



AUGMENTED REALITY FOR CO-DESIGN: THE PERSPECTIVE OF REAL ESTATE DEVELOPERS, ARCHITECTURAL FIRMS, AND PUBLIC ADMINISTRATIONS

Piga, Barbara E.A. ^{1*}; Boffi, Marco; Rainisio, Nicola; Stancato, Gabriele;

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Abstract

The paper focuses on the design and development of an Augmented Reality (AR) app for public participation in urban transformations. The project, named "AR4CUP: Augmented Reality for Collaborative Urban Planning", is part of H2020 EIT Digital (Digital Cities) and involves the Augmented Reality company *Artefacto*, the university *Politecnico di Milano*, the research center *VTT*, and the Real Estate Developer Company *Covivio*. The project began in January 2019 and will end on December 2019. A pilot case study application will be carried out at the end of 2019 on an urban transformation project in the south of Milan (Scalo di Porta Romana), namely the design project VITAE, developed in the frame of the C40 Reinventing City.

The AR4CUP project is organized in four main parts: analysis of customer's needs, development of the methodology for studying people experience in place, app design and implementation, pilot case study application with final users. The paper addresses the first phase. The AR4CUP AR app is able to: (i) show, directly on-site, urban and architectural proposals geolocated in real dimensions; (ii) gather citizens' emotional reactions to proposed urban transformations; (iii) automatically analyze the collected data; (iv) represent the outcomes of the analysis. The main customers of the app are Architectural Firms, Real Estate Developers, and Public Administrations, while the main target is citizens living in the area and future inhabitants, i.e. dweller and city users. The app contributes to (a) inform clients on citizens' perception on their design project, which might impact on its development; (b) inform and involve citizens in the urban transformation, enabling them to potentially play an active role in the decision-making process.

The app aims at facilitating the collaboration among citizens, stakeholders, and public administrators, to induce a virtuous process that contributes to the co-creation of the future of cities. Such a tool allows to: (i) inform citizens about design projects; (ii) represent subjective points of view and compare the overall people perception of design outcomes to designer/developer/administrators' expectations; (iii) support negotiation and decision-making of public administrations and private companies in the urban design and planning field.

The focus of the paper is the first phase of the AR4CUP project, which was dedicated to interviewing relevant stakeholders, i.e. Real Estate Developers, Architectural Firms, Public Administrations. The goal was to explore the needs of potential customers of the app, identifying practical and conceptual issues useful to develop its functionalities. We used semi-structured interviews for gathering information about: (i) their current workflow; (ii) the main key actors they interact with during the design process; (iii) the crucial technological solutions currently adopted for showing design projects to laypeople; (iv) how they envision the advantages that the AR4CUP app could generate in their field. What emerged from the interviews to professionals is a diffuse concern about the effectiveness of AR apps currently on the market as design and representation tools. This distrust seems to be induced by two main issues: (i) low quality of AR representation (details, quality of textures, reflections, shadowing on the virtual elements, and similar), that might lead to an undervaluation of the final project features; (ii) lack of the so-called "dream effect" due to the representation realism, that might negatively affect marketing strategies. Positive aspects of AR also emerged from the interviews, namely: (i) playful engagement of citizens directly on-site; (ii) simultaneous involvement of many citizens or other stakeholders.

More generally, the expectations about this new app follow the idea that experimenting 3D interactive model in AR is a useful tool to involve people in urban decisions. In the AR4CUP app, users' interaction can take place without requiring

¹ Politecnico di Milano, <https://orcid.org/0000-0003-3694-4583>; ² Università degli Studi di Milano, <https://orcid.org/0000-0002-8328-9270>; ³ Rainisio Nicola, Università degli Studi di Milano, <https://orcid.org/0000-0001-9846-9250>; ⁴ Stancato Gabriele, Politecnico di Milano, <https://orcid.org/0000-0002-7061-4935>; *Contact e-mail: barbara.piga@polimi.it



specific skills since every task is designed to be friendly and enjoyable; this will contribute to widen the audience and potentially lead to more informed design decisions. The app is not meant to function as a mere communication of the final design solution for marketing purposes, but is a means to anticipate the urban experience for design purposes. With this goal, the project develops an app based on the use of experiential simulation coupled with a psychological assessment for anticipating people's reactions to urban transformation projects. Through this collaborative process citizens provide their point of view on design projects to developers, architects, and decision-makers; in so doing, they become an active actor in the transformation process, and this contributes to citizen's empowerment.

Key words: Augmented Reality; Co-Design; Psychological Assessment

1. Introduction to the AR4CUP European Project

The “AR4CUP: *Augmented Reality for Collaborative Urban Planning*” project (later AR4CUP) is part of H2020 EIT Digital (Digital Cities) funding program and involves the Augmented Reality company Artefacto, the university Politecnico di Milano (POLIMI), the Technical Research Center of Finland VTT, and the Real Estate Developer company Covivio. The main outcome of the European project is the AR4CUP app, an Augmented Reality (AR) app with a double scope: (i) the proper visualization of urban design project on-site through smart devices, and (ii) the collection and analysis of people feedback on urban design projects. The potential customers of the app are: Real Estate Developers, Architectural Firms, and Public Administrations; nevertheless, other subjects might be interested in the solution, e.g. civic association. Final users of the app may vary according to the needs of the customer, and they might be citizens, tenants or other specific stakeholders.

The overall EU project is the result of the hybridization of different scientific domains, mainly: Computer Science, Architecture, and Social and Environmental Psychology. The project began in January 2019 and will end on December 2019 with the pilot case study application on the urban design project VITAE by Covivio (Real Estate Developer), Carlo Ratti Associati (Architectural Firm), the nonprofit organization Habitech (center for green building, renewable energy and innovation), and other partners, including Politecnico di Milano (Department of Architecture and Urban Studies - Laboratorio di Simulazione Urbana Fausto Curti). VITAE is one of the winning projects of the Reinventing Cities² competition by the C40 Cities Climate Leadership Group³ for the redevelopment of an urban zone in Milan, namely the Serio area⁴ in the Porta Romana district in the south of Milan (Italy).

The AR4CUP project is structured in four main parts: (i) analysis of customers' needs through semi-structured interviews, (ii) development of the app methodology for studying people experience (iii) design of the app functionalities and their implementation, (iv) pilot case study application with final users during the final event for testing the product. The AR4CUP app can: (i) show, directly on-site, urban and architectural proposals geolocated in real dimensions; (ii) gather citizens' subjective reactions to the proposed urban transformation; (iii) automatically analyze the collected data; (iv) represent the outcomes of the analysis.

As an urban planning smart tool, the AR4CUP app should be oriented towards medium and large urban projects since the real estate investment and the impact on the urban context (from the

² Reinventing Cities | Reinventing Cities. (n.d.). Retrieved 12 September 2019, from <https://www.c40reinventingcities.org/it/>

³ C40. (n.d.). Retrieved 12 September 2019, from <https://www.c40.org/>

⁴ Serio | Reinventing cities sites | Reinventing Cities. (n.d.). Retrieved 13 September 2019, from <https://www.c40reinventingcities.org/en/sites/serio-1273.html>



physical and social point of view) is relevant, and the number of actors involved (directly and indirectly) by the urban transformation is high. These urban projects often consist of new urban settlements or redevelopment of degraded areas inside the existing city. These projects include private settlements (e.g. residence, commerce, office, entertainment, etc.) and public spaces, making medium and large size urban projects generally quite complex and articulated, and then not easy to envision as a whole by laypeople. In European countries, the size of small\medium\large urban projects are not formally defined. In any case, medium urban projects have a Gross Land Area (GLA) between 5,000 and 15,000\20,000 square meters, while large transformation projects have a GLA bigger than 20,000 squares meters. The building site of the case study application VITAE is an urban void of 5,000 square meters, currently used as a parking area, that will be redeveloped as an ascending public space where “[...] people who stroll through this green spiral can pass close to a series of terraces and greenhouses for urban farming and hydroponic cultivation”⁵. This design solution represents a proper pilot application for assessing the effectiveness of the AR4CUP app from the developer perspective and for engaging citizens in the urban redevelopment.

The combined approach of Architecture and Psychology is the basis for the development of a smart tool able to pre-assess people experience of urban design projects. The collaboration of the two disciplinary perspectives was particularly useful for structuring the: (i) *Preliminary analysis*: we developed a series of interviews to deeply analyze the non-explicit needs and the explicit demands coming from the market in the Real Estate field and from Public Administrations, i.e. future customers and stakeholders; (ii) *Methodology design and development*: we selected constructs and designed calculation procedures aimed at operationalizing the complexity of the urban experience and transforming it into useful information for a broad (and often non-technical) audience.

This paper presents the logic and main outcomes of the first phase of the European project, that is focused on understanding the point of view and needs of potential app customers, namely Architectural Firms, Real Estate Developers, and Public Administrations. The objective of this preliminary phase is to inform the development of an original methodology pursuing two main goals. The first is to study, describe and communicate people environmental experience in place, using concepts that are consistent with the scientific literature and comprehensible for professionals and laypeople. The second goal is to assess the characteristics of such experience, obtaining qualitative and quantitative data to be represented in various forms (e.g. texts, tables, charts, maps) in order to maximize their impact on the design process.

2. Methodology

The importance of a preliminary analysis developed through the involvement of future stakeholders is twofold. On the one hand, it is a powerful ordering tool, since it traces a hierarchy of needs to primary frame the structure of the app. This leads to review and update the initial researchers’ scheme according to what emerges from the dialogue with potential customers. On the other hand, it offers the researcher the opportunity to interpret and further develop the demands expressed by stakeholders, applying theoretical and methodological skills to transform professionals needs into scientifically grounded analysis tools.

⁵ Retrieved 13 September 2019 from Carlo Ratti Associati website: <https://carloratti.com/project/> (Projects Archive).



2.1 Interviews set-up

A semi-structured interview, i.e. a qualitative tool widely adopted in the field of social research, was designed *ad hoc* for the project purposes. The interview allows to investigate the topics considered relevant by the researchers and at the same time to highlight unexpected thematic issues presented by the interviewees; these are examined in depth during the interview sessions and in the following dialogue with the interviewees. The interview protocol is focused on thematic areas, as follows:

1. General vision/mission of the interviewees and their companies/institutions.
2. Corporate and business context for companies, environmental and social context for institutions.
3. Procedures of intervention on urban spaces adopted to manage the whole transformation process.
4. Creative/design processes.
5. Tools and methodologies of intervention on urban space.
6. Tools and methodologies of co-design and public engagement.
7. Tools and methodologies of analysis of the social and cultural context.
8. Tools and methodologies of communication (and/or advertising) with citizens and other stakeholders.
9. Role of AR in current activity and perception of its future usability/importance.
10. AR4CUP app expectations and future usage scenarios.
11. Hypothetical synergies / conflicts between the app and other technological supports.

In parallel with the protocol and as a stimulus for the interview, we used a brief presentation of the AR4CUP project, that includes a general overview of the AR4CUP app, a brief description of the kind of information to collect for studying people-environment interaction, and the potential outcomes of the data analysis. In this prototypical form, the app was presented using a representative image of the app, showing a simple example of possible information provided by the final users and superimposed to the physical environment, without any details about the data collection procedures and the calculation parameters. Such material was addressed to ease the envision of the potentialities of the tool by the interviewees, leaving them free to imagine the functions more consistent with their needs. No technical nor contextual limitations were established for this conceptual exploration.

2.2 Participants and interview procedure

The interviews were done to selected interviewees considered key informants, that is relevant and competent figures in the Real Estate, urban design, and Public Administration sectors. The interviewees were high-level managers, and the interviews lasted around 1 hour and 30 minutes. In detail, we interviewed:

- Three well-known international Real Estate Developers, involved in medium and large urban transformation projects.
- Three international architecture firms in charge of relevant large urban development projects.
- A former Councilor for Urban Planning of a city with a population larger than 1,000 inhabitants.



The procedure started with an introduction about the general goals of the funded project, followed by the exploration of the first nine thematic issues included in the protocol. After this preliminary discussion, we presented the interviewees the above mentioned materials supporting the envisioning of the AR4CUP app potentialities, subsequently we completed the discussion about the remaining thematic issues of the protocol.

3. Analysis and results

The interviews were analysed investigating the main issues emerged, creating a thematic matrix for comparing the different answers and representing the contents in a unified framework. The results highlight the following main general issues that informed the creative process of the app designing:

- A common interest in social sustainability. The interviewees assign crucial importance to the community involvement initiatives; it is in fact seen as an actual *conditio sine qua non* for the success of urban renewal processes.
- A set of key topics considered as particularly relevant: place identity, social/emotional impact of urban transformation, space legibility, perceived permeability, aesthetic pleasure of the urban fabric.
- The AR4CUP concept (presented during the interviews) is seen as a key tool for interacting with non-expert stakeholders (e.g. tenants, city users, citizens) in order to clarify technical issues, support communication initiatives, and manage co-design processes.
- The main concern is about technological maturity of Augmented Reality since it is considered by the interviewees as a possible source of weakness for presenting design projects to a wide audience. The quality of the Augmented Reality solutions they have tested so far are evaluated poor both in terms of visual representation and storytelling of the architectural solution.
- Interviewees generally investigate social aspects of the urban environment using unstructured methods on an occasional basis; they generally manage the analysis independently, and only sometimes they involve experts from different fields, including social sciences.
- They consider the potential outcomes of the AR4CUP concept beneficial for informing urban design processes and for communication purposes.

In the following paragraphs, these issues will be discussed in detail.

3.1 *The crucial role of social sustainability*

According to the interviewees, the place where a new building will be built should be conceived both as a physical and social system. Moreover, they state that designing a fruitful socio context for their buildings is nowadays more important than the architectural object itself, as it deeply (and directly) influences commercial profitability. The developers consider the architectural object as part of a wider social network and their relationship with committed citizens' groups as a significant part of their job duties. In the current Real Estate market, the corporate mentality seems to be different from the past. According to the interviewees, the tenants no longer aspire to own an attractive building, closed and separated from the rest of the local context, like a private *enclave* in the urban fabric. Instead, contemporary tenants are looking for a place capable of giving an image of inclusiveness and permeability of the public space. These are the new watchwords in the Real Estate field and are part of a broader concept of sustainability. Often, the developer autonomously proposes and supports common



good-oriented actions, that of course contributes to give value to the urban transformation. A meaningful example cited by an interviewee is about the MIPIM (Le marché international des professionnels de l'immobilier), an important international Real Estate event assigning annual awards to projects in different categories, that is currently oriented to reward projects that emphasize the interaction between the design project and the existing urban context, both in physical and social terms. Another example is the attention devoted by respondents to public spaces, where they design buildings that are conceived as public places made for widespread social relationships, e.g. walkable roofs, skyways buildings, and so on.

3.2 *The Key topics emerged from the interviews*

The analysis of the interviews enabled to identify some variables, listed below, that are relevant for the app development. Indeed, identifying these variables was essential for guiding the research path; it allowed us to define the crucial issues to assess with AR4CUP app and, consequently, to define the app specific theoretical and methodological framework.

These variables emerged from direct questions as well as from inductive analysis of the textual contents (i.e. frequency of topics, occurrences of the words). The semi-structured interviews do not follow a fully standardized way of managing the conversation; for this reason, it is not possible to define a specific ranking of variables. Anyhow, it is possible to highlight the variables that were shared by many interviewees or, alternatively, the ones that were addressed by a single or few subjects, but with a peculiar emphasis, as follows:

- 1) Place identity: as mentioned before, the interviewees nowadays consider their core business the intangible characteristics of places and their collective meanings. Therefore, the bonds that the population currently has with the place acquire great importance, and even more the ones that are fostered or discouraged by the urban project. In short, the interviewees are very interested in having a tool able to pre-assess the urban transformation as 'immaterial object', that in the scientific literature of the late twentieth century is labelled in different forms: genius loci (Norberg-Schultz, 1980) sense of place (Relph, 1976), ambiance (Thibaud, 2002).
- 2) Emotional impact: in line with their interest in the immaterial dimension, the interviewees attributed great importance to emotional aspects, following a double path. On the one hand, design solutions that generate positive emotions, or at least that minimize the negative ones, is considered commercially profitable. On the other hand, the emotional dimension seems to play an important role as an internal communication tool, particularly between developers, architects, and public administrations. Indeed, the emotional sphere related to urban transformation projects can foster or slow down decision-making.
- 3) Legibility and visual permeability: according to the interviewees, a fundamental issue regards how understandable a place is. Referring to the literature in the field, we associate this aspect to the legibility assessment. This concept, which dates back to the seminal work of Kevin Lynch (1960), is equivalent to the "ability" of a place to convey immediate comprehensibility through its formal aspects (e.g. accesses, routes, functional areas) and to suggest specific actions to do. For the interviewees, a legible environment has a significant communicative and commercial advantage, as well as a greater possibility of being more frequently used and perceived as safe. A key element of legibility, also linked to the importance that respondents attribute to the local social networks, is its visual permeability, that often produces a perception



of being connected to the surroundings and of being easily and safely transitable and accessible.

- 4) Aesthetic pleasure: Real Estate developers, in particular, emphasize the importance of proper and detailed representation of aesthetic elements (e.g. colors, shapes, materials, architectural details) in AR apps. Their perception is motivated by two considerations: (i) these perceptually salient elements highly attract the attention of non-experts (e.g. tenants and citizens), especially when there is a short amount of time to present the design project in all details; (ii) the importance that some aesthetic details (e.g. a certain type of material) have for a design project, both in terms of symbolic and economic value. As such, it is crucial that these details are recognized by the desired target. An example offered by an interviewee is about the glasses of the facade of a building: if the design project includes a specific type of glass with a peculiar shade of color to convey an impression of lightness, that feature must be reproduced with an extremely high accuracy level. For this reason, there are significant concerns on the use of AR solution currently on the market (see 3.4).

3.3 *A tool to interact with non-experts and laypeople*

The interviewees recognize the value of the AR4CUP app for the dialogue between citizens, developers, and designers. They assert that citizens have the right to understand the aims of the project and communicate their opinions about its development. The interest of interviewees in the AR4CUP app lays in the assessment of the psychological/social impact of their design projects. Measuring and comparing the experience of people in place is considered a relevant opportunity since it simplifies the dialogue with inhabitants, potentially contributing to avoid aversion to new urban projects. The developers interviewed stressed that, usually, in the dialogue between developers and tenants, technical drawings seem not to be really helpful, while a photorealistic simulation allows even non-professional people to envision the project. Indeed, immersive and realistic visualizations foster even more the understanding of design solutions to laypeople, by providing a real-time and full-size experience. Hence, these solutions facilitate the sharing of urban projects. Anyhow, developers do not still consider VR/AR solutions enough to properly communicate design projects, since realisticness can diminish the atmospheric effect that is instead considered very useful for describing designers' intentions beyond the physical transformation.

3.4 *Current design tools and Augmented Reality: pros and cons*

According to the interviewees, one of the primary benefits of representation tools is storytelling. Their main goal is to ease the communication of the concept of the design project while making it appealing to a specific audience. This is helpful not only for marketing purposes, but also to involve the local community and to foster people interest in urban transformations. There are many typologies of representation tools that can support communication; these include both analog and digital solution. Many interviewees confirmed that, within the vast range of representational solutions, BIM is one of the primary tools adopted during the design process since it allows to manage the economic and physical performances of the building; renderings, photos, videos and digital illustrations are, instead, mainly used for evocative purposes; sketches, diagrams, collages, prototypes, and other traditional representation are considered powerful resources to convey highly conceptual ideas and to share the desired long-term social effect.



A key point is a diffuse concern about the effectiveness of AR apps currently on the market as representation tools. This distrust seems to be induced by different issues:

- Low quality of AR representation (e.g. details, quality of textures, reflections, and shadows on the virtual elements), that might lead to an undervaluation of the final project features.
- Lack of the so-called 'dream effect', due to the representation realism, that might negatively affect marketing strategies.
- Potential digital divide, especially for older people who do not have adequate skills in the use of digital tools. Interviewees, therefore, pointed out that a methodology should be established to guarantee that digital alphabetization is not an obstacle to access such representations of urban transformations.
- The difficulty of representing, through the AR, some dynamic elements normally characterizing an urban place. In particular, interviewees refer both to the human movements/relationships within the space and the continuous evolution of the natural landscape. In short, they doubt that AR could compellingly show the ambiance of the design project and the continuous evolutions of natural habitats.

Anyhow, positive aspects of AR also emerged from the interviews, namely:

- Playful engagement of citizens directly on-site. Interviewees highly value the potentiality of AR app as a communicative tool with non-professional, e.g. Public Administrations, citizens, tenants.
- Simultaneous involvement of many citizens. Interviewees devote specific attention to the ubiquity of digital devices. Thereof, gathering massive data on people behaviours and reactions may offer a detailed picture of the local community perception of their design project.

Starting from the results described above, we identified some correspondence between the interviewees observations and the AR literature (Sutherland, 1968; Caudell & Mizell, 1992; Bajura & Neumann, 1995; Foxlin, 1996; Swan & Gabbard, 2005; Billinghamurst, Clark, & Lee, 2015;). Low quality of AR representation may be related primarily on visualization methods achieved by photorealistic rendering techniques for mobile devices, and secondarily on mobile tracking methods. The lack of the 'dream effect' and the digital divide are strongly related to the interaction and user experience field, as well as user engagement by visualization methods. The difficulty of representing the dynamics of some elements, such as human behaviour of virtual characters, or meteorological effect and seasonal changes, are also related to photorealism and real-time visualization. More in detail, the trends emerging during the past 50 years of research on the topic of see-through devices and AR (Billinghurst, Clark, & Lee, 2015; Kim, Billinghamurst, Bruder, Duh, & Welch, 2018) addresses these primary issues (tracking techniques; visualization methods and photorealism level; Interaction and user experience) as follow:

- *Tracking techniques*: an issue for AR is to correctly locate objects in the real world, with precise orientation, right scaling, and correct elevation. These issues are related to GPS and RTK (Real Time Kinematic) accuracy, and electronic compass stability, that is sensitive to electromagnetic fields surrounding the device (this mostly happens in interior situations); the gap between the electronic compass and analog one may mismatch with an error about $\pm 3.2^\circ$ (Allmendinger, Siron, & Scott, 2017); latency is also still an issue. A solution for improving the superimposed virtual model stability is the hybrid system that combines GPS with inertial-



based (accelerometer, gyroscope, magnetometer) and vision-based approaches (determining pose via image analysis based on infrared sensors, visible light sensors, 3D structure sensors) (Feng Zhou, Duh, & Billinghurst, 2008); in particular, the Simultaneous Localisation and Mapping (SLAM) technique is an open and advanced research field (Kim, Billinghurst, Bruder, Duh, & Welch, 2018).

- *Visualization methods and photorealism level:* Visual reliability partly relies on the proper physical behaviour of the materials in the simulation. Projecting realistic light on the virtual objects aligned with the actual shadows in real-time, and according to the specific weather conditions, is a relevant issue (Piga & Morello, 2015). This can be controlled in various ways, including light sensors and ephemeris computation (Barreira, Bessa, Barbosa, & Magalhães, 2018). Studies on ray-tracing technique for glass effect suggest that around 40% of people could not recognise a virtual glass as fake if accurately rendered (Kán & Kaufmann, 2012), but the issue may be encountered when trying to cast caustic effects on real objects.
- *Interaction and User Experience:* Tim Hilken (2017) argues that AR as a marketing tool provide a sense of spatial presence that increase comfort during the decision-making phase, since customers perceive AR contents as more informative than other common representations (Hilken, de Ruyter, Chylinski, Mahr, & Keeling, 2017). Users willingness to visit a site may be fostered by AR depending on the visual appeal of contents and interface, but also on the belief that the app is serious and institutionally recognized (Chung, Han, & Joun, 2015). AR is also perceived as a useful tool to overcome place accessibility issues, e.g. unaccessible building sites, distant landscapes, and so on (Portman, Natapov, & Fisher-Gewirtzman, 2015). Joachim Scholz (2016) argues that a high level of user engagement is achieved mainly through content interactivity (Scholz & Smith, 2016). Furthermore, an AR representation is ideal to show a design project on-site and in full size to laypeople that are not trained to read 2D plans or to properly envision the final experiential outcomes from printed renderings that portray the environment in reduced dimensions and usually as a non-immersive experience (Billinghurst, Clark, & Lee, 2015).

3.5 Interviewees approach to social research

The interviewees declare a substantial interest for the emotional, relational and community aspects related to urban transformations; we deeply investigated the social research tools applied by the interviewees in their work. By social research, we mean disciplines such as psychology, sociology, anthropology and geography, that is those that mostly deal with the social dimensions of urban phenomena.

Among the respondents, a 'homemade' approach to social research prevails. They generally implement the analysis using non-specialized internal resources, or staff that they consider having equivalent backgrounds, e.g. service designers, marketing experts, community managers. One of the Architectural Firms stated that they are used to commissioning overview social analysis of the local geo-economic context, mainly based on quantitative data. Another adopts the strategy of collaborating with renowned professionals only for specific research projects, without applying otherwise standard models of analysis coming from the social sciences. All respondents agree that it is relevant to place this type of investigation at an early stage of their design process of a site, in order to assess its socio-economic potential or to deeply understand the local needs. However, they believe that, once the AR4CUP app is implemented, it could be useful in other phases of the design project as well. In particular, architects stressed that the AR4CUP app can



provide some useful insight on the social dimension, especially for further developing the design concept and the urban project starting from the users' perspective; Public Administrations and developers say that they envision that AR4CUP app can effectively foster the dialogue with stakeholders and future tenants. They are inclined to integrate the AR4CUP app in their standard working methods.

3.6 *AR4CUP app outcomes: What are they for?*

In conclusion, we asked the interviewees how they envision to use the outcomes provided by the AR4CUP. The outcomes portray the overall perception of the design project by final users. As described below, a difference between designers and developers emerged; designers mainly conceive the AR4CUP app as a design tool, while developers mainly as a marketing tool. This is reasonably due to the different role they play in urban transformation processes.

Indeed, on the developers' side, the AR4CUP app is seen mainly as a communicative tool. In particular, they believe that the tool can improve the dialogue with Public Administrations since they can gather preliminary feedback by final users on the perception generated by their design projects. This feedback can be provided as proof of the quality of the proposed design solution. They also assert that the same positive communicative effect could be achieved in the dialogue with possible tenants and citizens since it fosters the envisioning of the urban transformation.

On the other hand, architects appear to be more focused on the possibility of using the app as a design tool for testing the efficacy of the various design steps, starting from the initial concept up to the final design project. In this case, the potential of an iterative use of the tool is outlined. In particular, they consider the app as a useful support in the potential identification of the following deficiency: lack of specific services, commercial opportunities, local identity; problems related to mobility issues, wayfinding difficulties, perceived insecurity. With this in mind, architects appear to be partially concerned that this new process can be excessively expensive and time-consuming.

4. Conclusions

The first phase of the AR4CUP project, presented in this contribution, is based on interviews with relevant stakeholders, i.e. Real Estate developers, architectural firms, and Public Administrations. Questions were focused on their workflow, the design tools typically adopted, their expectations and concerns about AR in general and the AR4CUP project in particular. The main goal was to explore the needs of potential customers of the app.

What emerged from the interviews is that it is crucial that the design solution becomes itself an activator of social and relational processes, a condition that the interviewees intend to manage. Dealing with the (current and future) place identity is conceived as a valuable economic investment and a strategic lever to territory interventions. Furthermore, interviewees assert that one relevant goal of their design solution is to promote a positive emotional reaction. This emotional dimension is also considered crucial for internal communication between Real Estate developers, architects and Public Administrations. Another parameter considered important by respondents is the place legibility and permeability, that it is also connected to the perceptions of affordability, safety, accessibility. A further relevant issue is the aesthetic outcome of the urban



transformation not only for attracting final users, but also to express the qualities of the design choices assumed as a corporate cost. In relation to the above mentioned crucial issues, interviewees have significant concerns about the use of Augmented Reality. Distrust in AR mainly relates to the low quality of the design project representation that they previously experienced in several app AR currently on the market. Moreover, they stressed the importance to find an efficient balance between photorealism, able to provide an easy-to-understand representation of design projects, and conceptual and empathic communication, that of course influence the return of investment. Anyhow, respondents recognized positive aspects of AR as a playful engagement tool for fostering citizens' involvement, as a smart solution to share design schemes directly on-site, and as a potentially powerful means for gathering massive data on their urban design project (this last consideration is related to the AR4CUP project only).

Indeed, the AR4CUP app aims at gathering feedback on the experience of citizens and relevant stakeholders arose by urban transformation projects in order to inform Real Estate Developers, Architects and Public Administrations; such an approach aims at fostering and testing the implementation of the design solutions from the perspective of people experience in place. Medium-large urban projects with a certain degree of complexity (e.g. medium-large extension of the plot, heterogeneous functions, private\public spaces, and so on) that might benefit from the understanding of the psychological and social effects of the architectural solution and that aims at enhancing the immaterial and emotional value of the urban transformation, are the core target of the AR4CUP project.

The overall goal of the Ar4CUP app is to offer a scientific-based analytical tool for favouring the design process grounded on people-oriented approach. The AR4CUP app aims at answering to interviewees concerns about quality of the visualizations and the dynamics of virtual elements from the technical perspective⁶. At the same time, it contributes to the enlarge the toolkit for citizens' involvement, while providing perceptual data to the designer, the promoter of the urban transformation, or the decision-maker. The benefit is twofold, on one side it eases the understanding of the design project to laypeople while giving them a voice, on the other hand, it supports the design development and negotiation between the private and public sector.

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⁶ The technical development of the AR4CUP app is developed by Artefacto and VTT.



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