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Procedia - Social and Behavioral Sciences 223 (2016) 147 – 152

Procedia
Social and Behavioral Sciences

2nd International Symposium "NEW METROPOLITAN PERSPECTIVES" - Strategic planning, spatial planning, economic programs and decision support tools, through the implementation of Horizon/Europe2020. ISTH2020, Reggio Calabria (Italy), 18-20 May 2016

Determination of the Smartness of a University Campus: the case study of Aveiro

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Abstract

This study introduces the reader to a "people centered" and multidimensional definition of the "smartness" of an ecosystem and to its bottom-up detection, that here has been specialized to the case of a learning ecosystem: a university campus. The methodology developed and validated by a European consortium composed by members of the ASLERD – Association for Smart Learning Ecosystem and Regional Development (www.aslerd.org) – has been used to benchmark the smartness of the Aveiro University, Portugal. Actors animating the learning processes and the campus' life – bachelor students, master students and professors – have been asked to fill an electronic questionnaire to detect their perceptions. The quantitative and qualitative data analysis, reported in this paper, allows to identify the overall perceived degree of smartness of the Aveiro University and to highlight actors' expectations on how to improve the smartness of the campus. The "affordance" of a smart territory is also presented and discussed, drawing on recent practices that promote rethinking universities based on the smartness concept.

Peer-review under responsibility of the organizing committee of ISTH2020

Keywords: Campus Smartness; Smart Learning Ecosystems; human-centric design.

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Peer-review under responsibility of the organizing committee of ISTH2020
doi:10.1016/j.sbspro.2016.05.336

1. Introduction

The concept of ecosystem's smartness is acquiring an increasingly interest for university campuses. It is not by chance that new and old universities tend to use more and more the adjective "smart" to define their policies and, more in general, the campus as a whole. However the tendency is to attach, almost exclusively, a top-down infrastructural meaning to the adjective "smart", and to make reference to the Giffinger's indicators used to benchmark smart cities: i.e. smart economy, smart mobility, smart environment, smart people, smart living, smart governance" (Giffinger & Pichler-Milanović, 2007). In the recent past, other models have also been used in attempting to properly describe and, possibly, benchmark smart ecosystems, such as the Triple Helix (Etzkowitz, 2008; Leydensdorff, L & Deakin, 2011) and the three Ts (Florida, 2002) but, regardless of their appropriateness, their popularity has been, so far, quite limited (Giovannella, 2015a).

One of the problems common to all such models is the lack of strategies suitable to make emerge the relationships between the "infrastructural smartness" of the ecosystems and the human dimension.

A similar problem affects also all procedures that have been developed up to now to rank Universities, see the critical analysis presented in Giovannella, (2014) and *Global University Rankings Impact - Report II*, (2013). University rankings, in fact, do not consider in the underlying evaluation processes the perceptions of the university's actors: bachelor students, master students, professors, etc. -

To progress toward the inclusion of the human dimension one may consider another definition of smart territory: "a digital infrastructure within the physical city to improve, among other aspects, environmental impact, quality of life and economic growth". (Jensen, Michael ; Gutierrez, Jose; Pedersen, 2014) that integrate human, technological and institutional dimension and, as well, refer to the paper by Taewoo & Pardo, (2011) that promotes a conceptual shift by introducing the relevance of meanings in real interaction contexts.

Shifting the focus on campuses, to better understand the relationship between their smartness and the human dimension one may refer to various studies published by (Abuelyaman, 2008; Jensen, Michael ; Gutierrez, Jose; Pedersen, 2014; Jucevicius, Robertas;Patašiene, Irena;Patašius, 2014; Streitz, 2011). However to make fully emerge the human dimension and put in relationship territories and campuses we need to move some steps forward: we need to elaborate a definition of *smartness* and a benchmarking framework that can be adapted to investigate any kind of ecosystems, included those of our interest.

Everything that will be presented in the following make reference to definition of smartness given in (Giovannella, 2015b):

"*a smart context is a context where the human capital (and more in general each individual) owns not only a high level of skills, but is also strongly motivated by continuous and adequate challenges, while its primary needs are reasonably satisfied*, i.e. those placed at the lower levels of the Maslow's pyramid ".

Starting from this definition a new bottom-up benchmarking approach, based on Maslow's motivational theory (Maslow, 1943) has been designed and described in (Giovannella, 2015b). To follow a questionnaire has been developed and adapted to monitor the smartness of territories, schools and universities. While referring the reader for a detailed description to previous publications, here we resume briefly the procedure that has been developed. First internal and external elements composing a learning eco-system - infrastructures, services, social life, challenges, skills, etc. - and data typologies (subjective and objective, qualitative and quantitative) have been mapped onto the Maslow's Pyramid of needs, slightly redefining its inner layers. Afterwards, using such mapping as guidelines, a questionnaire aimed at collecting the opinions of all actors operating within a learning eco-system have been elaborated to collect both numerical indicators and textual opinions on all levels of the Maslow's pyramid of needs and, as well, parameters strictly related to the achievement of the state of flow (Czisikszentmihalyi M. 1990).

The questionnaire is available as part of (Giovannella, C; Andone, D; Dascalu, M; Popescu, E; Rehm, M; Roccasalva, 2015) and has been validated recently by investigating the degree of smartness of six European universities. In the following we report on the application of this method to the Aveiro University that allowed to compare this latter with the others investigated previously and to detect the feeling of the local actors on how it would be possible to achieve a higher level of smartness in the campus.

How individuals whish the campus to be transformed? How can technology improve quality of life in the campus ?

These are some of the questions that one may wish to answer and the analysis of the questionnaire's outcomes demonstrates how the feeling of the actors can be transformed in a collective fresco capable to make emerge problems, opportunities, wishes and expectations.

2. Data collection, results and discussion

The questionnaire was pre-validated by the local campus research coordinator. Observations were collected and the questionnaire adapted accordingly to the coordinators' requests. Once a full agreement was achieved, the final version of the questionnaire was made available for anonymously filling through an instance of the LIFE on-line environment (LIFE).

The questionnaire was announced and distributed by email to all the university's functional and organic (departments and schools) units. This email got delivered to each unit's stakeholders (teachers, students, researchers, non-teaching staff) after having institutional clearance from the departmental Dean or functional unit Director.

The questionnaire was answered by 122 people: 30 bachelor students, 33 master students, 38 professors and lectures, with the rest of participants belonging to other categories. In (Galego, Giovannella, Mealha, 2016) it has been shown that the various categories of "actors" have a slight different perception about the level of smartness of the campus. Because of this, in order to make data comparable to those collected by other universities (Giovannella, C; Andone, D; Dascalu, M; Popescu, E; Rehm, M; Roccasalva, 2015), we have considered and summed up only the answers given to quantitative questions by bachelor and master students. The outcome is the set of 10 numerical indicators reported in Table 1.

Table 1 Mean values of indicators extracted from the answers to the close quantitative questions given by bachelor and master students. Scale ranges between 1 and 10. In brackets are reported the standard deviations.

Indicator/University	**All**
Infrastructure	7,34 (0,22)
Food services	7,56 (0,24)
Environment	7,65 (0,25)
Info/admin services	6,77 (0,23)
Mobility	8,60 (0,21)
Safety	8,56 (0,17)
Support to social interactions	7,65 (0,21)
Satisfaction	7,38 (0,21)
Challenge	7,58 (0,21)
Self-fulfillment	7,48 (0,20)

As shown previously (Giovannella, C; Andone, D; Dascalu, M; Popescu, E; Rehm, M; Roccasalva, 2015) this set of indicators (that are related to different aspects of the learning ecosystem) are affected by relevant internal correlations that have to be carefully investigated. It can be done by using data collected from many different learning ecosystems. The goal of the investigation is to identify an adequate space of representation characterized by a reduced number of dimensions (indicators) showing the lowest degree of correlation. Thus, we have integrated the numerical values reported in Table 1 which those reported in (Giovannella, C; Andone, D; Dascalu, M; Popescu, E; Rehm, M; Roccasalva, 2015) and studied the correlation matrix of this integrated set of numerical indicators.

After the removal of the indicators that gave rise to stong correlations ($R > 0,7$) we were left with a reduced space of representation composed by the following indicators: – *Environment, Info/Admin services, Infrastructures, Satisfaction and Challenges*. *Safety* and *Mobility* have been dropped because they show important correlation with quite a large number of other indicators while *Support to social Interaction*, *Self-fulfillment* and *Food services* have been dropped because strongly show strong correlation, respectively, with *Challenge, Satisfaction* and

Environment.

Figure 1 Residual correlations among the subset of 5 indicators.

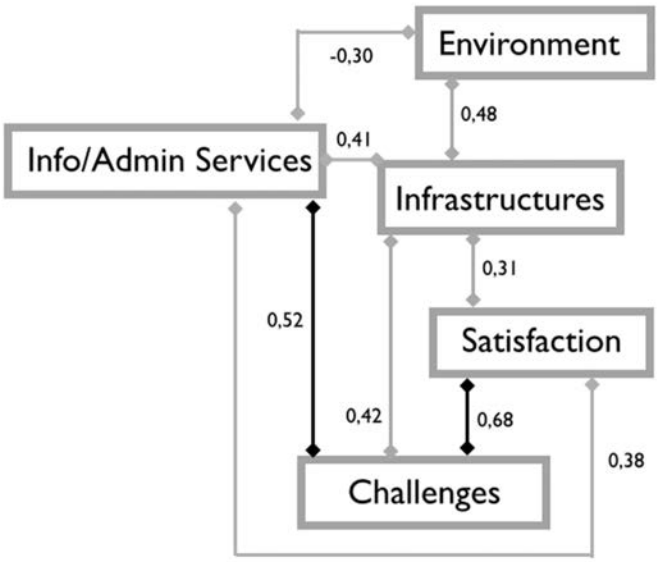
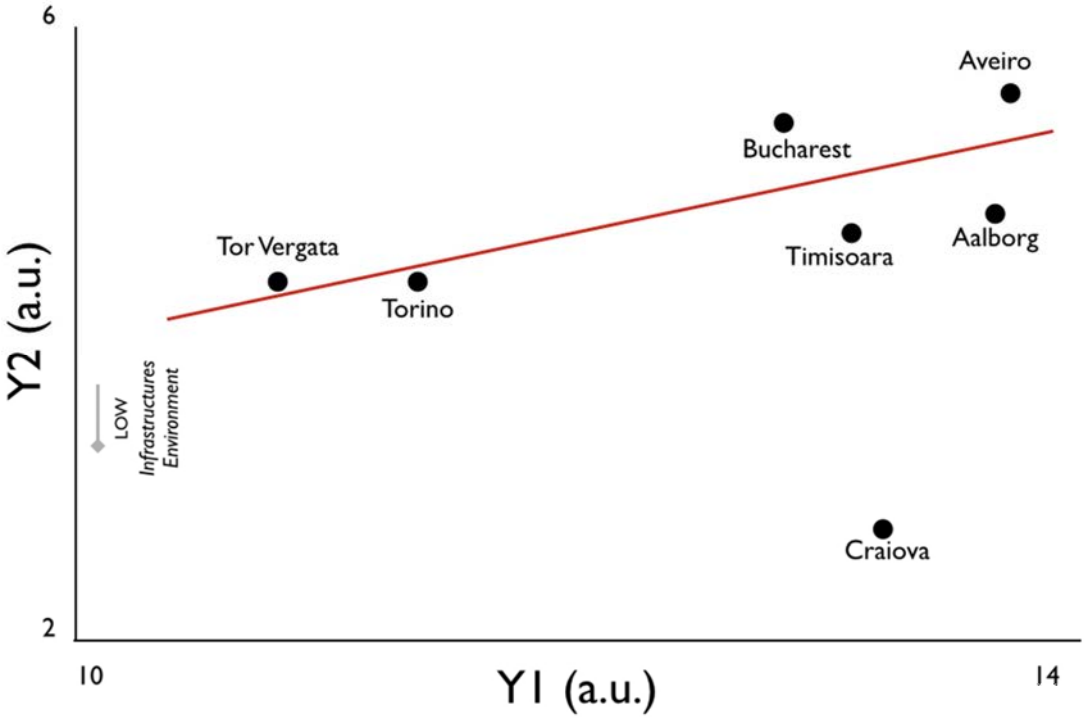


Figure 2 Positioning of the universities on the plan identified by the two principal components, Y1 and Y2, derived from a PCA applied to the reduced set of 5 indicators shown in Fig. 1. The red line, as explained in the text, represents the axis of "smartness"



Since it is almost impossible to select a subspace of fully independent indicators, we applied a Principal Component Analysis (PCA) (Jolliffe, I.T; 2002) to the 5-dimensional space of the survived indicators to obtain an orthogonal space of representation. The first two principal components derived by the PCA carry around 76,5% of the initial information and have been used as basis to generate Fig. 2.

By inspecting the contribution given to the principal components by the 5 indicators composing the original space of representation we can observe that, much the same as in (Giovannella, C; Andone, D; Dascalu, M; Popescu, E; Rehm, M; Roccasalva, 2015), the indicators *Infrastructure, Info-Admin Services*, *Challenge* and *Satisfaction* are strong contributors to higher Y1 values. In other words Y1 put together *basic physical* indicators like *Infrastructure and Info-Admin Services* with the those related to the highest human needs (see Maslow's Pyramid). The indicator *Infrastructure,* however, contributes also to increase the positive value of Y2 together with the indicator *Environment*.

Therefore the universities that performs at best on all indicators tend to place at the top right of the plane of representation. Accordingly we can draw the linear regression (in red) from Fig. 2, which represents the *axis of smartness* and increases with both Y1 and Y2.

As shown by Figure 1, the University of Aveiro is characterized by a very high level of perceived smartness to which contribute mostly the opinion of the bachelor students, as discussed in (Galego, Giovannella, Mealha, 2016). In that papers we have presented also a detailed text analysis of the answers given to the qualitative open questions. Although it is beyond the scope of this paper to get into such details, nevertheless it is worthwhile to note that students tend to have a very positive feeling about the Campus experience when they are novices (bachelor students) while start to be more critical with time. In fact, master students are much more concerned about unsatisfactory or old infrastructures (e.g. WI-FI connectivity, studying areas for students, old computers or lacking of parking slots for bikes), crowded canteens and waiting time in the queue, insufficient containers to operate a separate waste collection, etc. Bachelor students, on the other hand, tend to detect immediately problems related to the access to info, to cumbersome administrative procedures and to the planning of lectures that might generate problems when the building are far away or when the local signage system is not efficient and/or explicit enough. In general all categories of students wish a higher support to practical activities, to networking with productive activities and to exchanges. Moving from bachelor to master students' requests become more detailed (activities oriented to skills acquisition, practical challenges, etc.) and change in nature (more internships/scholarships, more opportunity of internationalization, etc.)

These few considerations demonstrate once more the relevance that human feeling have in the determination of the level of smartness of a University campus. Understanding feeling, wishes and expectations offers a better diagnosis and better opportunities to plan the transformation of a campus in a smart campus, much more focused indications that those provided by any University ranking. The method described in this work, in fact, allows to highlight key aspects which need institutional consideration to integrate citizen consciousness in a public place, in this case the academic place, the heart of a future-aware city. A certain amount of the observations requires changes in policies but many others provide useful indications to design and implement technology mediated solutions. All them, contribute to describe the "smartness" of an ecosystem that should be capable of nurturing needs, wishes and expectations that emerged.

Smart social structures tend to be highly dynamic, e.g. people at the campus of Aveiro have a proximity option of walking to university. Many people prefer to eat in the canteen, because it is cheaper and the food has a good quality. The fact of having a canteen, pathway, library, etc., does not classify the smartness of a campus, but the installed services and technologies characterize the usefulness of this space.

What should be considered "affordant" in the smart territory? How technology can efficiently assist those living on campus, in the city, at home?

One cannot answer to these questions by considering only infrastructural indicators or installed technologies. This is why one needs to implement a new evaluation model, where the person's motivations and needs are the most important. The method developed by one of the authors (Giovannella, 2014, 2015a, 2015b) represents, indeed, an innovative approach to map a human-centered, stakeholder-driven perspectives of the smartness of learning in an ecosystem, towards optimization of human usage of the ecosystem. An affordant smart ecosystem is one that is able to offer technology mediated solutions which are personalized for each individual's needs and to foster adaptable learning solutions based on new needs or to change environment elements, services or infra-structures.

3. Conclusions

This work can be considered a step forward the development of an empirical methodology to better understand the meaning that should be attached to the adjective "smart" when is used to describe campus or other learning and territorial ecosystems; and this has been done bottom-up, by involving the human actors of the place and asking them about how to improve the conditions for all people "living" this place.

The results of this study have revealed that although the indicators depend of contextual factors and on the category of actors considered, nevertheless it is possible to identify a regression line representing the smartness of an ecosystem that can be used to compare the campuses among them.

The method used in this study integrates a holistic and systemic vision to investigate concepts of context-aware feeling and perception in a smart campus context. A method that challenges individuals to reflect on many characteristics of the campus and many different activities. In other words, a method that helps to make emerge the smartness of the campus together with the holistic relevance of the human dimension in determining it. The complexity of the qualitative data that have been collected requires a much more detailed and contextualized analysis that is underway and will be published in the near future.

At this moment, the biggest challenge it to understand how to involve the human dimension in the effective design of the technology mediation to improve the quality of life.

Acknowledgements. This study integrates a master's dissertation and was partly supported by DGES – Diretoria Geral do Ensino Superior from Portugal and the Erasmus Plus European interchange program.

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