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## A SYSTEM TO EVALUATE AND MONITOR QUALITY OF LIFE IN A UNIVERSITY CAMPUS

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In Universities, the quality of teaching and research activities is somehow related to the quality of the spaces where they take place, either when considering buildings, including classrooms, laboratories and their support services, or when taking into consideration the campus open spaces, leisure facilities, traffic and parking conditions.

The University Campus users, besides the obvious needs associated with their specific activities, aspire to a healthy and secure environment with a good urbanistic and architectonic quality, appropriated and well located facilities, good mobility and accessibility levels, etc. In short, they aspire to a University Campus with quality of life.

Considering that a University Campus is, or is thought to be, an urban environment, the quality of life in Campi (QvC) conceptualization should follow the adopted definitions for that environment. In spite of the well known difficulties to find a universal definition of quality of life in urban spaces, there is some consensus concerning an approach conducive to its conceptualization. In this context, a quality of life assessment model for the University Campi case is proposed. The model's components, like the indicators, the required data, and on the other hand the multicriteria character of the proposed evaluation model, are discussed in this paper. Its orientation to an implementation and integration within a GIS environment, due to the importance of this support as a basic platform for discussing problems and for developing participated campus governance strategies, is equally addressed.

The proposed approach is tested in a case study carried out in Portugal, where the continuous growing of the university communities has motivated expansions and modernizations of the campi. For this reason, an appropriated Decision Support System for Campus governance was identified as a priority.

## A SYSTEM TO EVALUATE AND MONITOR QUALITY OF LIFE IN A UNIVERSITY CAMPUS

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**Abstract:** Usually considered as an urban space, a university campus is commonly planned and managed under this perspective. For that reason, the conceptualization of the university campi's quality of life (QLU) should fit to the definitions established for this type of environment. Although it is recognized the difficulty to find a universal quality of life definition for urban environments, there is some consensus for the approach to its conceptualization. In this context, this paper presents a model to evaluate the quality of life for university campi. Related topics are discussed, such as the multicriteria frame, the dimensions and indicators, and the data requirements. Furthermore, the methodology is applied to a case, which is the development of an accessibility map for the University of Minho campus.

**Keywords:** Quality of life, University Campus, Public Participation, Multicriteria Decision Making, GIS.

## **1 INTRODUCTION**

In an urban environment, there is a strong relationship between the quality of spaces and their citizens' quality of life. Inevitably, that kind of relation has a strong influence on all the activities developed in that kind of environment. In the case of university campi, the quality of teaching and research activities is somehow related to the quality of the spaces where they take place, either when considering buildings, including classrooms, laboratories and their support services, either when taking into consideration the campus open spaces, leisure facilities, traffic and parking conditions. The university campi users, besides the obvious needs associated to their specific activities, aspire to a healthy and secure environment with a good urbanistic and architectonic quality, appropriated and well located facilities, good mobility and accessibility levels, etc. In short, they aspire to a University Campus with quality of life.

Considering that a University Campus is, or is thought as, an urban environment, the quality of life in Campi (QLU) conceptualization should follow the adopted definitions for that environment. In spite of the well known difficulties to find a universal definition of quality of life in urban spaces, there is some consensus concerning the approach conducting to its conceptualization.

In the following section, the way how the quality of life concept has been defined is described. This concept is important as the base of the model proposed in this paper. The components of the university campi quality of life evaluation model are presented in the third section, describing the followed methodology, exposing the adopted dimensions and indicators and its integration in a decision support system. In the fourth section, an application of the methodology is presented for the case of an accessibility indicator. At last, the fifth section exposes some conclusions and considerations about the model.

## **2 QUALITY OF LIFE**

In spite of having become a common term in our vocabulary, the notion of quality of life has not acquired however a necessary and unequivocal sense (Tobelem-Zanin, 1995). Attempting to define a concept as vast as the quality of life one is, above all, a problem of dimensions and still stays a notion without established borders. This concept should take in consideration social aspirations, as well individual concerns, transport critics and contestations regarding the contemporary society, the conjuncture or the institutions, as well as the community needs and hopes. No consensus in turn of the concept was really reached among authors of the most several nationalities. There is a major hesitation when it concerns to define it as an objective or subjective notion. It happens, in several cases, that the concept of quality of life is confused or assimilated with well-being, life conditions or even living standard without, however, always presenting a valid justification (Tobelem-Zanin, 1995). Many times, the proposed definitions are no more than exhaustive sequence of variables, or indicators defined as objectives (extracted from statistical files previously elaborated without the specific end of its use in the evaluation of the quality of life), or subjective considerations (results of individual psychological inquiries). Using positive qualificatives, the description of any quality of life frequently corresponds to the identification and characterization of individuals or communities privations or lacks. Another quite spread method, consists in defining and evaluating

the quality of life of individuals or groups by the amount of accumulated goods, constituting an objective expression of the subjective satisfaction.

In many countries, like in Canada and in the United States, the quality of life was focus of research of some authors, which have tried to define the sense of the concept. For example, Harland (1972) interprets the quality of life as a synonym of pleasant life, social welfare, social protection and social progress, defining it as the totality of goods, services, situations and states that constitute the human life and that are necessary and desired. He presents the concept as belonging to the domain of the multicriteria analysis, depending on the presence or absence of set of properties.

Jarochowska (1975), geographer, considers that the quality of life is strongly related to the domain of the relationships between the man and his environment. For one individual, the quality can be affected by the existence of a gap between the environmental conditions and the sum of the individual aspirations. The larger is the group of satisfied individuals with their environment, the stronger are the ties developed between the members of the group and the life frame, and better is their quality of life (Tobelem-Zanin, 1995).

Another definition is given by Liu (1975) that conceptualizes the quality of life as a subjective term for the people welfare and the environment where they live. For any individual, the quality of life expresses the wills, translated as needs that, after fulfilled and all acquired, allow the individual to achieve his happiness or satisfaction.

Racine (1986) puts quality of life and welfare concepts in opposite fields: the quality of life expresses the means put in practice by people in their everyday material and social life, and reports most of the time to indicators that mirror material conditions and living standard of a human group; the welfare is, however, a more complex concept, reporting to individuals aspirations and too a more personal evaluation of the set of relationships that the individual maintains with himself and with the exterior.

A study of the Statistics Sweden (SCB, 1987) establishes a difference between welfare and quality of life. The study considers welfare as associated to the living standard and to the conditions of the individual's life (what he can consume, health, social relationships, motivation at work, etc.), while the quality of life introduces extra factors associated to the environment and personal feelings (preservation of the nature, aesthetics, hope in the future, etc.).

Myers (1987) refers that the way as the quality of life concept has been employed in the decade of 1980s became to mean liveability. He presents also the following definition: the quality of life of a community is built by the shared characteristics that the residents experience in places, by example, the air and water quality, the traffic, or the opportunities of leisure, and the subjective evaluations residents make of those conditions.

Expressions like "good city", "good place to live" and "good quality of life" involve conceptual perspectives that, frequently, vary from person to person, from place to place and along the time. From that point of view, the concept of life quality is

essentially subjective, since it depends on the set of needs and aspirations that, if and when satisfied, make an individual happy or satisfied (Bossard, 1999).

The European Foundation for the Improvement of Living and Working Conditions (2003) defines the quality of life in a society as the overall well-being of its members. Well-being reflects not only living conditions and control over resources across the full spectrum of life domains, but also the ways how people respond and feel about their lives in those domains.

For Fadda (2003), the concept of quality of life, in its broader sense, refers to the factors that make life better. The author tells us though that it represents more than individual life standards and relates to all the elements of the conditions in which people live, that is, all their needs and demands.

A common point to the several interpretations of the quality of life concept is always the human liveability of places and its characteristics. In this line, we propose a model which aims to describe and evaluate the liveability of the university campi through the characterization and quantification of quality indicators.

### **3 AN EVALUATION MODEL OF THE QUALITY OF LIFE IN UNIVERSITY CAMPI**

#### **3.1 Methodology**

Mendes (2004), when discussing the different attitudes about the problem of evaluating the quality of urban life, refers that some authors state that it is impossible and should not be attempted to define quality of life for a whole population and for any moment in time. Others, however, consider that the quality of life can be defined and quantified, but it should not be done because measuring such a sensitive concept turns the cities undesirable competitors and drives to deceiving results/conclusions. A third group defends that the evaluation of the quality of urban life can be made since the methodology and statistical base used are clear and used consistently. Although the three approaches denote valid points of view, the author gives a preference to the third one, as it combines a pragmatic view with a will of facing, monitoring and solving urban problems. This was the position of Liu (1975) who defended that the difficulty of the exercise should not stop the efforts to define and measure qualities of life, and to do it in a way that brings relevance to the decision framework of planning.

Some recent works (see Findlay *et al.*, 1988; Rogerson *et al.*, 1989; Brown *et al.*, 1993; Felce and Perry, 1995; Sawicki and Flynn, 1996; Savageau and Loftus, 1997; Cummins, 1998; Bossard, 1999; Mendes, 1999; and Mendes, 2000) suggest conceptual and operational approaches to the problem of the quality of life in urban spaces, that can be synthesized in the following points:

- (i) quality of urban life can be described by dimensions;
- (ii) dimensions rely on livability aspects of the urban space;
- (iii) quality of life dimensions may be described by objective or subjective indicators;
- (iv) dimensions and indicators can be combined in a weighted manner, through the application of different importance levels (weights), on a subjective basis.

When these four points are complemented with a list of indicators describing the



dimensions, the result is a definition for quality of life. Furthermore, in this conceptual/operational frame, different combinations of dimensions and indicators, together with the respective ranks of importance, drive to different definitions, more or less customized, closer or not to the common citizen, or to any social group, or even to any institution. In practical terms, the most sensitive aspect of this way of defining quality of life is the identification of the dimensions and indicators to be considered in the evaluation, extremely conditioned (or driven) by the availability of information or by any particular motivation, preference or objective. Given that objectivity and subjectivity are central and inevitable questions in this process, the details of the model have to be clear as they are the bases for a correct interpretation of the results (Mendes, 2004).

Considering a Campus University as an urban space, its liveability there is very similar to one of a small city, conditioned by many factors, such as the environmental conditions, the mobility, the accessibility to services and work places, and social conditions. In that sense, the methodology exposed by Mendes (2004) is adopted for the Evaluation of the Quality of Life in University Campi which includes the following steps:

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

### **3.2 QLU Dimensions and Indicators**

Looking at the presented methodology, the identification and enumeration of dimensions and indicators of quality of life constitute a basilar step. The indicators which describe each dimension can be organized by themes. This kind of structure provides a clearer organization and a better framing of the indicators. Table 1 presents the indicators themes selected for the five dimensions considered.

### **3.3 Dimensions and indicators aggregation**

Because of the different scales upon which criteria are measured, it is necessary to standardize (or normalize) them before aggregation using multicriteria formulas, and to transform them, if necessary, such that all criteria are correctly correlated with quality of life. A well known score in quality of life evaluation is the so-called z-score, which is a very convenient data form for data sets containing ratio data with sufficient number of elements to enable meaningful calculations of standard deviations.

**Table 1: dimensions and indicators themes**

QLU Dimention	Theme
<b>Environment</b>	Environmental noise
	Air quality
	Waste management
<b>Mobility and Parking</b>	Campus accessibility level
	Campus accessibility level for handicaps
	Internal road network
	Internal pedestrian network
	Pedestrian accessibility ratio
	Handicaps accessibility ratio
	Parking offer
	Public transport
	Service level of the axis campus-city
<b>Safety</b>	Crimes in campus
	Campus surveillance
	Fire fighting
	Evacuation exercises
<b>Urban Space</b>	Functional zoning
	Urban furniture
	Internal signalling
	Campus works
<b>Support services</b>	Food and drinks
	Shopping
	Services
	Leisure and culture
	Sports

Denoting the value of an indicator (i.e. a criterion) for a particular urban area by  $I$ , the mean of the values of  $I$  over all the urban areas under consideration by  $\mu[I]$  and the respective standard deviation by  $\sigma [I]$ , the z-score for the indicator is given by (Mendes *et al.*, 1999b):

$$Score_i = a_i \frac{I - \mu[I]}{\sigma[I]} \quad (1)$$

where  $a_i$  is a variable that assumes the value +1 when higher values of the indicator  $i$  contribute positively to the quality of life, and the value -1 when higher values of the indicator contribute negatively to the quality of life. Defined this way, the score of a criterion is the number of standard deviations that criterion is from the mean for the entire reference area. An extensive use of this concept in quality of life evaluation is presented by Mendes *et al.* (1999a, 1999b), with variations for air quality, water quality, and noise indicators in urban areas.

Once the criterion scores are standardized, they should be aggregated through a decision rule, to form a single index of evaluation. Multicriteria evaluation offers some procedures to combine information from several continuous criteria, namely the Weighted Linear Combination (WLC). With WLC (Voogd, 1983), criteria are combined by means of a weighted average, given by equation (2):

$$S = \sum w_i \mu_i \quad (2)$$

where  $S$  is the final score,  $w_i$  is the weight of criterion  $i$ , and  $\mu_i$  is the criterion standardized score. As criterion weights sum to one, the final calculated score will be expressed in the same scale. WLC allows criteria to trade-off their qualities, which implies that a very poor quality can be compensated for by having a number of strong qualities.

Applications of these aggregation procedures in quality of life studies are numerous in the literature (e.g. Mendes et al., 1999a and 1999b; Savageau and Loftus, 1997).

As most of the adopted indicators for the evaluation of QLU are spatially-referenced, it is quite usual and advantageous to implement the evaluation model within a geographical information system (GIS) platform. The integration of evaluation models based on multicriteria analysis and geographical information systems has been an active area of research since the decade of 90 (see Janssen and Rietveld, 1990; Carver, 1991; and Jankowski, 1995), even to the point of becoming a strong activity of development (Jankowski and Nyerges, 2001). For instance, the software IDRISI includes a module of multicriteria analysis which can be customized to different applications.

#### **4 INTEGRATING THE EVALUATION MODEL IN A DECISION SUPPORT SYSTEM**

The use of a GIS platform for the implementation of the proposed evaluation model provides an easier way to accomplish its integration in a spatial decision support system. Nowadays, GIS gives to its users the easiness to integrate, through several provided tools, complex models of spatial analysis.

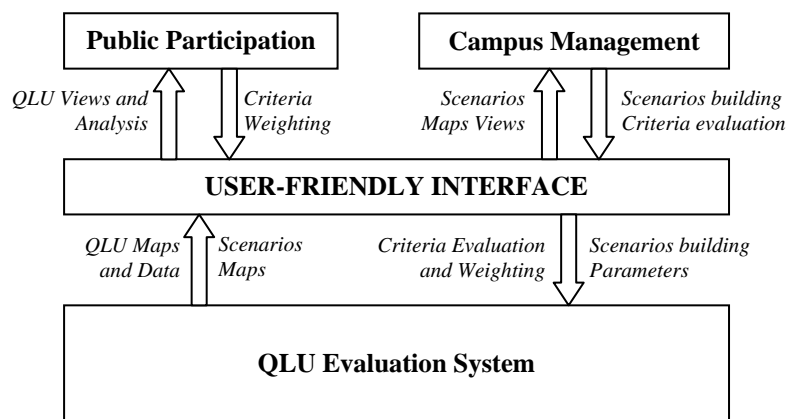
The use of GIS met an expansion in the last decade more accentuated than any other technology of information analysis. The most recent developments were centered in the orientation to the Internet, opening new possibilities for a better access to the spatial information and a respective increase of the benefits resulting from its use (Jankowski and Nyerges, 2001). However, the main focus of the GIS technology focused, in an initial phase, in the creation of generic tools, and easy of use, for spatial analysis and mapping, but lacking the capacity to allow to analyze interests and necessary interactions to support decision-making. For instance, the use of the information and analysis models developed in a GIS can be useful to implement necessary collaborative aspects for planning, such as, direct interviews where citizens may simulate or evaluate several alternatives proposed by the entity that plans and manages the territory. This, among other capacities, like the support of collaborative distributed works on space and time, are necessary to reinforce even more the citizens participation in decision-making, turning more realistic the democratic maxim that those affected by a decision must be allowed to participate directly in the conducive process to that decision (Jankowski and Nyerges, 2001).

Jankowski and Nyerges (2001) refer that spatial decision making problems commonly involve three categories of participants: stakeholders, decision makers and technical specialists. It means that a diversity of participant categories can exist theoretically in any decision problem, and that diversity can include a vast range of levels of expertise, for instance, from novice to expert. Reducing the complexity of a decision problem diminishing the cognitive workload of participants is one of the objectives of implementing collaborative decision support systems. The aim of this is

to provide a more thorough handling to information, by exposing more clearly initial assumptions, facilitating critiques of the information accuracy, and subsequently resulting in participatory decisions more effective and equitable.

The implementation of the proposed model is also considered relevant when there is a monitoring objective. The idea is to provide the means to develop a tool for dynamic evaluation, allowing a permanent consultation of the user community, returning important information for support decision-making.

The Figure 1 describes in a schematic manner how the interaction between non-experts users and the proposed QLU Evaluation System works. The major purpose of the system is to provide a way to dynamically evaluate the campus quality of life. The dynamic adverts from the possibility given to the user community to contribute with his point of view in the evaluation at any time, that is, the evaluation is opened to public participation for an unlimited period of time. On the other side, it constitutes a tool for campus management decision support, since building quality of life scenarios is possible and available for the campus management staff.



**Figure 1: Interaction between users and the QLU evaluation system**

As shown in Figure 1, a user-friendly interface is provided in order to allow users to interact with the QLU Evaluation System. Without this interface, public participation would require people to have GIS skills. Such requirement would obviously conflict, or even compromise, the attempt to open the process to a representative public participation. As a campus management tool, the lack of that kind of interface would probably result in a very deceiving and unattractive tool. Instead, through this interface, the use of all the enabled system capacities is transparent, that is, most of time, the user does not know that he has access to complex tools and operations. In a matter of fact, he really does not need to know that, but only that he has to provide all the asked information to get all the desired results.

## 5 CASE DE STUDY

The described model is being implemented in the University of Minho, in Braga, Portugal. This campus is located in a limitrophe area of the city of Braga. The built and infra structured zone has nowadays an extension of twelve hectares (Figure 2). The campus community is composed by approximately 13100 users, which are divided in 12000 students, 800 teachers and a support staff of 300 persons. The



existing buildings support the academic activity, hosting the diverse Schools and Institutes, three Pedagogical facilities buildings and several services, like the Library, the Restaurant, the Informatics laboratories, etc.

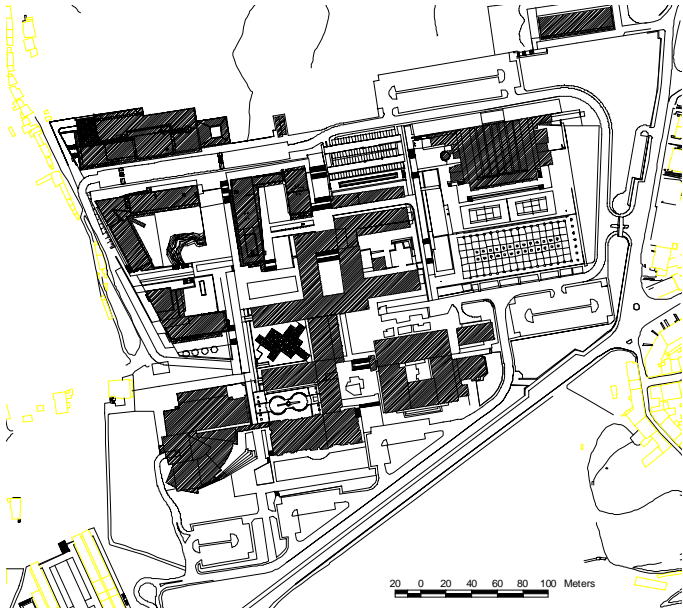


Figure 2: University of the Minho campus in Gualtar, Portugal

The application of the QLU model requires the creation of a database, which should provide the data needed to build the indicators. For instance, Figure 3 presents a map containing the data relative to the indicator - map of the distribution of the accessibility levels measured by the distances to key-destinations. For details on the calculation of the accessibility indicator, see Rodrigues (2001).

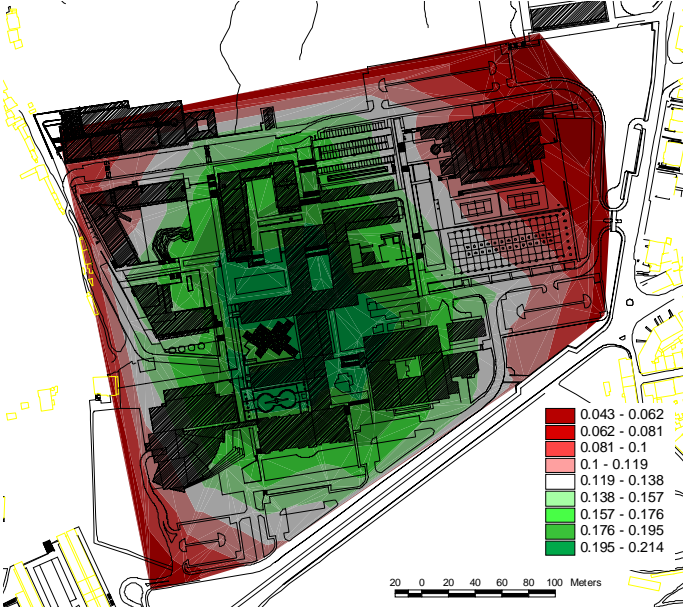


Figure 3: Accessibility levels distribution map

It must be stressed that data availability acts sometimes as a selective criterion for indicators and, in extreme cases, of dimensions. It happens that, in case it is not possible to gather necessary information for some indicator, it will not remain another solution than to exclude it from the evaluation model. At the moment, we are making options concerning the selection of indicators. Before eliminating indicators, field measurements and the use of proxy variables are under consideration.

## 6 CONCLUSIONS

The model proposed is intended to part of a decision support system for university campi planning and management. In this context, the case of study, still under development, will enable the validation of the presented methodology.

The data relative to the indicators, defined to characterize the considered dimensions in the evaluation model, is being gathering into a database within a GIS platform. A relevant question in the implementation is the information availability for the campus under analysis and the establishment of relative importance for the dimensions and their indicators, as a function of the aspirations and motivations of the user community. To promote an active participation and enable the collaborative and monitoring aspects associated to a system of decision support, mentioned in the previous section, the system is being implemented in a web environment. In this way, the system will be able to deliver information, about the QLU dimensions to the campus users, according to their own needs. On the other hand, the decision-making staff will be able to use the system to promote online dialogues with the community, in order to collect its opinions, and therefore to choose and adjust strategies.

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