Emotional Barrier-GIS – A new Approach to Integrate Barrier-Free Planning in Urban Planning Processes

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1 ABSTRACT

More and more people are handicapped, because of a certain disabilities or the natural aging in the course of the enormous demographic change in industrial countries. Thus barrier-free-planning is a concrete goal in the German urban planning system. The research work at hand "methodical and practical foundation for the establishment of the EmBaGIS" deals with the development of a new, innovative planning instrument to identify and optimize urban spatial barriers for handicapped people. The concrete aim includes a conscious composition of the planning specified "top-down-"and "bottom-up-approach" with the target to activate handicapped people in a participative method. The "bottom-up-approach" is based on a broad theoretical foundation, including the research fields of barrier-specified urban planning, subjective well-being and the field of emotional research. The question to the point is: How can we mark and evaluate urban spatial barriers in a valid and objective way to the concrete advantage of urban planning authority? In order to indentify barriers in the eye of the persons concerned, it is vital to know when and where a urban spatial barrier produces negative emotional reactions, e.g. a stress reaction. To achieve this, psycho-physiological monitoring is at the core of an Emotional Barrier GIS (EmBaGIS), using a sensor wristband to unobtrusively measure autonomic bodily functions as indicators for emotional reactions. Additionally, a GPS-Logger indicates the geographic position of the measured negative emotions. This approach was evaluated in two studies, concerning in the first study visually impaired and blind people (n=39), in the second study people with walking disabilities (n=21). Empirically, EmBaGIS is based on an "Empirical Three-Level-Analysis" to identify emotionally significant barriers. The first level is the measurement of the speed of movement. The hypothesis is raised that a decrease of kinetic walking energy is a first sign for the impact with a spatial barrier. On a second level skin conductance responses, indicating heightened attention demand, are described and on the third level skin temperature changes are used as indicators for stress. The results of our empirical studies show, that the EmBaGIS, based on psycho-physiological monitoring, adds to the identification of urban spatial barriers. By this experiences of handicapped people can be taken into consideration for urban planning processes.

2 INTRODUCTION

Especially a social compatible mobility is demanded, which offers non disadvantage or stronger handicap of specific population groups. Quantitative and qualitative deficits in the design of street and path networks and also in the structural proposition in the local public transport reduce the partaking of the population in the public and social life. People and groups limited in bodily as in financial regard, are thereof extensively affected [BUNDESMINISTERIUM FÜR VERKEHR, BAU UND STADTENTWICKLUNG 2008].

Quite a lot of physical impairments primary arise at an old age. Already in 2008, there are about 20 % mobility limited people in all of Germany [STATISTISCHES BUNDESAMT 2009]. The statistic number of severely handicapped people accounts to about seven million German people in the year 2007 [STATISTISCHES BUNDESAMT 2011]. This fact makes clear, that the establishing of a probably extensive barrier-freedom is an important component of common transport, building and urban development policy. The German Government has always understood the barrier-free construction of buildings and the public space as quality gain for all people [BUNDESMINISTERIUM FÜR VERKEHR, BAU UND STADTENTWICKLUNG 2008].

As seen in the exemplary statements of the German statistic federal office and the urban development account of the German Government 2008, the immense significance of barrier-freedom for a sustainable planning praxis in Germany is pointed out.

The planning praxis comes up to the intermixture of top-down- (town constructional rules and standards (DIN)) and bottom-up-approach (survey of concerned people groups). However especially the results of surveys mirror subjective impressions or situations depending on their imminent feelings. In addition, recently occurred, negative situations in context of spatial barriers are stronger present in the memory as, in this regard, unconsciously perceived reactions. This approach is after actual state of knowledge correct, because there is a missing of methods delivering objective data concerning the subjective feeling in context of urban spatial barriers. So far, it's not possible to measure urban spatial barriers in an effective and objective way under the circumstances to capture and identify these barriers from the unconsciously and consciously perception of impaired people. But the urban planning especially relies on objective and valid data for identifying issues. Out of this motivation, the problem of objectivation and validation of such subjective, target-group-specified data for identifying urban spatial barriers has to be solved in the research at hand.

Thus the absolute goal of the research is the development of an innovative, all-embracing instrument for identification and optimization of urban spatial barriers in a logical composition of top-down and bottom-up approach. The name of the instrument is EmBaGIS – emotional barrier GIS.

The emotionality of the title is implicated through empirical studies as zeitgeisty bottom-up approach. Corresponding to the planning principle of countervailing influence, the EmBaGIS satisfies also the requirements of the top-down approach through implication of a town constructional analysis of urban spatial barriers. A widespread geo referencing of the results of both approaches is the chance for implication in a geographic information system. More than this, the EmBaGIS delivers elementary, barrier-specific indications, which serve as optimization basis of each analyzed urban space.

Constructive on broad theoretical fundamentals concerning barrier-freedom, urban quality of life and the research of emotions, the EmBaGIS is on its way to be successfully developed and furthermore tested. Therefore, the method of psycho physiological monitoring is used in the empiric component of the instrument. It can directly measure negative emotions (e.g. a stress reaction) in the context of urban spatial barriers. The empiric component involves implicit the principle "humans as sensors" [ZEILE et al. 2010] and experiences of diverse researches in Mental Maps [MATEI 2003], BioMapping [NOLD 2009] and the emomap-project [Zeile 2010].

3 STATE OF RESEARCH

3.1 Subjective well-being

The attainability and the maintenance of a high quality of life is a central goal of the social policy, which contains all age groups in equal measure [DEUTSCHES ZENTRUM FÜR ALTERSFRAGEN 2002]. The 'better' compared with the 'excess' is the basic guideline principle within the concept of quality of life. This concept is based on a multidimensional understanding of the 'good life' and the individual welfare. Material and immaterial, objective and subjective components are likewise herein included. In the point of view of subjective experience of the environment is especially important for empirical monitoring. In context with impaired and handicapped people, the subjective feeling and experience is an indispensable criterion for the assessment of spatial environments [DEUTSCHES ZENTRUM FÜR ALTERSFRAGEN 2002]. So it counts to identify un-/comfortable areas in the city for further strengthening positive detected area and qualitatively enhancing negative detected areas. Consequently the filtering of an adequate method for measuring the subjective well-being is in the focal point of the research.

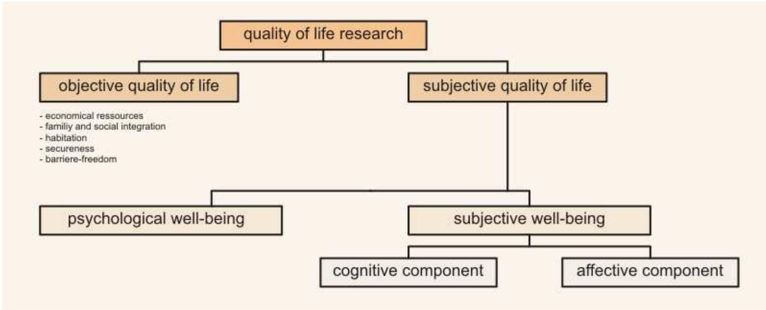

Fig. 1: Components of research quality of life (Bergner 2010).

The broad theoretical analysis shows, that an instrument concerning the measuring of subjective well-being/quality of life of handicapped people and in this context spatial barriers in the urban space has to fulfill two main criteria:

- Recording of affective moment-to-moment emotions and experiences in real-time and for every instant of time barriers has to be guaranteed for identifying concrete barriers.
- Undisturbed development of the individual in its environment by the measurement hast o be guaranteed.

The tested methods for measuring the cognitive-evaluative and affective well-being do not fulfill the requirements in all aspects. However, these requirements are vital, to guarantee the transparency and traceability of the results. This is absolutely necessary for acceptance in government and citizens. To be able to utilize currently recorded emotions, it is required to tag them using coordinates (GPS). Current emotion is most important. Thus the question arises, how to measure these emotions, positive and negative, in real-time. Emotion-analysis has tended to this field of science extensively.

3.2 Research of emotions

Within the field of emotion-science, psycophysiological monitoring offers the best method to measure spatial barriers in urban space through detecting and georeferencing of stress reactions. The experamental research consistently shows that emotional reactions go along with changed activity in the autonomic nervous system. Because these nervous reactions reveal themselves in specific physiologic parameters like skin conductibility and skin temperature (Kreibig 2010), psycophysiological monitoring offers an optimal method to asses a test person’s emotional reactions, without having to use self reports. Recent technological developments, such as a sensor wristband, now allow the recording of theses parameters outside a lab, even without limiting a test person’s mobility. A wrist-sensor like that is therefore the ideal instrument to record emotional stress reactions one encounters while moving through urban space and to georeference them by recording the exact coordinates. As for the measurement of urban barriers it is very impotant to show the mental load, stress, through physiological indications. In the context of this research, stress is understood as a product of anger and fear. That’s why it natural, from a test person’s point of view, to speak of stress, when he or she encounters a barrier in urban space. Another advantage of psycophysiological monitoring is that no observer has to be immediately present, because the files can be extracted from the technical device and the GPS-logger after the study or experiment is finished. This very much suggests the use of psycophysiological monitoring in the real world and in real time.

4 DATA AND TECHNIC

4.1 Methodical foundation and data production

Only a high degree of barrier-freedom in a city increases the subjective quality-of-life reception of impaired and disabled persons. In the past a “Measurement of quality of live”, an analysis and evaluation of quality-of-life, only happened through questioning and retrospective self-accounts. According to the goals of „EmBaGIS“, valid and objectively measurable subjective data have to be provided for urban planning to determine urban spatial barriers. That’s the only way to assess urban space transparently and traceably. The big challenge urban planning faces, is to generate objective and valid data, out of the subjective data sets, related to the individual, using psycophysiological monitoring.

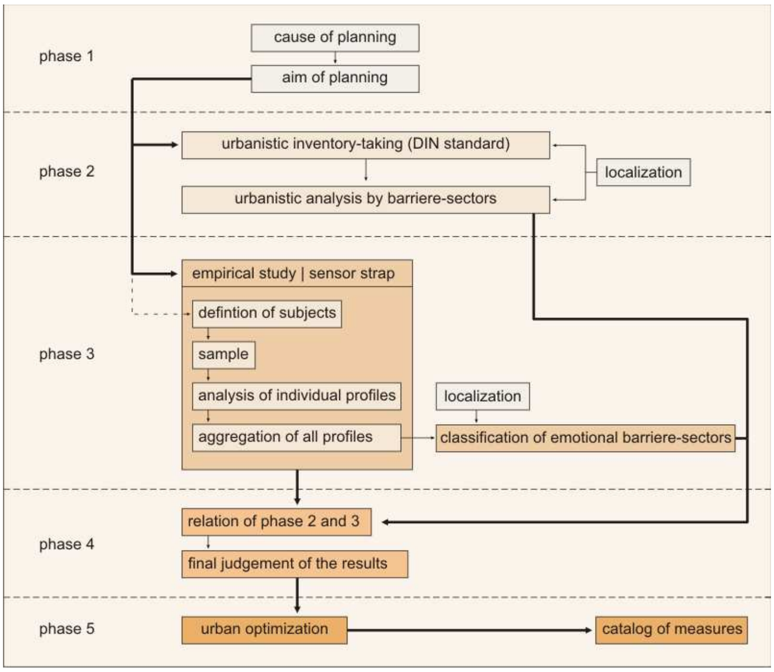

Fig.2: Multilayer phase-modell showing the mothodical fundations of EmBaGIS (BERGNER 2010).

The utilizing of the previously introduced methods enables to initiate, a new, far reaching instrument to identify urban spatial barriers. The resulting "emotional barrier-GIS", EmBaGIS, converges into a multilayer phase-model, representing a composition of top-down and bottom-up approaches, the mixed planning (Fig.2).

4.2 Experimental 3-Level-Analyses and psycophysiological monitoring in the context of the experimental subcomponent

The purpose of the 3-level-analisys is to determine urban spatial barriers using a three layer indication system. The parameters of this analysis are:

- The kinetic in form of movement speed, measured by the GPS-logger.
- The skin conductability, measured by the sensor-wristband (Smartband).
- The skin temperature, again measured by the sensor-wristband (Smartband).

The geographic position of all data is recorded by the GPS-logger, in another step the data is synchronized and analyzed as individual barrier indicators. (Fig.3)

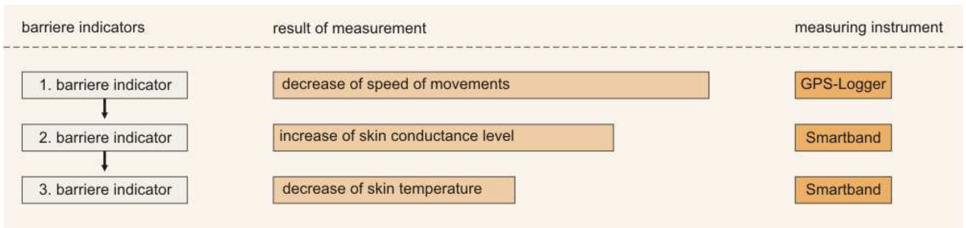

Fig. 3: Experimental three level analysis (BERGNER 2010).

The experimental 3-level-analysis is conducted basing on the recorded data and bio signals of the GPS-logger and Smartband (Fig.4). The results are graphical curves resembling telemetric data from car engineering. To get meaningful results, the curves have to be looked at in relation to one another. According to emotion scientists a negative experience is at hand, if the skin conductibility rises and short afterwards, the skin temperature drops (see right illustration). If the curve shows a decrease in movement speed at the same time, the combined curve course indicates a negatively experienced barrier in urban space (see left illustration)

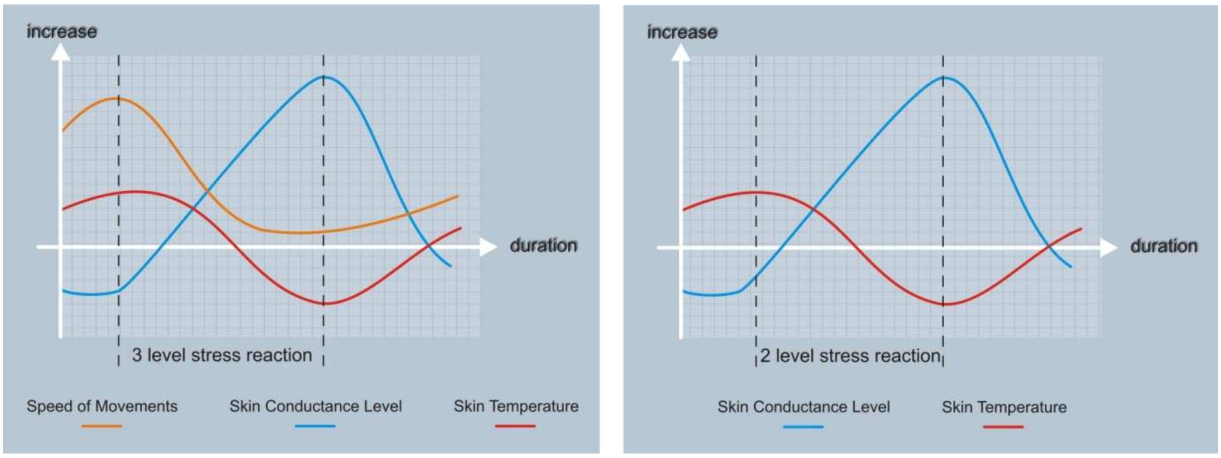

Fig. 4: Generic waveform of a negative emotion, in general on the right side, with a physical barrier in urban space on the left side, indicated through decreasing of the speed

To make the analysis of the curves easier, they are simplified in a statistic analysis, according to the following criteria:

- Decrease in movement speed: Scoring -1
- Increase in skin conductibility: Scoring +1
- Decrease in skin temperature: Scoring -1

Through the assignment of scoring points a statistical analysis of the individual stress reactions can be done tabularly. (Fig.5). It indicates a stress reaction with a spatial barrier when all three indicators report at the same time. Hence the name of the analysis - 3-level-analysis.

Speed of Movements	Skin Conductance Level	Skin Temperature
0	0	0
0	0	0
0	0	0
-1	0	0
-1	1	0
-1	1	0
-1	1	-1
-1	1	-1
0	1	-1
0	0	-1
0	0	0

Speed of Movements	Skin Conductance Level	Skin Temperature
0	0	0
0	0	0
0	0	0
-1	0	0
-1	1	0
-1	1	0
-1	1	-1
-1	1	-1
0	1	-1
0	0	-1
0	0	0

Fig. 5: 3-Level-Scoring-Analysis (left), 2-Level-Scoring-Analyis (right)

During the course of the project it got clear that the analysis of the factors, skin temperature and skin conductibility set aside from the factor of movement speed is also of interest. The reason therefore was a phenomenon: On a certain spot (traffic light), stress reactions where measurable from many test persons, while their speed did NOT slow down. So this particular traffic light is a barrier that causes a steady or rather increasing movement speed.

The identified stress reactions of all test persons, evaluated using the scoring model, are aggregated and fixed to certain areas which represent emotional barrier sectors. These cover the same space as the previously defined urban planning barrier sectors. To get a meaningful indication of barrier-freedom of the individual emotional sectors, the total number of all test person’s stress reactions is divided by the length of the individual sector (in meters). After that, follows a comparison with the previously defined urban planning barrier sectors, to be able to make certain overall statements about their barrier freedom.

4.3 Technical Devices

A certain sonsor-wristband (the SMARTBAND by bodymonitor www.bodymonitor.de) that was developed by GESIS, the Leibniz-Institut for Sozialstudies in Mannheim (Papastefanou, 2009) is used for this experiment. This wristband records body-reactions which indicate the test person’s current emotional state. In combination with a pocket-size recording device that records the GPS coordinates of the test person’s path, it makes it possible to exactly identify every spot in the city, which poses a great mental stress to people with disabilities.

Fig.6: Smartband and GPS-Logger.

5 PRACTICAL EXECUTION OF EMBAGIS

The perceptions and spacial experience of disabled persons in the inner city space serves as an empiric basis for urban planning concerned with barrier freedom. To either change an existing situation or to keep it the way it is. The studies about the inner city space perception of disabled persons in the pedestrian zone were especially initialized to test the EmBaGIS. The development of the instrumental approach of EmBaGIS forms the theoretica foundation at first to exactly identify and evaluate barriers in the city space. EmBaGIS now faces being tested in the field. That’s why two experimental studies have been conducted in the course of this research.

The first Study to practically test EmBaGIS was conducted during the “Europe wide actionday of disabled persons” on Mai 08. 2010. The intention was to test the psycophysiological monitoring with disabled persons for the first time. The first EmBaGIS Study „Innerstädtische Raumerfahrung und mentale Belastung von blinden Menschen in der Fußgängerzone“ was initialized by the Leibniz-Institut GESIS in Mannheim in cooperation with the „Referat für Stadtentwicklung“ of the city of Kaiserslautern and supported by the department „Computergestützte Planungs- und Entwurfsmethoden (CPE)“ of the Technischen Universität Kaiserslautern. The stress reactions of 39 blind and visually handicapped people were examined regarding monitored during their walk on a fixed route through the pedestrian zone in Kaiserslautern. As a result especially punctual barriers such as retail advertisement boards, lamp post and trash cans could be identified. But also areal barriers such as uneven ground cover and outdoor seating areas are stress triggering barriers for blind and visually handicapped people.

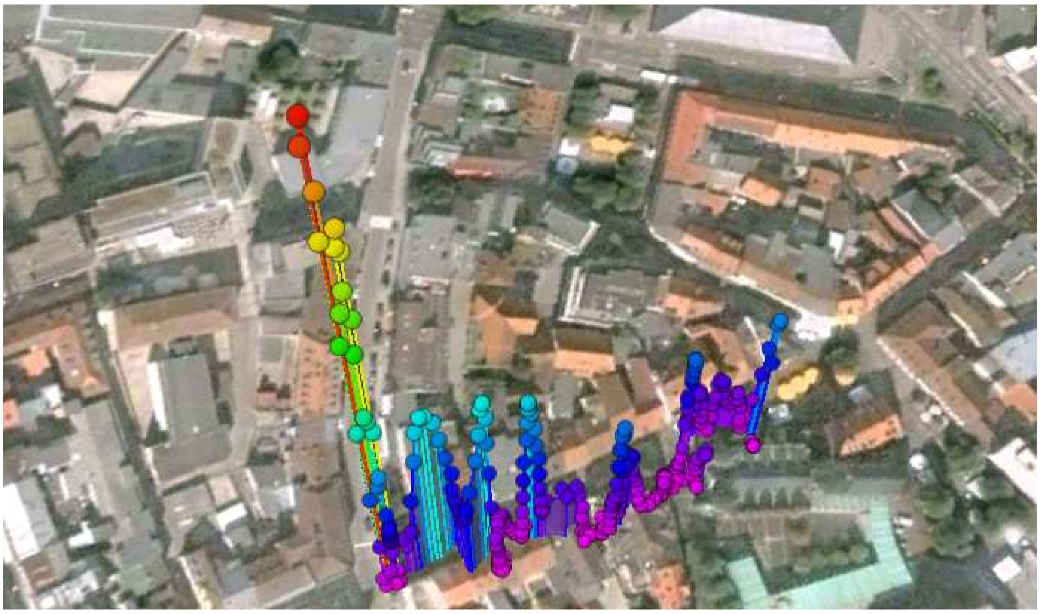

Fig. 7: 3D-visualisation of a blind person‘s mental stresspoints illustated using Google Earth (BERGNER 2010).

In a second EmBaGIS-study „Innerstädtische Raumerfahrung und mentale Belastung von gehbehinderten Menschen in der Fußgängerzone“ the whole instrumental approach came into use in connection with bodily handicapped people. The test person’s (n=21) mental space experience revealed an urgent need for action, regarding areal barriers such as cobblestone patches, ramps and staircases. The research finally resulted in an urbanistic improvement of certain areas and a concrete catalog of actions taking the whole test area into consideration.

Fig. 8: Test area Sector 7 St.Martin (BERGNER 2010)

As a result the described stress indication (see 4.1 Methodical foundation and data production) reveal themselves in various shapes. The higher the indicator, the more stressful the respective emotional barrier sector was for the test person. For each sector the 3 level as well as the 2 level stress indications got evaluated, which is illustrated below. It especially shows that sector 3 (traffic light) has a 2 level indicator that is almost twice as high as it is the 3 level indicator. Such a big difference does not occur in any other sector. The reason for that is the steady or even increased movement speed that comes along with physiological stress (2 level analysis). This points to the interval of the traffic light, which is to short and forces physically handicapped people to walk faster while putting them under stress.

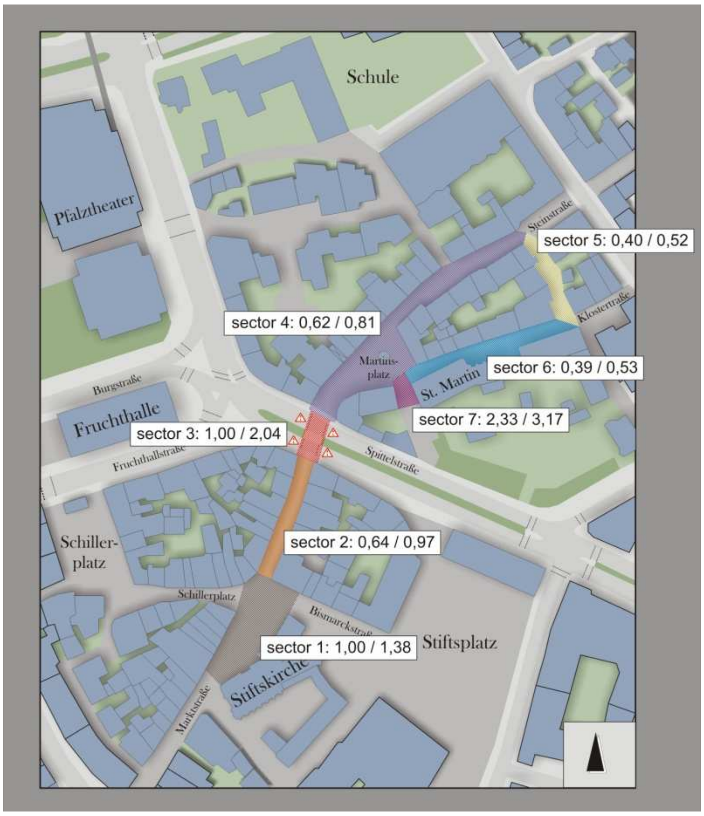

Fig. 9: 3- and 2-Level-Stressindicator for all sectors in a part of the pedestrian precinct of Kaiserslautern, Germany

Additionally, sector 7 has to be highlighted, it shows compared to it's length an especially high indication value. This is because the ramps in this sector are not mountable especially with a wheelchair, which is emotionally and urbanistically proven.

Based on the hereby acquired empiric results in comparison with the urbanistic analysis of the test areas using DIN norms, one can speak of a gain of valid and objective individual data, as a bottom-up-approach for urban planning.

6 CONCLUSION

In this interdisciplinary approach with research fields of psychology, sociology, geo-computer-science and urban planning the new method of EmBaGIS is based within the field of urban planning. The approach of an objective measurement of individual well-being in the process of bottom-up thinking, focused on people with disabilities, is new within this field. It is possible to gain an improvement in the defined test area, within the projects chosen workflow, the five-layer-phase model, by using a counter current / mixed planning method:

- The classic top-down-approach is realized through urbanistic analysis and appraisals according to the DIN norms. The result is the allocation in urbanistic barrier sectors. These are conditioned in a way that their geographic position is recorded and filed in a GI-System.
- The bottom-up approach is characterized through its experimental, IT supported study using the Smartband. Psycophysiological monitoring allows the measurement of the mental load of a particular target group in a particular moment within a barrier sector. Hence the method is capable of measuring the "affective moment-to-moment emotions".

In contrast to previous studies it is now possible to measure emotion, because not only the skin conductibility is recorded, but the reactions of the parameters, movement speed, skin temperature and skin conductibility are combined in the "3 level analysis", as described. This "3 level analysis" together with a synchronized position tracking of the test persons, gives a crucial hint to urban barriers, the "emotional barrier sectors".

The informal planning tool, the "emotional Barrier-GIS", contributes a new way to sustainably develop a barrier free city. The far reaching fields of application of EmBaGIS within the integrative urban development planning, in the pre planning phase and in the decision making phase assure that. A special charm of applying this method is that especially handicapped people can play an active role in it. Thus not only the trend of the demographic change, of an aging population, but also the political demand for fewer barriers is taken into consideration. To be able to give the inner cities, as the most important urban living- and movement-space, a new quality, EmBaGIS –more than just a method- is a very important contribution to integrative urban development and offers new chances to enhance the subjective quality of life of handicapped people.

7 SUGGESTIONS FOR FURTHER PROJECTS

The method of EmBaGIS is still in a state of development and optimization. During the project phase the following points for further enhancement arouse very quickly: The reduction of errors from the sensors used, the influence of different individual environmental factors, the chronological and manually synchronization of time events, as well as the lacking of semiautomatic embedding options in GI-Systems.

7.1 Error sources

A significant source of error is the big discrepancy of the GPS-data from the actual situation. Sometimes differences of up to 20m can be noticed especially in the passage between an open space and an urban canyon (Fig.10).

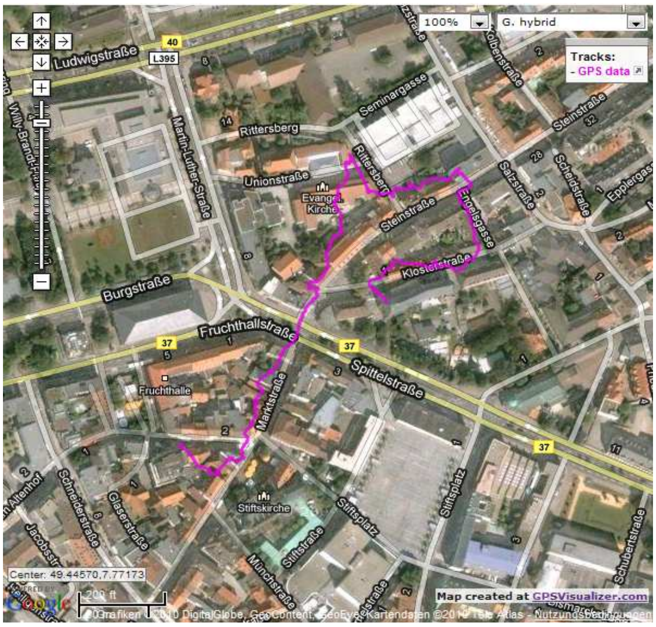

Fig. 10: GPS-data significantly differing from the actual situation. Source: Own illustration based on GPS-Visualizer and Google Earth.

Thus, with the used devices, it was only possible to make barrier specific sector divisions, created using a buffer around the recorded position data. Thanks to direction changes on the end of the individual sector, the designated urbanistic barrier sectors could be differentiated very clearly even in the GPS data. Due to this error source, punctual assessments within the sectors cannot be given.

But to establish EmBaGIS for other groups of handicapped people, like the blind, a punctual assessment and location of the stress reaction is of the most importance. The target group of mobility handicapped people favored an areal diversion of stress reactions, according to the urbanistic analysis of barrier sectors, but for a exact identification of urban barriers, it is necessary to get adequate GPS data. Hence a further differentiation is possible, as to what part of cobblestone or which manhole cover is triggering the stress reaction. The experience of the pre study, to detect the mental load of blind test persons, showed that recording barriers as areas does not lead to good results in their case. Here especially punctual barriers such a certain advertisement boards and other obstacles, a blind person can engage, have to be detected. This problem can easily be solved by using newer GPS devices with better reception and less aberration.

Another source of error is to mistake stress reactions, triggered by external influences, an uncomfortable call on the cell phone for example. Through analysis of kinetic and physiological data alone those special stress reactions cannot be differentiated from other stress reactions.

In this context it is worth mentioning that to date it is not possible do detect the orientation of a test person's body, or the direction of the gaze. The latter can only be guessed through the walking direction, but can not be determined when the person stops. If those parameters could be recorded as well, external stress triggering influences like playing kids can be eliminated from the barrier related data analysis.

It can be assumed that these specific stress reactions occur rarely and are adjusted through the combined number of stress reactions of all test persons.

As a way to solve this, test persons could wear glasses with a video camera attached to them.

7.2 Needs of improvement

There is still a need for optimization, especially within the experimental part of EmBaGIS. To make the analysis easier, the sensor based measurements have to be simplified.

The Smartbands have to be chronologically synchronized with the GPS device to allow for a quicker overlapping exactly to the second. By tagging, the setting of a way point on the GPS device, on the beginning and the end of the test track, and by an increase in the physiological measurements through putting on the Smartband, the data can be arranged to be almost simultaneously. Here technological development is still pending.

Another area for optimization is the principal automatization of the empiric analysis operation, like simplifying the 3 level and 2 level analysis through adequate algorithms used for statistical assessments.

To further validate the data it is suggested to make a study with a control group of not handicapped persons to make the results even more traceable.

7.3 Further needs of action

Looking at the results, a further discussion has to be held as to what the meaning of the single stress reaction is, within the total combined number of stress reactions. The assumption that the sector with the most stress reactions has to be the one with the most barriers is wrong, because the sectors differ in their length. A possible way to solve this problem is to divide the total number of stress reactions through the length of the individual sector; this generates a new indicator that makes the sectors comparable. A high absolute number of stress reactions, in this context, points to a barrier that reoccurs because it stretches over a certain area. The results always have to be looked at in context of the actual barrier.

That is the reason why a qualitative analysis operation, as applied in the EmBaGIS-study, combined with a synchronized position tracking, along with the establishment of a barrier indicator that relates to the length of the individual sector, is the right approach to evaluate the individual sectors. The goal of an urbanistic optimization, focused on barriers, has to be the actual reduction or even elimination of stress reactions related to the individual barrier.

Another future point of interest can be the analysis of well-being-areas within an EmBaGIS study, to get a feeling for the local and contextual relation of stress and recovery and to get a high validity of the data through the experimental and urbanistic comparison of stress- and well-being-areas. A new method to assess EmBaGIS can be engineered out of this comparison. It would also allow to check relevant DIN norms with well-being-areas and to further evaluate their value. More over those well-being-areas could be further developed, according to the motto: improve your strong points.

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9 REFERENCES

BERGNER, B. S.: Methodische und praktische Fundierung zur Etablierung des EmBaGIS - Emotionales Barriere-GIS als neues Instrument zur Identifikation und Optimierung stadträumlicher Barrieren für mobilitätseingeschränkte und behinderte Menschen - Am Anwendungsbeispiel der Fußgängerzone in Kaiserslautern, Diplomarbeit Lehrgebiet cpe,

Kaiserslautern, Kaiserslautern, 2010. Web: http://cpe.arubi.uni-kl.de/2010/12/01/methodische-und-praktische-fundierung-zur-etablierung-des-embagis-benjamin-bergner/ (14.01.2011).
BUNDESMINISTERIUM FÜR VERKEHR, BAU UND STADTENTWICKLUNG (Hrsg.) (2008): Stadtentwicklungsbericht der Bundesregierung 2008 – Neue urbane Lebens- und Handlungsräume, Berlin, S. 114. Web: http://www.bmvbs.de/cae/servlet/contentblob/
27952/publicationFile/29032/stadtentwicklungsbericht-der-bundesregierung-2008.pdf (12.01.2011).
DEUTSCHES ZENTRUM FÜR ALTERSFRAGEN (Hrsg.) (2002): Das hohe Alter – Konzepte, Forschungsfelder, Lebensqualität, in: Expertisen zum vierten Altenbericht, Band 1, Hannover, S.232-311.
KREIBIG, S.D. (2010), Autonomic nervous system activity in emotion: A review. Biological Psychology, Volume 84, Issue 3, 394-421.
LAZARUS, R./FOLKMAN, S. (1986): Cognitive theories of stress and the issue of circularity, in: Appley, M. E./Trumbull, R. (Eds.): Dynamics of stress. Physiological, psychological and social perspectives, New York: Plenum, S. 63 – 80.
MATEI, S.: Making collective mental maps: a case study, 2003. Web: http://web.ics.purdue.edu/~smatei/MentalMaps/resource.html (14.01.2011).
NEPPL, M.; BERCHTHOLD M.; KRASS, P.: GPS-Studie Studie Studentenstadt. Karlsruhe. 2009. Web: http://www.stqp.uni-karlsruhe.de/index.php?option=com_content&view=article&id=151:gps-studie-studentenstadt&catid=1:aktuell&Itemid=31 (14.01.2011).
NOLD, C.: Emotional Cartography - Technologies of the Self, Pubkished under Creative Commons License, ISBN 978-0-9557623-1-4S, 2009. Web: http://emotionalcartography.net/ (14.01.2011).
PAPASTEFANOU, G., 2009, Ambulatorisches Assessment: Eine Methode (auch) für die Empirische Sozialforschung, Österreichische Zeitschrift für Soziologie, Sonderheft 9, 443-468.
Statistisches Bundesamt: Gesundheitsberichterstattung des Bundes - Indikator 3.44 des Indikatorensatzes der GBE der Länder, gemeinsam mit Robert Koch-Institut und Bundesministerium für Gesundheit. Wiesbaden. 2011. Web: http://www.gbe-bund.de/ (14.01.2011)
STATISTISCHES BUNDESAMT: Pressemitteilung zur Bevölkerungsentwicklung in Deutschland bis 2060 (12. Koordinierten Bevölkerungsvorausberechnung 2009). Web: http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Presse/pk/2009/Bevoelkerung/Statement__Egeler__PDF,property=file.pdf, S. 10 (13.01.2011).
ZEILE, P., EXNER, J., HÖFFKEN, S., STREICH, B. (2010): Menschen als Messfühler – die Kombination von Geowebmethoden und Sensorik, Kaiserslautern. Web: http://programm.corp.at/cdrom2010/papers2010/CORP2010_44.pdf (15.01.2011).
ZEILE, P.: Echtzeitplanung – Die Fortentwicklung der Simulations- und Visualisierungsmethoden für die städtebauliche Gestaltungsplanung, Dissertation TU Kaiserslautern, Fachbereich Raum- und Umweltplanung, Kaiserslautern, 2010.