mobility in arms and legs:

The weights of properties one level deeper than 'office' add up to 100% (if they are fitted for NM, of course).

If only round edges is filled in, the weights are: Rounded edges 100%

If round edges and furniture are filled in, the weights are: Rounded edges 47%, Furniture 53%

If round edges, furniture and Internal lighting are filled in, the weights are:

Rounded edges 38%, Furniture 43%, Internal lighting 19%

Three levels deep we found for properties of alternative communication system of office

If only Type of communication system is filled in, the weights are:

Type of communication system 50%

If both Type of communication system and button are filled in, the weights are:

Type of communication system: 50%, Button 50%

In this example it is seen that not filling in 'button' results in a maximal accessibility of 50%.

Changes made:

This was not in conformity with the initial idea of the modelling of Polis. The intention was that empty fields are ignored, and that the percentages are calculated only on the properties that are filled in. The sum of the weights of the properties that are filled in, should always sum up to 100% (A. Mediavilla, pers. comm.). There are two exceptions:

- If an empty field is a critical value, it is considered as 0%. Almost by definition, critical values should not be ignored. If nothing is filled it, it can not otherwise be interpreted as absent.
- If all relevant fields for a group are empty, there are no data to calculate an accessibility percentage with. Hence, the percentage is set equal to zero. In this way, the empty fields are not really 'ignored'. It looks more as if they are all set equal to zero.

The formulas are changed in this way.

Present situation:

Formulas are changed.

6.4 From service to route: a missing service ?

Following information comes from "Deliverable D1.1 Universal Building Design, Technical Specification" van Perez et al. (2005).

First the accessibility of a service is calculated (qk,lb) and the accessibility of all paths to this service (Qw,lb). With these values the accessibility of the actual service route is calculated (Perez et al. 2005:23-26):

$$A_{r,lb} = Min\left(q_{k,lb}, \underset{w \in W_r}{Max}\left[Q_{w,lb}\left(\frac{d_w}{\underset{w' \in W_r}{\min}(d_{w'})} \right)^{-c_{l_b}} \right] \right)$$

Figure 5.5: Accessibility of an actual service route.

$A_{r,lb}$ = accessibility of an actual service route

$q_{k,lb}$ = quality factor of the service (k) for disability (l_b), the service which is being accessed.

W_r = set of all actual alternative ways (w) implementing the actual service route (r).

$Q_{w,lb}$ = quality factor of the actual alternative way (w) for disability (l_b).

d_w = distance of the actual alternative way (w).

c_{lb} = penalty factor with the distance for the disability (l_b).

This formula only includes the accessibility of the service of arrival. But if the origin service is not accessible, the route is not accessible neither. If routes are put into the database from a centered services, e.g. the reception, then the accessibility of the reception will not be in the final calculation of the building. Therefore, one could argue that both the accessibility of origin and destination of a route should be in the calculation of the route:

$$A_{r,lb} = \min\left(q_{destination,k,lb}; \quad q_{origin,k,lb}; \quad \max\left[Q_{w,lb} * \left(\frac{d_w}{\min(d_w)} \right)^{-c} \right] \right)$$

At the other hand, exactly for situations where a reception is the origin of many routes, one can argue that this origin should not be in the calculation of the routes. This origin would have too much impact on the overall accessibility of the building.

The solution to this dilemma is making routes from a first service to a second service, then a route from the second service to a third service, and so on, the last route connecting the last service again with the first service. Unfortunately, this nice theoretical concept is hardly followed by anyone in case studies, since these routes do not coincide with the intuitive logic of most buildings.

Changes made:

Nothing yet. As the Belgian group was divided about what should be done, the DSS was kept as it was.

Present situation:

Formulas are not changed.

6.5 Non-reflecting glass screen present

Presence of a non reflecting glass screen was considered as bad for everyone. We think this is a mistake. Non-reflecting glass improves reading compared to more classical reflecting glass.

Changes made:

The percentages of accessibility of presence and absence of non-reflecting glass are switched in the tables.

Present situation:

Active.

7. Bibliography

7.1 Articles and reports

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