



Belgian cases studies for the DSS of Polis

Research for IWT-project 060872

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

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1. Summary

In the European Polis-project, a Decision Support System (DSS) was developed to calculate the accessibility of buildings. This DSS is downloadable from the internet. In a Belgian project, this DSS was adapted by correcting some wrong or missing parts and by improving input and output facilities of the DSS. Then it was tested in four test cases.

The usability of the adapted DSS is now OK, but a manual would decrease the subjectivity of the input.

Contrary to earlier test cases of the Polis-DSS, the DSS is very restrictive; no building got an overall percentage of more than 8% for any disability group. But there is strong evidence that the present DSS on the internet differs from the earlier tested versions of the DSS. Hence, the different test cases are not comparable. The present accessibility percentages are so low, that they are unrealistic, making the DSS unsuitable for discussion with managers of commercial or public buildings.

The main reason for these low percentages is an overuse of 'critical values'. Critical values are variables that, when they are not fulfilled, define a service or a route as inaccessible, no matter how good the other properties of that service /route may be. A second reason is that every service has to be the destination-service of a route. A service that is never the destination of a route is supposed to be inaccessible, even if it is the origin of a route. It is suggested that the system of the critical values and the impact of origin and destination of routes should be reconsidered. The DSS should be retested afterwards..

2. Introduction: the Decision Support System (DSS) of the Polis-project

In a European project, the Decision Support System (DSS) of the Polis-project was made to calculate the accessibility of a building. This DSS 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 also evaluates the fire safety and the evacuation possibilities of the building.

In a first step of this project, the Polis-DSS was downloaded from the internet and tested on some real existing buildings. The internet location and login was obtained by contacting polis@sociale.it.

The DSS calculates the accessibility of a building in a bottom-up way (Pérez et al. 2005). The building consists of several services (e.g. bedrooms, reception, parking space,...) and routes between these services. Every service and every route has some properties (e.g. bedroom: bed, furniture, presence of round edges, e.g. route: internal door, stairway, lift,...). Every property can have properties on itself (e.g. height of the bed, handle type of a door), which again can have some properties and so on. In the DSS there are tables that indicate how good a property is for a given type of person. There are 8 types defined: partially blind, totally blind, partially deaf, totally deaf, cognitive problems, walking difficulties, mobility in arms only, no mobility in arms and legs. If one has input given in all information in the DSS, the accessibility is calculated bottom-up independently for the 8 types of persons. For instance, if the height of the bed is too high for people in a wheelchair, the bed has a low accessibility for mobility in arms only. On the next level, the accessibility of this bed, but also the accessibility of the window, the other furniture, the obstacles in the room, etcetera are considered to calculate the accessibility of the bedroom. This is done for all the services. Next, the accessibility of routes between services is calculated. Again this is done bottom-up. For example, the handle type of a door influences the accessibility of a door, which in turn influences the accessibility of the route. Finally, from the combination of the accessibilities of services and routes, the accessibility of the building is calculated.

The accessibility of a higher level is calculated as a weighted mean of the accessibilities of the properties on the lower level. But this weighted mean will be reduced to 0%, if an important property is not accessible. As an example, if the WC is not accessible, a toilet will always have 0% accessibility, no matter how good the washbasin may be. Such an important property that reduces the accessibility on a higher level to zero is called a 'critical value'.

This DSS as it was available on the internet was tested on 4 buildings. It turned out that the DSS had several drawbacks. There were four kinds of problems.

- (1) 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.
- (2) The input of the DSS was in agreement with the manual, but the input of the DSS was difficult. In some cases we extended the facilities of the DSS.
- (3) 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 DSS to facilitate the interpretation.
- (4) The calculation of the DSS was in agreement with the manual, the results were interpretable, but the results seemed unrealistic. Since this is the heart of the DSS and the formulae were made in a large international project, we were reluctant to change the formulae. We only decreased the penalty factors for detours. Later, we heard that these factors were even more decreased for earlier test cases (see chapter 5.).

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

The detailed description of these changes can be found in another report (Nuyts & Lambrighs, 2009).

After all these changes, again four buildings were tested. The results of these tests are given in the present report.

3. Four Belgian cases studies

3.1 *The users of the DSS*

The DSS has been tested by second year architecture and interior architecture students. These students match more or less the target group of the users of the DSS: persons with some background of buildings and architecture, but not necessarily experts in accessibility.

They co-operated in groups of five or six students. This number turned out to be too large to work efficiently when investigating the buildings. Groups of three students would have been more efficient. Again, this seems to represent the real use of the Polis-DSS. Definitely, the tool can be used by a single person, but for input and interpretation of some results it is comfortable to be at least with two persons to talk things through.

At the start, the students were given a presentation of one and a half hour, in which the features of the DSS were shown on a case study of an earlier test case. Afterwards, they had the facility to ask questions when they met difficulties doing the field work.

3.2 *The buildings*

Each group investigated a hotel. Three test cases were customary hotels, the fourth was a restaurant/bistro with a minor part that was used as a hotel.

The input of the DSS is rather time consuming, and the students also suffer from deadlines. Hence, it was decided that for every building at least following rooms should be investigated:

- At least one bedroom. If there were bedrooms adapted for persons with disabilities, at least one of these bedrooms was also investigated.
- At least one toilet. If there were toilets adapted for persons with disabilities, these toilets were also investigated.
- The reception.
- A restaurant or dining room.
- The car park.

These services are assumed to be representative for a hotel. Every group inventoried at least 8 locations. Even if this is not completely representative for a building, it is at least sufficient to evaluate the calculated accessibility of a hotel.

The calculated accessibility percentages of the hotels were subjectively unbelievably low. This is meant literally. The percentages are that low (actually reaching from 0 to 8%), that we do not believe the calculated results. To avoid any unfair negative publicity, the hotel managers asked to publish the results anonymously. Evidently, although not mentioned by name, we still are grateful to the hotel managers and the hotel staff for their kind cooperation.

4. Results of the test cases of the DSS

4.1 *The usability of the DSS*

After an initiation session of one and a half hour in which both the input and the output of the DSS were explained, the students were able to collect the data in a correct way. The first hours, every group had the classical problems of using an unknown program, but at the end of one day, it all went well.

After collection of the data, all groups asked independently a second session to explain the interpretation of the result again. This second explanation was more individualised, since the data used were the data they had collected themselves. But again, after one hour every group was perfectly able to interpret the DSS-output.

The input of the DSS is time consuming. Not all groups worked equally efficiently, nor equally accurately, but the shortest time to collect sufficient data to evaluate a hotel was 1 working day of ± 6 hours. One group needed 3 days of ± 6 hours. This duration is caused, among others, by the need of internet since the DSS is an internet application. Some buildings have wireless internet connections. But when moving the laptop from one place to another, this connection can be interrupted, most often resulting in losing part of the data. Other buildings had a fixed internet connection. In such a case, a list with the variables needed for a given service was written on a paper block, the data were collected in this service and afterwards filled in in the DSS. This also was time consuming, since the list of variables per service is rather long.

Not all variables of the tool are easily interpreted. Especially about the 'application' we are uncertain what is meant with it. Other variables are not always relevant for a specific situation. For instance, the service 'parking place' has a variable 'vending machine', but hotels do not have vending machines on the parking place for their guests. Initially, it was decided that when the students were uncertain about a variable, the field was left open. For the students, it seemed both safe and easy to leave many fields blank. Unfortunately, when the field was a critical variable, this resulted in 0% accessibility for that property, and also in 0% accessibility on the higher level of the calculation, which gave an underestimation of the accessibility of the building. For some test cases, an extra effort was done afterwards to collect all the missing data.

4.2 *Not all the variables are as objective as expected*

The DSS is made to be very objective. In more classical investigations of building accessibility, an expert fills in a questionnaire. This often implies answers as: "this part of the building is: bad/not adequate/just sufficient/ good/very good". Hence, the result is always somehow subjective. The DSS gives a very objective impression, since most variables are really measurable: door width, distances, type of telephone, etc... However, the output of these results remains subjective. A door width between 75 and 90 cm gives an accessibility of 80%. But why an under limit of 75cm and not of 74cm? Why an accessibility of 80% and not 75%? In the Polis-method, these numbers are given by an expert group, based on a combination of personal experience, legislation and common sense. And although these numbers are somewhat subjective, one could argue that the output is still objective in the way that it will be the same output for everyone who uses the DSS.

Most of the variables are objective. But some of the variables are more subjective than they look like. Some examples:

- "Door width": What with a double door, of which one door leaf is almost always closed? Does one have to measure the width of one open door leaf, or of both?
- "Distance to the car park": To the middle of the car park? To the first parking place? To the parking place for people with disabilities?
- "Round edges in the room": What if there are some round edges but not everywhere? What if there are more round edges than sharp edges, but the sharp edges are more in the passage way of the room?
- "Door handle position": What if the door handle is a long vertical bar? This is a good handle, since it is at a reachable height for everyone, but the DSS accepts only one specific number.

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For all these examples, it is possible to write a manual that prescribes what to do. But as far as we know, such a manual does not exist at present.

For some other variables, things are more complex. Even with a manual it seems hard to become exact prescriptions. Again some examples:

- “Lighting in the room, expressed in lux”: In almost any room there are differences in lux measured depending on time of the day (morning, evening), weather (sunny, clouded), location (near the window, just behind the door, under the lighting). And although one can find prescriptions on the internet how lux in a room should be measured, we could easily find two measurements for the same room that differed more than 200 lux, while both measurements were in agreement with the prescriptions we found on the internet.
- “Obstacles in the way”. How heavy and how permanent must these obstacles be to be included in the DSS? A cupboard is clearly an obstacle that will not have changed the next day and that should be taken into account, and a bucket is probably very temporarily at a given place and hence ignorable. But what with a small table, a chair, the roller table of the cleaning staff if it is left in the corridor during the night, cardboard boxes in an office, ...

Luckily, these variables form a small minority.

4.3 The DSS is too restrictive

The calculated overall accessibility percentage is very low. For the four buildings, the accessibility percentages of all the groups of disabilities varied between 0% and 8%. Probably, some of these percentages would increase a bit if an extra effort was done to fill in some empty fields. But also for the test cases in which special care was taken never to leave fields empty, unless the property was not available (e.g. a vending machine) or incomprehensible (“application”) none of the accessibility percentages was higher than 8%.

It is ironic that these low percentages were also given to a hotel where people with disabilities, of which a large part in a wheelchair, regularly gather for a meeting. They come back year after year, among others because they are satisfied with the facilities of this hotel.

From a scientific point of view, the overall percentage as such is not so important. The strength of the Polis-DSS is not this final number. The strength of the DSS is that it allows zooming in into the problematic service to find out what is the specific property that causes an accessibility problem. By zooming in, we found that the major cause for the low percentages is a high use of “critical values” (see section 4.4).

From a strategic point of view, these low overall percentages are not good. Managers, and especially managers of commercial buildings, don’t find it good publicity if accessibility percentages of their building are low. If the numbers remain that low, the target group of the DSS will not use it, since the outcome does not feel reliable.

4.4 Too many critical values

The major reason for the low percentages is a high use of critical values. A ‘critical value’ is a property that is critical for the higher level. If this property is bad, it is given 0% accessibility and also the higher level gets 0% accessibility, no matter how good all the other properties may be.

An example of a toilet. If the pull down rail in the toilet is too low, it is useless for the person in a wheelchair. Hence, for persons in a wheelchair the height of a pull down rail is a critical value for the pull down rail. On the next level, it is assumed that a person in a wheelchair needs an aid to reach the toilet. Hence the pull down rail itself is a critical value of the WC. And the WC is obviously a critical value of the toilet. How good the washbasin may be, if the WC is not accessible, the toilet does not fulfil its most important purpose. This cascade of critical values has as a consequence that, if the height of the pull down rail is lower than 75 cm, the accessibility of the toilet is presented as 0%. No matter how much effort has been done to suit persons in a wheelchair (ample space, height of the

washbasin, space under the washbasin, alarm cord, flush spatula, spatula tabs,...). This sounds severe, but seems all in all acceptable.

In other situations, the method of the critical values seems to be overused. Some examples for a reception.

- Counter height is a critical value of the counter, which in its turn is a critical value of the reception. For people in wheelchairs (No Mobility + Mobility in Arms only), only a height range of 10cm is accessible: 0.80-0.90m. All other heights have 0%. Hence, if the counter height is 92 cm, the reception is presented as inaccessible for persons in wheelchairs.
- For people with hearing problems (Partially Deaf or Totally Deaf), entry phone type is a critical value of the entry phone, which in its turn is a critical value of the entry control system, which for total deaf people in its turn is a critical value of the reception. For people with hearing problems, the only acceptable entry phone is a video phone which allows the person outside the building to see the reception. Such an entry phone is hardly found in Belgium. As a result, almost all receptions will be presented as 0% accessible for persons with hearing problems.
- For persons with visual disabilities (Partial Blind and Totally Blind), type of information is a critical value for the information, which in its turn is a critical value for a reception. Only Braille information and acoustic information are acceptable for those persons. Hence, all receptions with standard type information have 0% accessibility.
- Presence of an induction loop is a critical value in a reception for partially deaf people.

The combination of all these critical values makes it difficult for a reception to be calculated as accessible.

Note that the DSS has 887 critical values. Therefore, it happens quite often that one element e.g. a clear space under a washbasin or a telephone, sets the higher level in the calculation equal to zero (in the case of insufficient clear space under the washbasin, the accessibility of the washbasin is set to zero, in the case of the telephone the service in which the telephone is placed is set to zero).

Some critical values come back rather often, and seem to be more restrictive than originally was planned. Some examples:

- the absence of Braille or acoustic information makes many services inaccessible for persons with visual and cognitive problems
- the presence of rectangular edges makes many services inaccessible for persons with visual or cognitive problems
- (not in the context of a hotel). Only few telephones are adapted for partially or totally deaf persons. But since telephone is a critical value of a living room or a sacristy for persons with hearing problems, almost every common living room appears as inaccessible for people with hearing problems. Yet, if one asks people about their impression of that room, also persons with hearing problems answer that there is no problem with the room.
- The absence of a shower makes a toilet inaccessible for people with no mobility in arms and legs. But only the toilets in the bedrooms have also showers. No other toilet ever has a shower.

There are 393 chains of two critical values following one another. Most of them are critical values for people with moving problems: persons with Walking Difficulties or with Mobility in Arms only, or No Mobility in legs and arms. For example, if there is not sufficient clear space in front of the furniture, the furniture is unsuited. And if the furniture is unsuited, a bedroom is inaccessible. Note that 'furniture' is not the bed, since the bed is a different property of a bedroom.

An often returning reason for inaccessibility of services in a hotel is an imperfect type of alarm. A non-visual alarm makes most services inaccessible for people with hearing problems. This makes many services inaccessible, but as a warning about possible safety problems, this strictness can be defended.

Finally, there are 12 cascades of critical values in which an element can influence the accessibility percentage two levels higher. Hence a bad property of a property of a service makes the whole service inaccessible. They can be grouped in following three classes:

- A wrong type of entry phone makes receptions and entrance halls inaccessible for persons with hearing problems
- A pull down rail that is too high or too low results in inaccessible toilets and inaccessible bathrooms for people with walking problems.
- If there is no alarm that can put into work by a voice, a toilet or a bathroom is inaccessible for persons in electric wheelchairs

We had a personal communication on these results with Asier Mediavilla from Labein Tecnalia, who was involved in the original Polis-project. He agreed that they had also the impression that the (over)use of the critical values made the DSS too restrictive.

4.5 Calculation of the overall accessibility of the building.

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

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

Figure 5.10: Accessibility of the building

RA_{l_b} = 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,l_b} = accessibility of the service path that ends in service (k) for disability (l_b).

In real hotels, there are many rooms and many routes, and no one enters all rooms and services into the DSS. Only those services and routes are entered in the DSS of which the user wants an accessibility-estimate. As a result, often not all the rooms are linked to each other by a route.

In some cases, users have put in services that are not linked by a route to any of the other services. But the formula RA_{l_b} includes also weights for these services. By definition, the accessibility of the routes to these services equals 0%, as there are no routes to these services. Hence, this decreases the overall percentage of the building. Not necessarily because the unlinked service is badly built, but because the route to it is missing.

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. If the reception is always entered in the DSS as the origin service, and never as the arrival-service of a route, it seems as if no route end in the reception. Technically, this results again in an A_{k,l_b} that is missing for the reception and thus being 0%. This decreases also the overall accessibility of the building. And also in this case one can argue about the formula. The disadvantage of this formula that only includes the destination service

and not the origin is clear from the example above: if routes are inputted from a central service, this service is not taken into account in the final calculation and the accessibility percentage of the building is an underestimation. 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. If this is the way the DSS should work, then this reasoning should be clearly stated in a accompanying manual.

5. Comparison with former case studies

The accessibility percentages we find in Belgium are very low, therefore we want to compare these results with former testing of the DSS. We looked for examples where the Polis-DSS had been used in real situations and found five other test cases:

1. A university: School of Applied Technology, Technology Institute of Crete, Greece (Sakkas & Pérez 2006)
2. An office building of the government: Edificio Ensanche in Spain (Pérez & Mediavilla 2005a)
3. A building of the City council and technical support: Edificio de la Naviera Aznar in Bilbao (Mediavilla et al. 2006)
4. A research centre: the National Research Council in Rome (Centanni & Moruzzi 2006).
5. A museum: the Museum of the Diaspora in Tel Aviv (Bendel & Sharan, 2006).

5.1 School of Applied Technology, Technology Institute of Crete, Greece

The test case of the School of Applied Technology was kept simple by purpose, since the case was meant to explain the methodology, rather than really testing the DSS (Sakkas & Pérez 2006). The case supported the conceptual framework, but it was not meant to be a completely worked out test case. Taking a closer look to the text, one notices that many numbers are decided, and not calculated: *“...The toilet is totally inaccessible for people with wheelchairs and has therefore assigned as zero quality value... A quality value $q=0.7$ is assumed for this way..... Lastly, the first floor classrooms can be accessed through an appropriately sized elevator and thus we have kept a $q=1$ value for this path”* (Sakkas & Pérez, 2006). Hence, the results of this real life test support the general reasoning of the DSS, but they do not prove that if one uses the DSS without interfering, the calculated percentages have intuitive realistic appeal.

In another presentation of this test case, more details are given (Sakkas et al., 2005). From these details, we conclude that the DSS used was not yet the final DSS as it is put afterwards on the internet (e.g. for an elevator, presence of a sensor and surface quality are evaluated). But these properties are not in the present DSS. At the other hand, lighting is in the present DSS but seems not to be evaluated in the presentation of 2005. Comparable differences appear for corridors, internal doors, etcetera. Hence, this evaluation is not comparable with the tests we did. If some of the critical values were put in the DSS after the test of this prototype, it is evident that the accessibility percentages of the School of Applied Technology are higher than in our test cases.

5.2 Edificio Ensanche, a public building of the government in Spain

For the “Edificio Ensanche” in Spain many detailed results are available (Pérez & Mediavilla, 2005a, 2005b). In this section, we will compare the services and route-properties for the most elaborated example of the Belgian hotels with the Spanish building. Since both buildings have another purpose, not all the services / route-properties are comparable. But a sufficient number is comparable to allow some conclusions. All data of the Spanish building in this section come from Pérez and Mediavilla (2005a, 2005b).

For the car park, the accessibility percentages of the Spanish and the Belgian test case are very comparable; both range between 62% and 85%.

For the reception we found very low percentages: between 0% and 37%. In the Spanish test case, some data are missing. To continue the process, they have put the quality of the reception equal to 100% for all disabilities. This assumption is a very optimistic one, if we compare this with the Belgian data (see section 4.4)

In the Spanish building a stair has only two times a 0% accessibility: for No Mobility in arms and legs (NM) and Mobility in Arms only (MA). This is evident since both groups are not able to climb stairs. In the Belgian test case we find for a stairs with only one step also 0% for Walking Difficulties (WD) and Cognitive Problems (CP), since this step has no handrail, and a handrail is a critical value for those two groups.

Another Belgian stair has 0% for six groups. Evidently NM and MA. These stairs does have a handrail, but it is 5cm too low. And since height is a critical value of the handrail, and a handrail is a critical value for the stairs, this stairs also has 0% for WD and CP. The 0% for the persons with Partially Blind (PB) and Totally Blind (TB) is the consequence of a change in a formulation between the original Spanish parameter and the present parameter of the DSS. Originally, the parameter was “absence of slippery surface: yes/no” (Pérez & Mediavilla, 2005b). At present, it is “non slip surface: no/yes”. The stairs under consideration has common stone steps. Not especially slippery, but neither a definite non-slip surface. Hence, slippery surface is absent (Spanish version 2005), but non-slip surface is not present (present version 2009). In the present DSS, this is the ‘bad answer’ and since non slip surface is a critical value for PB and TB, the stairs has 0% accessibility. With the other formulation, PB would have 32% and TB 39% for this stairs.

The Spanish ramp has more than 90% for all disabilities. The Belgian percentages for the ramp that is the alternative for the stairs with one step mentioned above, range from 0% to 76%. This is again partially due to the formulation of the slippery surface. The ramp is made of clinker bricks, which are neither especially slippery, nor especially non-slippery. For a ramp, this is not a critical value, but it has an effect ranging from 10% till 31%. Very surprising is the fact that having a parapet is a critical value for Cognitive Problems and for Partially Deaf. The ramp is very wide and has no parapet. The need for a parapet seems not necessary in this case. And if it should be, then for people with Walking Difficulties, and not for CP nor for PD.

The access and internal doors in the Spanish building have more than 75% for all disabilities. In the Belgian case, with the present DSS, there are many 0%. For Partially and Totally Deaf, there are no differences between deaf and hearing people concerning the accessibility of an internal door. In theory, this should have been 100% accessibility, what is also presented for the Spanish building. But in the present DSS, the calculation seemingly is different. There are no relevant parameters for TD and PB. As a consequence, no numbers are available to calculate the accessibility, resulting in 0% accessibility.

For an entrance door, only the entry phone has impact on the accessibility for persons with hearing problems. Since most often only one entrance door has an entry phone, all other entrance doors have 0% for PD and TD.

In the Belgian hotel, there were no internal automatic doors for bedrooms, toilets, meeting rooms, etcetera. This resulted in 0% accessibility for No Mobility in arms and legs, since door type is a critical value for this group. Or the internal doors in the Spanish building were all automatic doors, or the draft of that DSS had other critical values.

In the DSS, there is a penalty factor for extra distances. If there are two routes from one service to another, the longer route has a smaller accessibility than the shorter one. The longer route is ‘punished’, since people do not like to make detours. In some situations it is not evident to give an exact distance, e.g. for surroundings or for a car park. In the Spanish building, the penalty factor is then put equal to one, meaning no penalty. In the present DSS, this is not possible. The user has to fill in a distance, e.g. to the parking place for disabled people. Then, if a detour is made, the penalty factor will always be larger than 1. Again, the present DSS will end with a smaller accessibility percentage than the one tested on Edificio Ensanche.

The toilets in the Spanish building have all percentages higher than 80%. In the Belgian test case, many percentages equal 0%. All toilets have 0% for Totally Deaf, since the alarm is not visual, and an acoustic alarm is a critical value for a toilet. Many toilets have 0% for TB, PB and CP since there are more sharp than round edges. WD, MA and NM have 0% since there is no sufficient place around the toilet, or the height of the washbasin is not suited, or both.

We conclude that the accessibility percentages of the Spanish test are systematically higher than the percentages of the Belgian test case. This might be a difference between the two buildings, but it is definitely also a consequence of a difference between the two DSS’s used.

5.3 Edificio de la Naviera Aznar in Bilbao, Spain

The accessibility of the city hall in Bilbao was calculated by the DSS, showing also results on the level of the building (Mediavilla et al. 2006). This surprised us initially, since the program as we found it on the internet had no subroutine to calculate this general result. It was one of the parts we added ourselves to the DSS. Later, we heard by personal communication that the test on the city hall was not performed on the final DSS, but on a prototype in Excel.

The most striking difference between the test case of the city hall and our test cases is the high overall results. The accessibility percentages ranged from 23% till 92% (Mediavilla et al. 2006). The Belgian accessibility percentages were all lower than 8%.

Mediavilla et al. (2006) notice that putting Braille signalling in the reception, waiting areas and corridors improves the accessibility substantially for people with visual problems. This is in agreement with our finding that this is an important restrictive critical value.

Also all the other measures that they suggest to improve the building substantially –more precisely: to increase the accessibility percentage substantially- are critical values: door width, height of washbasin, free space around WC and washbasins. Some of them are actually critical values in a cascade of two critical values (e.g. free space is critical to washbasin, and washbasin is critical for a toilet).

Hence, also in this test case, the impact of critical values was very important. Then it remains surprising that the overall result differs so much. Probably, there were more differences between the Excel prototype and the final DSS than only the subroutine to calculate the overall accessibility.

5.4 CNR-research centre in Rome, Italy

The test of the building devoted to the CNR-research area centre in Rome does not present accessibility percentages (Centanni & Moruzzi 2006). The test was mainly performed to test the procedures of the input, and not the validity of the output. We can not compare our results with the results of this test case.

5.5 Museum of the Diaspora in Tel-Aviv, Israel

The results are presented in a powerpoint-presentation with few details on the methodology (Bendel & Sharan, 2006). Except for the gift shop with 0%, the presented accessibility percentages for users with mobility only in arms are high, ranging from 56% to 88%.

The presentation does not suggest that the DSS as found on the internet was not used, or that it was adapted. If they used the same DSS as we did, it is surprising that at least one of the following properties did not result in 0% accessibility, since they both are critical values for people in wheelchairs in the present DSS:

- *“ramp dimensions (length, height) are inadequate creating a steep slope”* (Bendel & Sharan, 2006)
- *“Car park:the width of bay, underdimensioned (2.5m)”* (Bendel & Sharan, 2006)

In the summary Bendel and Sharan (2006) state that *“no arrangements are available for Visually or hearing impaired as well as for mentally impaired”*. From our own tests, we suppose that this means that the building has very low accessibility (< 8%) for these groups.

5.6 Conclusion of the comparison

Four of the five earlier test cases present accessibility percentages. All these test cases give systematically higher accessibility percentages than our Belgian test cases. But at least three of them were tested with earlier versions of the Polis-DSS and differ with the version that is now presented on the internet. The present DSS is more restrictive than the earlier versions were. Moreover, in some of these tests, the DSS was not strictly followed. Some percentages were estimated and not calculated. These estimates are almost always higher than the strict calculation by the present DSS.

6. Conclusions and suggestions for the future

The usability of the DSS is OK. It takes some time to learn the program, more or less 1 day, but afterwards both input and output become understandable.

Although the variables look all very objective, some are more subjective than it seems. A manual could solve most of this subjectivity.

At present, the DSS is very restrictive; no building got an overall percentage of more than 8% for any disability group. This is surprising, since this was not reported to this extent in earlier test cases. But the earlier tests were not performed on the DSS as it is presented nowadays on the internet-website. Seemingly, this final version is more restrictive than the earlier tested drafts.

Even if it is explained to the audience that the output should merely be seen as a qualitative result pointing out weaknesses of the buildings, the overall results are so low, that they are hardly acceptable by the managers and the owners of commercial or public buildings. If a tool is considered as exaggerating, its output will easily be ignored in a discussion and the gain of using a DSS is lost. Therefore, the output should be changed.

The DSS is restrictive, mainly as a consequence of an intensive use of critical values. There are three kinds of critical values:

1. Properties are defined as critical values since they have immediate impact on the major purpose of a service. For example, the WC is a critical value for the toilet. If the WC is not accessible, the toilet is presented as inaccessible.
On a lower level, the same holds for properties of properties. Clear space near a WC is necessary for good use of a WC. Hence, if there is not sufficient space, the WC is inaccessible.
2. Some properties are critical values since they have immediate impact on an important, but not the major purpose of a service. For instance, if there is insufficient space near the cupboard of a bedroom, the bedroom is presented as inaccessible for persons in a wheelchair.
3. Properties are defined as critical values since the DSS wants to give a warning. E.g. a corridor can be perfectly suited for persons with hearing problems as a way to pass from one service to another. But if the alarm is only acoustic, there is a major problem in case of fire. Hence, although this corridor is accessible in more than 99.9% of the situations, it is presented as inaccessible since the risk in the rare remaining situations is so high. Note that in this example, the DSS actually does not calculate 'accessibility' but 'risk', or perhaps "suitability".

A decision should be made if these three groups should stay critical values. For the first group, this is rather evident. For the second group, this is questionable. Critical values should only be used to really critical properties.

The third group is a matter of policy. If the main purpose of the DSS is to represent accessibility, alarm should not be a critical value. If the main purpose of the DSS is to point out possible problems in buildings, the more severe the consequences of an inadequate property, the stronger the warning of the DSS should be. In such a situation, alarms should be critical values.

After deciding on a policy, all the critical values should be assigned to one of these three groups. We suggest that critical values that belong to group 2 would not be critical anymore. Then the DSS should be tested again to see if the results are more in agreement with expectations. At present, the impact of the critical values is so strong that it is hard to see if the other partial results have intuitive appeal. If the results seem acceptable, a stronger validation should be done by comparing the results of the DSS with existing tools for the measurement of accessibility, e.g. the Housing Enabler.

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