Campus quality of life information system: A case study applied to the University of Minho

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Abstract: - When analysing characteristics, form, dimension and organisation of university campi, it can be concluded that they can be seen as urban spaces. This fact is often enhanced due to their location: in urban areas or even merged in the city. In this context, a model for the evaluation of the quality of life based on concepts for urban spaces is presented in this paper. Its main purpose is to provide conceptual bases for the implementation of a decision support system that evaluates the university campus quality of life. The process integrates users' perception and provides the ability to assess the impact of future interventions on the campus quality of life using scenarios. Those scenarios can be created by a tool included in the system and enabled to express through indicators values updates corresponding to possible changes in campus. The evaluation of the quality of life variation that would result from the scenario execution will serve as a decision support tool for campus management when studying several possibilities.

Key-Words: - Quality of Life, Decision Support System, University Campus, Public Participation

1 Introduction

Over the past few years, studies about the quality of life have increasingly been focusing on urban reality, as the majority of the world's population lives in urban places. This is certainly a reason for the appearance of a new line of research on the quality of urban life [9]. The European Commission has also recognised that Health and the quality of life are top priority areas of the Sixth Environment Action Programme [2]. It even says that, for people living in cities, a good quality of life largely depends on the quality of the urban environment.
On the other hand, Universities have been recognised as an active agent in the society development and evolution. One of the marks of this acknowledgement was the *Magna Charta Universitatum* [10] where it is sustained that their role is to promote cultural, scientific and technical development of new generations, but also of the whole society, providing permanent training. The Commission of the European Communities [1] refers that the growth of the society's knowledge depends on the production of new knowledge, its transmission through education and training, its dissemination through information and communication technologies, and on its use through new industrial processes or services. Joining that relevance to campi extension and the university community dimension, the quality of life in university campi became a critical factor for management purposes.
In addition, there is a consensus about the fact that Portuguese Universities are leaving a period of continuous building growth, incoming in a cycle of stabilisation and consolidation. The demand tends to be satisfied. So, a new process shall emerge where the physical expansion will be substituted by a quality increase.
Therefore, the main objective of the work presented in this paper is to implement an information system to evaluate and monitor university campi quality of life. The system embodies two main functions: to inform, allowing any user to know how the quality of life on campus has evolved; and to be a decision support tool, mainly for facilities planning and management, getting a global quality of life users perception, taking advantages of users' participation, through the integration of individual evaluations.

2 Methodology

In spite of the known difficulties to find a universal definition of quality of life in urban spaces, there is some consensus concerning the approach conducing to its conceptualisation. In this context, and without depreciating the discussion about the conceptual and qualitative aspects, the development of evaluation and monitoring tools to analyse the quality of life degree provided to campi users is seen as relevant.

The first step of the methodology approach is the identification of a set of quality of life dimensions, which is related to aspects of the campi liveability ([7], [8]). This is done by using a "standard" list previously defined and gathering the opinion of a set of users (directly or through a representation scheme). The result should be the characterisation of these dimensions by an exhaustive number of indicators in order to portray the quality of life in the campus (QlC). As indicators can also be used for the dimensions' evaluation and monitoring, it is possible to conceive a system that contributes to the decision making in the campus' management.

2.1 Quality of Life in Campus - QlC Evaluation model

As in a small city, the liveability in a university campus is conditioned by many factors, such as the environmental conditions, mobility, accessibility to services and work places, and social conditions. Then, it is understandable that a university campus can be seen as an urban space. This idea is reinforced when considering the definition of a city given by Merlin [6]: "a reunion of men, in a favourable localisation, to impel collective activities, a place for people, goods, capitals, ideas and information exchange, being simultaneously a framework, a motor and the result of human activities" (free translation). For that reason, the methodology exposed by Mendes [5] and implemented in several previous works of the author ([3], [4], [5]) was adopted for the Evaluation of the Quality of Life in University Campuses. With the necessary adaptations, the following steps were proposed as a framework for the QlC Evaluation model:

a) identify the dimensions to be considered in the evaluation of the QlC;
b) establish a system of weights for the dimensions, through direct inquiry to the users, groups of interest or decision-makers;
c) identify/build the set of indicators that characterises each one of the dimensions considered. This process is essentially based on the judgement of the investigator about the relevance of the indicators, since its adoption is usually conditioned by the availability of information;
d) establish a scoring scale for the evaluation of the indicators, properly normalised, allowing its aggregation;
e) establish a system of weights for the indicators. The weights attributed to the several indicators, inside each dimension, should be essentially based on the judgement of the investigator, due to the specificity of the indicators;
f) establish the indicator aggregation rules, inside each dimension;
g) establish the dimension aggregation rules.

Moreover the identification of QlC dimensions and indicators, users should participate in the evaluation model definition and, periodically, in the monitoring of results. Globally, Fig. 1 describes the sequence followed by the definition, evaluation and monitoring process.

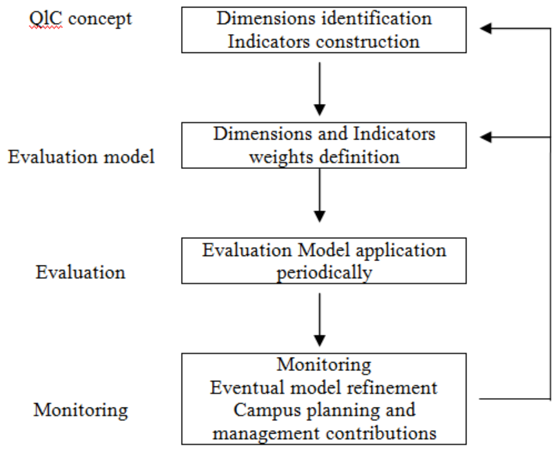

Fig. 1 QlC definition, evaluation and monitoring process

This exercise only makes sense if, besides involving the users, it results in contributions for campus planning and management. For each loop, a report about the "State of the Campus" should be produced, including the indicators evaluation, where it will be possible to identify imbalance and deficit of global quality of life, as well as for each identified dimensions used in the analysis.

2.1.1 Indicators

As the objective was to evaluate and monitor the Quality of Life on campus, five dimensions were identified as appropriate for the study [8]: Environment, Mobility and Parking, Safety, Urban Space, and Services. Then, each dimension was characterised by the construction of a list of relevant indicators for each one. As the list was getting longer, the introduction of an intermediate grouping level was considered adequate: themes were introduced as dimensions sub items, creating smaller groups of indicators (Table 1, adapted from [7]). The inclusion of this new grouping level showed some benefits. On one hand, when listing and selecting indicators to be considered in dimensions characterisation, it helped to better define the extent of the task, delineating sub-contexts of the quality of life to be described. On the other hand, when developing the evaluation process, this layered structure for indicators grouping could also be replicated in tasks to be performed by the users, such as the selection of indicators and weights assignment operations, and even in the calculation process, when combining values to obtain the desired indexes.

2.1.2 Global QlC index

To get a global QlC index, it is necessary to find a way to combine the meaning of the indicators values. The calculation of the global QlC will reflect the grouping structure adopted for indicators. It means that indicators are combined at the theme level, themes indexes are combined at the dimension level, and finally, the global index results from the dimensions indexes combination.

Denoting the standardised value of an indicator *i* of a theme t by x_i^t, and w_i^t as its weight, a theme QlC index (S_t) is given by equation (1):

$$S_t = \sum_{i}^{n_t} w_i^t x_i^t \quad (1)$$

Equation (1) is essentially a Weighted Linear Combination, one of the aggregation procedures available in the context of multicriteria evaluation [11].

A very important component of a multicriteria evaluation model concerns the priorities attached to the various criteria, i.e. the values of the weights in equation (1). The objective of developing weights is to quantify the relative importance of criteria to one another, in terms of their contribution to an overall index.

Using the same approach as for the calculation of the themes indexes, a dimension QlC index (S_d) can be calculated by equation (2), where w_t^d denotes a theme weight and S_t^d a theme QlC index (see equation 1):

$$S_d = \sum_{t}^{n_d} w_t^d S_t^d \quad (2)$$

Finally, the global QlC index (S) is achieved by equation (3), where S_d is a dimension QlC index (see equation 2) and w_d its respective weight:

$$S = \sum_{d}^{n} w_d S_d \quad (3)$$

As indicators are measured in different scales, it is necessary to standardise their values before aggregation, i.e. all values must be reported to a common scale to allow their integration in subsequent operations, for instance, equation (1).

As one of the main purposes of this work is to evaluate the evolution of the QlC, the adopted standardisation process of indicators values is the result of comparing values to be normalised to those of a reference year. So, all the values of the reference year are established as the standard value, in this case the value 100. The values of the year to be evaluated are compared to original values and standardise values are calculated. The evolution of an indicator is measured through the comparison between the obtained standardised value and the value 100 (standard value) . For instance, when an indicator has a positive contribution to QlC (i.e. its value increase also means a QlC improvement), we can say that an indicator as evolve positively in QlC contribution, when its standardised value is greater than 100. If an indicator is classified as having a negative contribution, then its standardised value will be greater than 100 (positive evolution) when its value is smaller than the one from the base year.

To avoid that standardisation could result in virtually infinite values, a limit value to positive contribution should be established. This limit value represents a value that indicates when a maximum positive contribution is achieved, i.e. the standardisation of any value greater than the limit will result in a same standardised value for the limit. For a more detailed explanation, see [7].

Table 1. QlC Dimensions and Themes

Dimensions	***Themes***
(1) Environment	(1.1) Environmental noise (1.2) Air quality (1.3) Waste management
(2) Mobility and parking	(2.1) Campus accessibility level (2.2) Campus accessibility level for handicapped people (2.3) Internal road network (2.4) Internal pedestrian network (2.5) Pedestrian accessibility ratio (2.6) Handicapped people accessibility ratio (2.7) Parking offer (2.8) Public transport (2.9) Service level of the axis campus-city
(3) Safety	(3.1) Crimes in campus (3.2) Campus surveillance (3.3) Fire fighting (3.4) Evacuation exercises
(4) Urban space	(4.1) Functional zoning (4.2) Urban furniture (4.3) Internal signalling (4.4) Campus works
(5) Support services	(5.1) Food and drinks (5.2) Shopping (5.3) Services (5.4) Leisure and culture (5.5) Sports

2.2 QlC System structure

A system containing four major components was idealised (Fig. 2). These components are a database subsystem, a models subsystem, a reports creator and an interface with the community.

The database subsystem includes a database (DB) that stores all the relevant data for the problem, as well as their description (metadata). All data accesses are made through a Database Management System (DBMS). The models database subsystem is dedicated to the management, maintenance and operation of models. It integrates a Models Base (MB) for storage and a Models Management System (MMS) manages the operations on the models base. The reports creator contains all the necessary procedures and tools for the presentation of results, showing the information in tabulate or graphical form.

The interface with the community is a subsystem that allows, in a transparent manner, the interaction and operation with the remaining subsystems. Users can participate in the process and take advantages of the available functions, without however being required extended computer skills. For that reason the interface should be based on a well known working environment and with which computer users are more familiarised: the internet browser was elected. Also with the aim of making the interaction with the system as simple as possible, users should only be asked to do basic actions, such as inserting values, selecting items or clicking on buttons to initiate new actions, tasks that are very common when using a web browser.

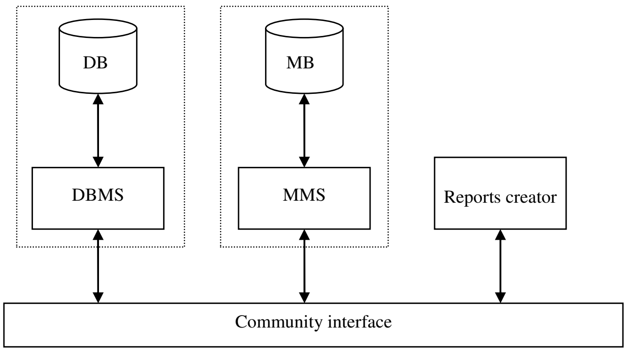

Fig. 2 - Components of the QlC System structure

For that reason, we recommend the inclusion of wizards to simplify and guide users' actions. This is a way of interaction that guides the user through a process. This guidance is done providing, in sequence, the steps that the user should follow. The aim is to reach the end of the task, performing simple actions and also reducing as much as possible users' interventions. The adoption of wizards is considered appropriated in order to turn the system more appealing and accessible to users, for it is a way to promote the community's participation. Another goal of the appliance of this type of interface is also to minimise mistakes when gathering useful and essential information that would result in incorrect subsequent analyses. This is in fact a concern associated to system developed, since one of its critical processes is the collection of individual evaluations from members of the academic community.

3 A case study: University of Minho Campus, Braga - Portugal

The methodology presented in the previous section was implemented and tested as a case study developed at the Gualtar Campus of the University of Minho, Braga, Portugal. The Campus is located in a peripheral area of the city of Braga, and occupies an area of twelve hectares. The community of the Campus has about 13100 users, being 12000 students, 800 professors and lecturers (teachers) and 300 staff employees. The buildings support academic activities, congregate Schools and Institutes, three Classroom Complexes and several buildings for services, such as the Library, the Computational Centre, the Academic Services, the Sports Complex, etc.

3.1 Indicators, themes and dimensions weights

To a panel of 45 students, 8 teachers and 10 members of the administrative staff that intended to represent the different groups of users existing in the academic community was asked to set weights to dimensions, themes and indicators. In Table 2, obtained values can be seen. The Community value is the aggregation of the other three values (groups of users), proportionally to their relative importance. It can also be observed that the several groups have assigned different levels to the dimensions.

Table 2. Dimension weights by users' groups

	Students	Teachers	Staffs	Community
Environment	0.206	0.206	0.218	0.208
Parking and mobility	0.197	0.212	0.194	0.198
Safety	0.206	0.230	0.218	0.211
Urban space	0.181	0.164	0.181	0.179
Support services	0.210	0.188	0.190	0.204

3.2 QlC evaluation scenario

To validate the model and the system, a scenario for 2007 was created. It consists of updating the values of several indicators that intend to reflect possible changes/interventions on campus. The considered possibilities were:

i) installing a new recycling container to improve actual coverage (to reduce the distances) of the campus. It implies the assignment of a new value to indicators total number of recycling containers and total number of recycling containers per hectare;
ii) increasing to 14 the number of daily buses running between the campus and the city centre, from 8am to 8pm;
iii) installing 6 new exterior fire hydrants to reinforce the existent net. The affected indicators are a number of exterior fire hydrants, a number of exterior fire hydrants per hectare and a number of exterior fire hydrants per 1000 m2 of construction (implantation);
iv) planting 50 new trees, trying to improve the physical and natural environment of the campus, the indicators total number of trees and total number of trees per hectare received values that reflect this change;
v) constructing the new building announced in the UMDicas newspaper (published by the university social services), which will include a new sports complex, a cardio-fitness room and a medical centre; it affects several indicators, distributed on more than one dimension;
vi) installing another Automatic Teller Machine (ATM), that could improve the coverage of this type of equipments, namely in the sports complex where the offered services require payments;
vii) increasing the medical support to 10 hours, making it available from Monday to Friday, even for short periods of 2 hours;
viii) improving the wireless network coverage, especially outside buildings that is for now only available indirectly (only when in range of inside buildings network coverage).

3.3 QlC evaluation results

The last step of the quality of life variation evaluation process consists of calculating indexes for each group. This task implies the application of the weights derived from users' participation through the calculation process described in section 2.1.2. Table 3 shows indexes obtained for each campus user group.

As it can be seen in Table 4, the implementation of the evaluated scenario could origin a positive variation of the quality of life for all the groups, i.e. the obtained indexes are all higher than 100 (base value). Presented values do not differ much. This can be justified by the fact that users assigned weights in a quite similar manner. Even short, the biggest difference is found between the students index and teachers one. This gap happened because the teacher group took some different options when assigning weights in comparison to the remaining groups.

Table 3. Quality of life variation indexes by group

Group	Index
Students	107.4
Teachers	108.0
Staff	107.7
Community	107.5

Using the scenario previously described, Table 4 shows how the variation of each affected indicators is numerically translated by the normalisation process. Only these indicators are shown, although the remainders were unchanged, i.e., their normalised value is equal to 100 (reference value).

Table 4. Scenario indicators normalised values

Total number of recycling containers	133
Total number of recycling containers, per hectare	135
Number of daily buses running between the campus and the city centre (8am to 8pm)	121
Number of exterior fire hydrants	143
Number of exterior fire hydrants, per hectare	142
Number of exterior fire hydrants, per 1000 m2 of construction (implantation)	140
Built area (implantation)	98
Built area (pavements)	99
Built area (pavements), per user	99
Percentage of built area	96
Number of trees	108
Number of trees, per hectare	107
Number of ATM	120
Number of ATM, per 1000 users	118
Percentage of wireless network coverage	167
Medical support	250
Area of indoor sports facilities	122
Area of indoor sports facilities, per 1000 users	122
Area of outdoor sports facilities	92
Area of outdoor sports facilities, per 1000 users	92

The system also provides graphical results. Charts show the quality of life variation by dimension. With that kind of representation, it is possible to observe how each dimension has contributed to final indexes. For example, Fig. 3 shows that Environment dimension got a higher value, more than 100 for each group. It means that the QlC variation is always positive, i.e., in any case, this dimension contributed positively to the global index. Looking at the results of each group, we can also see that they were not quite similar, because only the value for the Teachers' group is different.

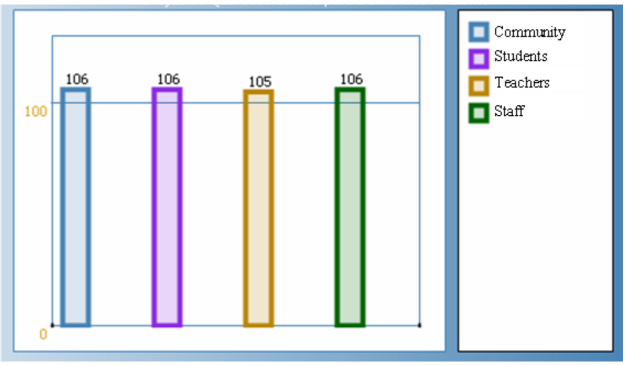

Fig. 3 - Quality of life variation for the Environment Dimension

Analysing the graphs of the other dimensions - see [7], the differences between groups' indexes values, when they exist, were never higher than one positive point. When comparing those values the reference indexes (100), the urban space dimension and the mobility and parking dimension presented a variation which was not higher than one point. The others revealed a more significant variation with a difference of five, six or seven points. However, the safety dimension got results that are beyond those, presenting a variation of twenty-two points for teachers and twenty-three for the other groups.

4 Conclusion

Basically, the presented model aims at determining a global index of the Quality of Life in Campus (QlC) variation, comparing different moments in time. Comparing directly a set of indicators, this index allows us to evaluate how QlC has evolved in general terms. If results are analysed at the indicator level, i.e. studying the variations of each indicator, it is possible to identify which ones have more significantly contributed to QlC variation trend. That kind of analysis can also be conducted to a theme level, as well as to a dimension level. Moreover, each individual participation and a few users' profile data were store in the database, enabling the calculation process of QlC variation indexes by users' groups. In other words, the system's outputs can be used to analyse the quality of life variation profile.

The system also provides another functionality that allows measuring the impact on QlC of future interventions through the creation and evaluation of scenarios (assignment to indicators of new hypothetical values). Providing these functions, the system can effectively work as a decision support tool for campus planning and management, when searching for solutions that meet users needs. Furthermore, as the community involvement is important, a special attention was given to the system's interface design. All required actions were kept as simple as possible and a user-friendly interface was developed, using web browsers as working environment.

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