Supporting Citizen Participation with Adaptive Public Displays: a Process Model Proposal

Antoine Clarinval, Benoît Duhoux, Bruno Dumas

Supporting Citizen Participation with Adaptive Public Displays: A Process Model Proposal

Proposition d'un modèle de processus pour les affichages publics adaptatifs supportant la participation citoyenne

Antoine Clarinval
antoine.clarinval@unamur.be
Université de Namur (UNamur)
Namur, Belgium

Benoît Duhoux
benoit.duhoux@uclouvain.be
Université catholique de Louvain (UCLouvain)
Louvain-la-Neuve, Belgium

Bruno Dumas
bruno.dumas@unamur.be
Université de Namur (UNamur)
Namur, Belgium

ABSTRACT

In recent years, public displays have been studied as a way to foster citizen participation. However, their surroundings and users are prone to high variability, which makes it tedious to accommodate different contexts with an optimal participation experience. In this paper, we propose adaptive public displays as a lead for solution in tackling this issue. From a review of the motivators and barriers affecting citizen's interaction with public displays we defined a process model destined to serve as a guide for designers of such systems.

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KEYWORDS

Citizen participation; adaptive public display; process model.

RÉSUMÉ

Au cours des dernières années, les affichages publics ont été étudiés comme moyen d'encourager la participation citoyenne. Cependant, leur environnement et leurs utilisateurs sont sujets à une grande variabilité, ce qui rend fastidieuse l'adaptation à différents contextes en conservant une expérience de participation optimale. Dans cet article, nous proposons les affichages publics adaptatifs comme piste de solution à ce problème. A partir d'une revue des motivations et des barrières qui affectent l'interaction des citoyens avec les affichages publics, nous avons défini un modèle de processus destiné à servir de guide aux concepteurs de tels systèmes.

MOTS CLÉS

Participation citoyenne ; affichage public adaptatif ; modèle de processus.

INTRODUCTION

With the emergence of the smart city paradigm, many cities have developed technological solutions in an attempt to answer the challenges they face (e.g. road congestion, waste management). However, research showed that these initiatives are doomed to failure when cities do not give enough consideration to the specific needs of their territory and inhabitants [17, 31]. As a result, initiatives aiming at engaging citizens in the public life have emerged and methods to achieve this have been extensively proposed [55]. Methods such as workshops [47] and citizen participation platforms [57] have proved valuable, but show a representativity limit as they tend to attract "usual suspects" with a prior interest in civic engagement.

Public displays have been researched as a citizen participation means [29, 33] and have been successful in enticing much more participation than traditional methods [25] due to their innovative, contextualized (i.e. the content shown on the display is related to its location), collaborative and opportunistic (i.e. citizens encounter public displays without planning to do so) nature. Public displays are often in the form of a voting systems inviting passersby to answer displayed questions, either via a multiple-choice answer (e.g. [13, 29, 59]) or free-text allowing richer feedback (e.g. [33, 53]). Various techniques allow users to vote with a public display [5], including direct touch [33], body movements [63], and the use of external devices such as smartphones [53] and pressure plates [58]. Recent work is also studying the potential of immersive public displays [19].

Deploying interfaces in the urban environment for any citizen to use raises challenges, as the surroundings and the characteristics of the users change constantly. Consequently, a public display

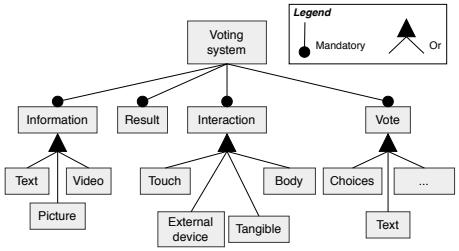

Figure 1: Simplified feature model representing the different functionalities of the voting system.

Venue	Motiv.	Barriers	Both
PerDis	0	0	2
C&T	0	0	2
CHI	1	0	2
DIS	0	1	1
CSCW	0	0	2
Other ACM	1	1	3
Other	0	1	3
Total	2	3	15

Table 1: Number of articles reporting motivators and barriers to interaction

cannot provide an optimal interaction at all time, which in turn hinders its citizen participation purpose. The challenge of the adaptation of public displays to such a changing environment has been underlined in the literature [3, 38], and some previous work has focused on the adaptation of public displays according to one or several context factors. A well-know example is proxemic interaction [7, 28] that adapts the content shown and the features according to the distance between the user and the display. Previous implementations of proxemic interaction have proposed to adapt the content and content presentation to the position of the user [10, 37]. Other works have focused on the user attention and interest, which includes his proximity and orientation relatively to the display [64] and the presence of other users [51]. A public display adapting to the height of the user by allowing the user to move interface elements was presented in [48]. Kurdyukova [41] has studied how public displays can be adapted according to the user (e.g. user interest, attention, emotional state) and social environment factors (e.g. number of people around the display, their age and gender).

However, none of the public displays described in these works serve a citizen participation purpose, and they tackle adaptation to one changing element of context for the most part. In this paper, we address this gap by exploring how adaptive public displays can be modelled from a designer's point of view. From an extensive literature review, we identified the motivators and barriers impacting interaction with public displays supporting citizen participation. These served as a basis to the process model we defined to guide designers of adaptive public displays. An hypothetical adaptive voting system running on a public display is described as illustrative example of the process model usage.

RUNNING EXAMPLE: A VOTING SYSTEM

Before describing the process model and the methodology that guided us in its development, we first present a running example of adaptive public display in order to illustrate how adaptation can yield added value. This example is an adaptive voting system that gathers the opinion of citizens on a given issue, by prompting them to answer a question shown on a public display.

Fig. 1 depicts a feature model to design this adaptive system. Citizens passing by the display are informed about the issue with contextual information by text, pictures or videos. They can also give their opinion on the question. Depending on the surrounding environment (e.g. the weather or their time availability), they can provide an answer with predefined choices or in a richer way such as a plain text opinion. In addition, the vote can be performed through various interaction modalities [5] such as direct touch on the display (e.g. [33]), body movements (e.g. [63]), and using an external device (e.g. [53]). Finally, the citizen can see the current results for the question.

A feature model is a good way to represent the commonalities and the variabilities of an adaptive system [36], which is why we chose to model the voting system using this representation. The nodes represent the functionalities of the system while the edges describe the hierarchical relations between

Factor	Motiv.	Barrier	Both
Technology	[29, 52] [39, 58] [22, 23]	[33, 34] [65]	[53]
Social exposure	[53, 58]	[6, 12] [29, 63] [33]	-
Time available	[6, 58] [54]	[15, 53]	-
Topic interest	[39, 54]	[53]	[52, 58] [13]
Content from others	[53, 63] [34]	[54]	-
Feedback form	[33]	[53]	-
Content presentation	[39, 59]	-	[11, 43]
Perceived impact	[15]	[47, 52]	[59]

Table 2: Articles reporting factors impacting interaction, as motivator, barrier, or both

the features. A *Mandatory* relation implies that the child feature is always present in the system. An *Or* relation forces that at least one of the child features is present in the system at runtime.

PROCESS MODEL FOR ADAPTIVE PUBLIC DISPLAYS

Even if many motivators encourage citizens to interact with public displays for participation, many barriers dissuade them to use such systems. We believe that adaptive public displays could increase the interactions in such citizen engagement by strengthening these motivators and lowering these barriers. For that we created a process model to help the designers to conceive adaptive public displays. In this section, we first describe the methodology used to define this process model and then we present the process model.

Methodology

Previous empirical contributions presenting public displays supporting citizen participation have reported on the motivators (resp. barriers) encouraging (resp. deterring) users to interact with their systems. These serve as foundation for the process model we propose. Its goal is to improve the citizen participation experience by leveraging adaptation to strengthen motivators and lower barriers.

In order to extract an exhaustive list of these motivators and barriers, relevant literature (i.e. empirical works proposing public displays for citizen participation) was collected following a systematic approach. A keyword search was defined following [49] and was composed of terms related to **public displays** and **citizen participation**. The former keywords were refined throughout the review to include synonyms and cover related fields, whereas the latter were reused from a previous systematic literature review on citizen participation [56]. The search was performed on the title and keywords fields of the articles on the ACM Digital Library, IEEEXplore, and ScienceDirect. Bibliographies of the selected articles were perused as well to extend coverage. In total, 34 articles were captured, 27 of which report on motivators and/or barriers to interaction. We only noted the factors that are reported sometimes as a motivator and sometimes as a barrier in the literature. Factors impacting interaction solely as motivator (e.g. honeypot effect, playfulness) or as barrier (e.g. display blindness, interaction blindness) were set aside for these papers, as they inform general design recommendations rather than opportunities for adaptation. 20 articles report on motivators and barriers relevant for adaptation. Table 1 details the number of articles reporting on motivators and barriers, for each publisher. Table 2 lists the factors impacting interaction along with the articles reporting them as motivator, barrier, or both.

Process model

Fig. 2 depicts the process model defined to help designers in the creation of adaptive public displays. This model is composed of five steps, each dedicated to one of the five big W questions (**W**hy, **W**ho,

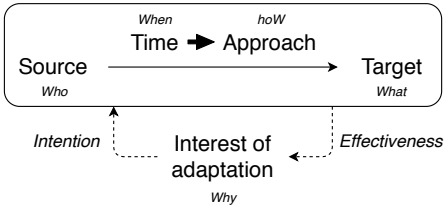

Figure 2: The process model destined to help the designers in the creation of adaptive public displays.

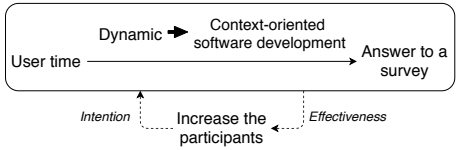

Figure 3: An instance of the process model where the adaptation proposes different ways to answer a survey depending on the time availability of the users to increase the number of participants.

[1]a specific field of adaptive systems

When, ho**W** and **W**hat). Starting from an interest of adaptation in the intention to increase the motivators and/or decrease the barriers, the designers must design the source, the time, the approach based on the time and the target of the adaptation. Furthermore, with this process model, the designers can assess the impact of the adaptation in a field setting by measuring the difference between the effective and the intended effect on motivators/barriers to confirm or not the interest of adaptation. Each of these steps are described and exemplified below and illustrated in Fig. 3.

Interest of adaptation. Designers must first think about **why** an adaptation can strengthen the motivators or lower the barriers to citizen participation. In our voting case study, the main objective is to increase the participation of the voters. So for that, the designers must also consider a way to gather feedback from citizens having less time available or increase their topic interests.

Source. After considering why an adaptation is interesting, they must define **who** causes the adaptation. In adaptive systems, the perception of the environment leads to an adaptation to refine the behavior of the system [9]. For example, in context-aware systems[1], this environment can be defined by the users (e.g. the time they have), by external information (e.g. the weather) and by physical information (e.g. the size of the screen) [16, 45]. Based on this definition of the environment, the feedback from the citizen in our voting system can be different according to his time or the weather.

Target. They also have to define **what**/which features (i.e. functionalities) can be adapted according to the environment in which the system runs. For instance, the feature proposing to send a feedback can be adapted according to the surrounding environment. If the citizen has little time available or if it is raining, giving feedback could consist in choosing from a range of predefined answers. Otherwise, a richer plain-text feedback could be sent. The modality to send a feedback can also vary. Depending on the citizen's preferences, he could send his feedback from an external device preserving privacy or by touching the screen to answer the question in a less private way.

Time. The designers must consider **when** the adaptation must occur. The adaptation can either be static or dynamic. While a static adaptation is planned entirely by the developer, a dynamic adaptation is planned at runtime for which some behaviors can be refined depending on the surrounding environment in which they run (i.e. the source in our process model) [44]. Even though we mention static time, we only focus on dynamic time in this paper as our scope is adaptive public displays.

Approach. Finally, the designers must also define **how** the adaptation will occur, in terms of technology. Static approaches as well as an extensive coverage of the existing approaches are out of the scope of this paper. Some dynamic adaptation approaches are briefly discussed. A first approach is based on model-driven engineering approaches even if their solutions are mainly devoted to the user interface adaptation, by relying either on the Cameleon Reference Framework [8] such as for example

UsiXML [42, 61], or on their own architecture such as the three-layered CAUCE architecture [60], or COMET(s), a software architectural style and interactors toolkit for plastic user interfaces [18]. Other approaches dealing with the software engineering aspects of dynamic adaptation exist, e.g. context-oriented programming [4, 21, 24, 26, 27, 30, 50].

CHALLENGES TO ADAPTIVE PUBLIC DISPLAYS

Although this paper has discussed the potential of adaptive public displays supporting citizen participation, the development of such interfaces is fraught with challenges that would be fair to acknowledge.

First, building an adaptive public display is clearly a more complex task for developers than developing a traditional one. However, the software engineering literature has proposed programming approaches as discussed previously and development tools (e.g. [20]) to support developers in this regard. The development of adaptive public displays also requires sensors, which induce additional hardware equipment expenses, thus increasing the already high cost [35] of public displays. In the context of citizen participation, such displays are often deployed by local governments, who might be reluctant to deploy costly systems.

Second, one issue that is likely to emerge at some point in the deployment of an adaptive public displays is conflicting contexts. For instance, if the display adapts the content presentation to the age of its user, a conflict can emerge when several users of different ages are using the display simultaneously. Previous works have proposed techniques for handling conflicting contexts and are surveyed in [46].

Third, [40] reported that adaptive public displays are likely to lose users' trust if they lack transparency and controllability in their behavior. This issue is critical in the context of citizen participation. Indeed, several studies surveyed in [2] noted that the trust in the technology has an important impact on citizen's trust in electronic government (e-government) and on the intention to use e-government systems. Also, [62] has shown that "increased government trust is produced by improved interactions through e-government." Therefore, mistrust in the adaptive public display would have a heavily detrimental impact on not only the public display use, but also on the efforts toward e-government in general. This calls for careful consideration of user evaluations in adaptive public displays research in order to ensure that they are trusted and accepted by the public.

Fourth, previous literature has highlighted the challenges pertaining to the evaluation of public displays [1, 32]. Indeed, whereas laboratory studies are able to predict usability issues, factors related to the environment require a more costly field evaluation to be studied [32]. In the case of adaptive public displays, dynamic events have to occur in order for the behavior of the display to be evaluated. Nonetheless, a promising avenue in this regard is controlled in-the-wild evaluation [14] which allows simulating such events in a field setting, thus preserving ecological validity.

CONCLUSION AND FUTURE WORK

Public displays are being deployed in the urban environment as enablers of citizen participation. However, such systems are confronted to a high variability in their environment, making it challenging to provide the most suitable participation experience at all times. In this paper, we studied adaptive public displays as a solution to this issue. We make the following two contributions. First, a literature review of the motivators and barriers impacting interaction with public displays. Second, a process model destined to guide the designers of adaptive public displays based upon it.

As next step, a validation of our proposal is necessary. First, to assess whether adaptive public displays do enhance citizen participation in comparison to traditional ones. Second, to evaluate the efficiency of the process model as a guide for designers.

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