















**Fig. 5.** Positioning of the different categories of players on the plane identified by the two principal components, Y1 and Y2, derived from a PCA applied to the reduced set of the four indicators: *Infrastructure, Environment, Safety and Challenge*

To have a better insight on the difference of the perceived level of smartness we have analyzed the texts of the open answers looking first at the occurrences of the words that have been used and then, when needed, by direct inspection of the answers. Table 2 shows the outcomes of such analysis that seems to confirm the conclusions derived by the analysis performed on the quantitative answers. As far the *safety*, in fact, bachelor students did not detect any problem and professors pointed out few problems that appear less relevant with respect to those described in more details by master students (that, for example, may have suffered bicycle robbery during their longer stay in the campus). As another example, if we look at the indicator *challenge* we observe that bachelor students wish to have more exchange opportunities and contacts with companies, while master students are more concerned with the lack of a sufficient number of internships/scholarships and hope for stronger support to internationalization. Professors are complaining with the present level of international exchange too, but also with the lack of adequate information and support to the exploitation of potential opportunities. They also invoke a more adequate appreciation and valorization of the efforts done in exploiting opportunities and in promoting advanced didactic activities. To assign the right weight to the above

concerns, however, we have to stress again that on average only about 30% of the participants answered to the open questions. They are thus representative of about one third of the sample, although in reasonable agreement with the outcomes of the quantitative analysis.

Many other interesting issues emerged from the analysis of the texts but their detailed discussion goes beyond the aim of the present work and will be left for future comparative analysis that will involve several European Campuses. Some of them, however, will be dealt with in the next paragraph to show how the outcomes of the bottom-up approach used in this study may also serve as a starting point towards the design of a process aimed at increasing the university's smartness.

**Table 2.** Keywords and topics emerging from the analysis of the texts of the open qualitative answers. In brackets the occurrences, after the colon specifications of the keywords.

Indicator/University	B students	M students	Professors/Lecturers
<b>Infrastructure</b>	poor WI-FI connectivity (2); lack of socialization and studying rooms; <i>wishes</i> : luggage storage service; microwave oven; minimarket;	poor WI-FI connectivity (11); unsatisfactory studying places (5); noisy classrooms; old computers (3) & equipments; building maintenance (2); heating (4) <i>wishes</i> : better library (5); bike (4: slot to park, university service); grocery	buildings (4: maintenance, noise), not well equipped classrooms and labs (6); bathroom maintenance; no socialization spaces: poor wifi (2) <i>wishes</i> : parking places (car and bike); walking pathways; pharmacy and minimarket
<b>Food services</b>	queue (2: canteen)	canteen (6: crowd (2), waiting time, noise) bar (expensive & not healthy)	canteen (2, slow, distance, queue), bar (not good quality), restaurant (3: expensive, healthy (2), hot meal)
<b>Environment</b>	poor separate waste collection; green area maintenance	waste/garbage (9): poor separate waste collection (6), insufficient N. of bins/containers (9); too many cars, lack of park seats, few parking slots for bykes	bins (4: insufficient number); paper (4: no separate collection); recycling (more organization, more information) waste/litter (5: poor separate waste collection, no action plan); energy (2: more attention to consumption); smoke (2): lack to reserved place to); green area (3: not just grass, maintenance);



Indicator/University	B students	M students	Professors/Lecturers
<b>Info/admin services</b>	no clear information on admin procedures and website (4); poor organization, long waiting time and customer care (3)	no clear information on admin procedures and website (6); unsatisfactory services (6: slow, lack of ticketing service, customer care, lack of mobile application)	no clear or not updated information (3); lack of process tracking; poor support by technical services; lack of cloud services
<b>Mobility</b>	internal distance because of rain; signage/orientation; pavement maintenance	buildings (8: internal distances & timetable, signage, raining weather, speed of bikers) campus/ university (3)/ department (2)/ classrooms(5); missing signage & maps	buildings (7: distance, rain (6), wind(4)), bike: secure and protected parking slots & infrastructures), respect of pedestrians by car drivers, signage (2) architectural barriers (ramps/stairs)
<b>Safety</b>	nothing detected	night/dark (7) lack of guards (2) robbery (2: bikes); no security agents; camera in some areas; drug sellers	lack of security information/awareness (2); lighting at night (3), need security agents at night; fire alarm disabled
<b>Support to social interactions</b>	access sport facility	poor support to internationalization and networking (4: enterprises); poor student integration(2), scarce cultural activities	poor support to socialization and no action plan; lack of opportunities and dedicated spaces
<b>Satisfaction</b>	<i>wishes</i> : more practical activities; better networking with productive realities (2); ability to listen	<i>wishes</i> : more practical activities (3); more useful didactic content also skill oriented (2); more internships (2); more Erasmus opportunities	<i>wishes</i> : less admin tasks (3); more transdisciplinary interaction (4); more international R&D and educational initiatives; better networking (companies) recognition of efforts (2); reduced teaching load;
<b>Challenge</b>	poor support to exchanges (2) and tweaking with companies	scarce N. of internships/ scholarships (3); poor support to internationalization; low productiveness	poor support to trans-disciplinary internationalization; poor support to exploit opportunities; lack of recognition

Indicator/University	B students	M students	Professors/Lecturers
<b>Self-fulfillment</b>	<i>wishes</i> : involvement in working experience & innovative teaching	<i>wishes</i> : more workshops (3) & practical challenges (3); more cultural initiatives	<i>wishes</i> : stronger support to participation in projects and conferences (2); clearer internal communication; more international exchanges and collaboration; more opportunities for training and personal development; support to innovative teaching; more adequate working loads
<b>Housing</b>	cleaning (2), noise (2); heating; safety	expensive or small flat/ room (10); poor appliances (3); poor internet connectivity (2); noise (2); relationship with owners (2)	

#### 4 Toward a Design for “smartness”

According to the definition of smartness that has inspired the bottom-up approach used in this study (see par. 1) the smartness of an ecosystems should be interpreted as the ultimate goal of an on-going process rather than a static attribute of an ecosystem. Being the goal of such transformative and resilient process it has necessarily to be supported by a design process.

The questionnaire used in this work, as shown in the previous paragraphs has been designed not only to provide numerical landmarks for benchmarking (see Table 1) but also to support the problem setting phase included in the *investigation* layer and of the “organic” process of design, an experience based one [13,14]. Table 2, in fact, offers to the designers a reach set of indications on how to put in place a process to step towards the campus’ smartness.

The most evident request is for on-line technologies, possibly available also on smart phone, that from one side may facilitate the access to local services to optimize processes, and from the other offer mentoring and act as facilitator. Actually a mobile application is already available for free, fig. 6: UA Mobile [15], but accordingly to the outcomes of the questionnaire there is room for improvements to optimize one of the most important individual resources: time. Indeed it should help to reduce the time spent in the queues (to take the lunch or to access administrative services) and, because of this, should offer a reservation and ticketing facility to be complemented by a process tracking (i.e. to track the status of the queue or the progress of the administrative procedures). With reference to meals, the application could also offer

the possibility to choose the meal to enhance customer satisfaction and optimize the consumption of food resources (also to reduce waste production and to help in programming the provisions) and, as well as, “home” delivery (at university buildings) for those that have no time to move to the canteen. This latter service should be accompanied by the identification of spaces suitable to favor social interaction and sharing, spaces that may also help to solve the problem of “not soundproof” canteens and that may be equipped with appliances such as microwave oven, fridge, coffee machine, etc.. In particular, some of such spaces could be positioned to favor contacts among people working in different domains (to foster inter-disciplinary exchanges with a reduced loss of time). Integration and exchanges could be favored also by the design of socialization corners - maybe having different and integrated functionalities - that could be placed in the park surrounding the university buildings.



**Fig. 6.** Screenshot of the homepage of the UA Mobile app.

Also connected with time saving is the request for an optimized time-table and usage of the lectures' halls, to reduce walking distances and transfer time from one lecture to the next, also to mitigate the trouble that may be provoked by possible rain falls. The minimization of the commuting time could certainly be also supported by a more efficient outdoor and indoor signage system that should be offered not only in electronic form (more relevant for last minute changes) but also as physical evidence of the location of buildings, halls, bureaux, etc.

Still related to time saving is the possibility to improve the mobile app with geographical positioning information on available parking slots for car or bicycle that

introduce the interplay between mobile application and the physical computing: i.e. sensible parking area. Expectations by bikers, however, are more structured: e.g. the increase of secure parking slots (to limit bike thefts) and the separation between walking and biking paths (to allow for quicker transfer and protect pedestrians). Still on bikes: another possible action could be the offer of an internal (to university) service to borrow bikes when people wish to minimize the transfer time. Similarly a RFID/NFC based service could be offered to borrow umbrella to mitigate the problems caused by sudden and unexpected rain falls.

As far as the facilitator role of the technology, the UA mobile application is expected to promote and support social interaction (and related action planning) and student integration, internationalization and territorial networking (i.e. to facilitate internships, job placement and career development).

The application could also be improved to include service evaluation, support to social recognition for the efforts done in favor of the university, but also to improve clarity and correctness of information about all services and administrative procedures offered by the university. Moreover it could possibly offer access to open data and, why not, to offer a mediation on occasion of house renting (to prevent student discrimination, help to keep the cost of the flats at a reasonable level and support trusted relationships between students and owners).

On the physical computing side the “well being” of all actors and the smartness of the campus could be further increased by implementing luggage self-storage services, a system of intelligent light systems in the park. To preserve the environment, finally, the participants advocate the implementation of an efficient system for separate garbage collection that, in principle, could be supported by automatic detection of the filling levels of the bins and by gamification strategies to foster social responsibility. Also related to the environment preservation is the request to distribute detectors of light consumption that could provide also open access data and produce public evidence within the campus through dedicated signage.

The request for a wider wi-fi band and for the availability of better technological equipments for the classrooms/labs are, to some respect, trivial because related to the improvement of basic infrastructural resources that do not demand for relevant and creative design interventions.

## **5 Future Developments**

Being this the first work that reports on differences in the perception of the campus' smartness by the actors animating the educational process, the next step will be to compare the outcomes of this work with results obtained by similar investigation performed on other campuses. A second direction of investigation is represented by a comparative study on the perception of the city's smartness to foster the emergence of possible correlation among the smartness of the Aveiro University and that of its

territory of reference. A third possible path of research is the application of the same method to detect the perceived level of smartness in other local learning ecosystems like the schools (K12 and High schools). Finally an additional direction is represented by the development of the design process to produce detailed concepts and the improvement of the applications sketched in the previous paragraph to support the realization of a Smarter Campus in the Aveiro University.

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