Universidade do Minho
Escola de Engenharia

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Practices and tools for situated publication and self-exposure on public displays

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Tese de Doutoramento em Tecnologias e Sistemas de Informação

Trabalho efetuado sob a orientação do
Professor Doutor Rui João Peixoto José

abril de 2019

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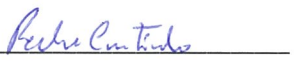
Assinatura: 

Est modus in rebus

Horatio (Satire 1,1,106)

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The journey to take a PhD degree seems to be a long and lonely. However, this would not be possible without the presence and contribution of many people to whom I would like to thank for the unconditional help.

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I dedicate this work to my daughter Ana Margarida and my son João Pedro, a reward for all the moments I was not able to dedicate them during this period.

Abstract

Practices and tools for situated publication and self-exposure on public displays

Digital public displays are increasingly ubiquitous and perceived as a technology that may radically change communication in public and semi-public spaces. Interaction around public displays makes them potential focal points for social coordination, promoting a sense of place, encouraging people to action and setting behaviour expectations in public venues. However, enticing people to participate and contribute with content to public displays is still a major issue. There are significant challenges regarding the motivation of people to share content using the displays, and also the motivation display owners have to share their displays with others. A diverse range of interaction alternatives has been proposed to address this issue, but public displays are still far from being seen by people as a communication medium that they can use for their own communication purposes.

Therefore, it is necessary to uncover alternative usage paths for digital public displays to inform the design of new communication concepts. These should help to contribute to turn displays into an open medium for place-based communication. Media publication practices would thus be more spontaneous, which would enable content to evolve towards the same creativity and informality levels that are now common in social media practices.

The objective of this research work is to identify novel media publication approaches for public display systems, which people can understand as something they can use to accomplish their diverse content publication goals. Those approaches represent publication paradigms that should be an abstraction for what happens when someone publishes something on a display, enabling interactions to be clearly interpreted as publication acts, and scoping them in terms of authorship, reputation, moderation and reach. It should also convey a full understanding of the publication process, supporting selective control of self-exposure, expressing the scope and context of publication actions, and enabling practices that are well aligned with the social dynamics around the displays.

To accomplish the objectives, we have made four different research studies. They explore existing publication paradigms from other domains, such as social networks and

also from non-digital media, in the context of diverse problems. These studies have produced a set of contributions corresponding to innovative publication paradigms for digital public displays. We contribute with an identification of the main usage dimensions for place-based displays when supporting place-based communication. This thesis also contributes to the understanding of the primary role and value of combining content originating from external sources, showing that place-based communication is not just about locally created content. We proposed a risk management framework to approach the diverse sensitivities associated with moderation and risk management, including the identification of the threats of user-generated content and moderation techniques to mitigate them. We also came out with a set of design sensitivities, uncovered across the several studies made, suggesting that the place-based nature of these displays may prompt for more situated and spontaneous forms of communication.

The contributions of this thesis are expected to have an impact on the understanding of publication practices in digital public displays, informing the design of novel place-based display systems, sensitive to people and their desire to express themselves and communicate. This will eventually be a step towards allowing user-generated content to become a commodity in public displays, allowing them to be an open medium that presents contextual information relevant to the place and its visitors. This would definitely confirm the expectation that future display networks may become a more open medium for self-expression and appropriation.

Resumo

Práticas e ferramentas para publicação situada e autoexpressão em ecrãs públicos

Os ecrãs públicos digitais estão cada vez mais onipresentes e são percecionados como uma tecnologia que pode mudar radicalmente a comunicação em espaços públicos e semipúblicos. A interação junto a ecrãs públicos torna-os potenciais centros de coordenação social, que promovem uma sensação de local e encorajam as pessoas a agir, gerando expectativas de determinados tipos de comportamento em locais públicos. No entanto, incentivar as pessoas à participação e contribuição com conteúdos para serem exibidos em ecrãs públicos é ainda uma questão muito relevante. Existem desafios muito pertinentes relativamente à motivação das pessoas em partilhar conteúdo usando ecrãs, bem como à motivação dos proprietários desses mesmos ecrãs em partilhá-los com outras pessoas. Apesar das enumeras alternativas de interação que têm sido propostas para resolver esse problema, os ecrãs públicos ainda estão longe de serem percecionados pelas pessoas como um meio de comunicação que podem utilizar para satisfazer as suas próprias necessidades de comunicação.

Assim sendo, torna-se necessário encontrar alternativas para a utilização dos ecrãs públicos digitais por forma a informar o desenho de novos conceitos de comunicação. Desta forma, estar-se-ia a contribuir para que os ecrãs públicos pudessem ser transformados em meios abertos para a comunicação nos locais onde estão instalados. As práticas de publicação dos vários conteúdos seriam assim mais espontâneas, o que permitiria que o conteúdo evoluísse para os mesmos níveis de criatividade e informalidade que são atualmente apanágio das redes sociais.

O objetivo deste trabalho de investigação é identificar novas abordagens de publicação de conteúdos em sistemas de ecrãs públicos, que as pessoas possam entender como algo que está à sua disposição para atingirem os seus objetivos de publicação. Essas abordagens representam paradigmas de publicação que devem ser vistos como abstrações para o que efetivamente sucede quando alguém publica algo num ecrã, permitindo que as interações sejam claramente interpretadas como atos de publicação, delimitando-as em termos de autoria, reputação, moderação e alcance. Devem igualmente fazer transparecer um entendimento integral do processo de publicação, que suporte o controlo seletivo relativamente à autoexpressão; a indicação do alcance e contexto dos atos de publicação;

e que permita práticas que estejam bem alinhadas com as dinâmicas sociais que ocorrem junto aos ecrãs.

Para alcançar estes objetivos, foram realizados quatro estudos diferentes. Os estudos suportam-se em paradigmas de publicação de conteúdos existentes noutros domínios, tais como as redes sociais e os meios de divulgação não digitais, no contexto de diversas problemáticas. Esses estudos ajudaram a produzir um conjunto de contribuições relacionadas com paradigmas de publicação em ecrãs públicos digitais. Contribui-se com uma identificação das principais dimensões de utilização dos ecrãs públicos no suporte à comunicação em vários tipos de locais. Este trabalho também contribui para a compreensão do principal papel e do valor intrínseco da combinação de conteúdos provenientes de fontes externas aos locais, mostrando que a comunicação dos locais não é apenas baseada em conteúdo criado localmente. É igualmente proposta uma estrutura para a gestão do risco que abrange as diversas sensibilidades associadas à moderação e gestão do risco, incluindo a identificação das ameaças relacionadas com a geração de conteúdos por parte de terceiros, e as técnicas de moderação que poderão ser usadas para mitigar essas mesmas ameaças. Também se aborda um conjunto de sensibilidades para o desenho de sistemas de ecrãs públicos, que emergiram dos vários estudos realizados, e que sugerem que a natureza essencialmente local desses ecrãs pode levar a formas de comunicação mais espontâneas e contextualizadas ao local.

Espera-se que as contribuições desta tese tenham impacto na compreensão das práticas de publicação em ecrãs públicos digitais, informando o desenho de inovadores sistemas de ecrãs para locais, sensíveis às pessoas e ao seu desejo de se expressar e de comunicar. Eventualmente será um contributo no sentido de permitir que o conteúdo gerado pelas pessoas esteja disponível em ecrãs públicos, permitindo que estes constituam um meio aberto, que apresenta informações contextualizadas, relevantes para o local e para os seus visitantes. Isso confirmaria definitivamente a expectativa que futuras redes de ecrãs se possam tornar num meio mais aberto à autoexpressão e à apropriação.

Table of Contents

List of Figures

List of Tables

List of Acronyms

API Application Programming Interface

CMS Content Management System

HTML HyperText Markup Language

HTTP HyperText Transfer Protocol

MMS Multimedia Message Service

NFC Near Field Communication

QR Quick Response

PDA Personal Digital Assitant

RFID Radio Frequency Identification

RSS Really Simple Syndication

SMS Short Message Service

UI User Interface

USB Universal Serial Bus

URL Uniform Resource Locator

WAP Wireless Application Protocol

WWW World Wide Web

1 Introduction

Ubiquitous and mobile technologies are opening many new opportunities for presenting messages in places and enabling new locative experiences shared by co-located people. Digital public displays are a classical example. They are becoming increasingly ubiquitous in smart cities as they are more available, thinner and lower-priced and are increasingly perceived as a pervasive communication medium. Digital displays are perceived as a technology that may radically change communication in public and semi-public spaces (Davies, Langheinrich, José, & Schmidt, 2012). Whenever interactive or sensitive to the presence of people, these public displays can have an enormous potential as central points for social coordination, contributing to the sense of shared place, creating awareness about local communities and congregating co-located people around common topics, inviting them to action and defining behaviour expectations in public places (K O'Hara, Perry, & Churchill, 2003).

However, despite their huge potential to address a very generic and very relevant need, which is communication, public displays have not yet managed to become a mainstream digital channel. Overall, they persist as an essentially separate and strongly technical domain in the ecosystem of digital services and devices that characterises our current world (E. M. Huang, Koster, & Borchers, 2008). Unlike mobile and social media, which are now must-have channels in any digital strategy, public displays are still seen as a much less obvious and much more complex medium. Their technical and conceptual design is yet to provide simple paths for their appropriation by the many entities that could benefit from their existence. This seems to have a major impact on usage expectations, which are normally very narrow and focused on a small set of classical use cases, including advertising, marketing, brand communication and supporting processes (e.g. departure timetables or service queues).

Altogether, these are the types of usage situations that are commonly associated with public displays. Clearly, they are not the only ones, but they represent the killer apps around which the Digital Signage industry has evolved. Still, the above usage scenarios may be considered as a very small fraction of the contexts in which public displays should be delivering their potential as a powerful medium for situated communication.

Therefore, there is an opportunity to move beyond current assumptions and explore new communication concepts and alternative usage paths (Davies, Clinch, & Alt, 2014). Instead of any particular concept, the true killer application for digital public displays might be in their role as a generic and open medium for place-based communication.

Before digital public displays can become an effective communication medium for everyone, they need to move away from a vision of close devices operated individually to a broader vision where they are part of large-scale networks of pervasive public displays that are open to applications and publication of content from many sources (Davies et al., 2012). In fact, the current prevailing paradigm for public displays is still based around multiple isolated display networks, each narrowcasting its content to a set of displays that serve as mere distribution points for centrally created content without much consideration for users. In reality, most of current displays are managed in a centralized mode, leading to the presentation of content which is not contextualized to the place where the installation is set, or even to the environment around it, including people and all the social interactions occurring among them.

A key enabler for this novel vision is the ability to allow users to contribute with their own content for the displays. While empowering users as content creators may seem more like a source of value for the users, display owners also have important motivations for sharing control of their displays, such as improving the relevance of the content to their audience, promoting a sense of community or strengthening the bond with guests. Moreover, by accepting user-generated content from people in their vicinity, public displays can become truly situated devices, reflecting the environments in which they are inscribed and the social practices and contexts around them.

The present research hypothesizes that in a world where place-based displays would become the norm, rather than the exception, media publication practices would be much more informal, and would lead to more situated, social, mundane and creative uses of public displays. Communication based on the use of place-based displays would thus be closer in concept to the current social media paradigms than to the tightly controlled model that currently prevails in display networks. This would promote spontaneity and enable display content to evolve towards the same levels of creativity and informality that are now common in social media.

1.1 Challenges

The perspective of public displays as multi-purpose communication media means assuming their ability to support a broad and open-ended range of communication goals. To make this a reality, it is necessary to explore new communication and media publication paradigms for digital displays, which may constitute an important step towards a major breakthrough in the role of digital displays in public and semi-public spaces. This would be a contribution to enable public displays to migrate from a situation where access to the screens is tightly controlled to a situation where user-generated content could become a commodity that would drive entirely new services and the emergence of entirely new business models around those networks of digital displays (Davies et al., 2012), leading to the concept of place-based display.

There are major challenges concerning the motivation of people to share content within the display's networks, and also the motivation of display owners to share their display with others. In particular, there seems to be a strong gap between the potential aspiration to communicate and the necessary understanding of the communication process and meaning that clearly goes beyond the usual interaction issues.

These challenges can be addressed by providing a set of specific content publication paradigms that offer abstractions for what happens when someone publishes something in a display, enabling interactions to be clearly interpreted and situated as publication acts. They should provide a complete comprehension of the publication process, supporting selective control of self-exposure, expressing the scope and context of publication acts in terms of authorship, reputation, moderation and reach, and enabling practices that are well aligned with the social dynamics around the displays.

However, existing display systems and their publication paradigms still have to evolve in order to be effectively used as an open communication medium. It is a challenging objective which this research work aims to contribute. The challenges identified within this research work can be stated on the following questions:

- How to make publication practices in digital public displays available to people so that they can publish their own content and be aware of their act and its consequences?
- How can place owners share the display with other people and still manage social expectations and content appropriateness in the place?

- How can a place-based display present and combine content that was originally created for specific situations, and still make them meaningful to the place where the display is installed?

1.1.1 The challenge of simple publication practices

Digital public displays can have a huge potential as a communication medium for individual creativity and self-expression. Once open to accept content from other sources, digital public displays are recognized as an important tools for social coordination, promoting awareness and interest about local communities (Davies et al., 2012). However, enticing people to participate and generate regular contributions to public displays has revealed itself to be a recurrent problem. Huang and Mynatt (E. M. Huang & Mynatt, 2002) observed that in shared displays for large groups, individuals tend not to be motivated to supply content, or have difficulty identifying appropriate content, thus leading to displays that are uninformative because of a paucity of content. Moreover, the public nature of the publication act may constrain peoples' actions, as they need to feel confident and in full control over the publication process (J. Müller, Alt, Michelis, & Schmidt, 2010). Therefore, opening public displays to user-generated content and personalisation requires content publication practices that people may easily understand and appropriate according to their communication goals.

This framing is something that digital displays systems are not yet able to provide. Even though there is a wide range of implicit and explicit interaction techniques that can be used to support user-generated content, there is not a clear mapping between possible interaction events and specific publication concepts (Davies et al., 2012).

A publication paradigm should offer a particular mental model that allows users to understand the semantics and expectations behind a particular form of publication and reason about what is occurring. Otherwise, users will not feel in control, even if they understand the basics of interaction. The selection of an appropriate paradigm would be the major and possibly the unique decision that people would have to make when deciding how to publish content. A diverse set of publication paradigms with well-known properties should be much more effective in enabling people to easily express diverse communication goals and should also offer people familiar concepts that they would learn to recognise across multiple displays.

Therefore, it is necessary to explore new and flexible publication concepts for public displays that people can easily control and understand, but without requiring any

complex procedures or parameterizations. These publication concepts should enable situated interactions to be interpreted as publication actions, allowing people to focus on the meaning of the interactions rather than in the specifics of the process. This is also extended to the control over the publication act and the understanding of its consequences. In fact, those are considered as challenging issues, which are of paramount importance to build confidence and promote spontaneity of content publication in public displays.

Existing publication practices with digital social networks and with non-digital media are a reality that should be considered to inform the design of publication processes for digital public displays. Common practices from social media may help to simplify publication paradigms, so that people can appropriate them to reach their publication needs. Understanding what their communication paradigms can offer will also provide a stronger insight into the future boundaries between current social networks and future social interactions around public displays. Other forms of self-expression and individual publication practices (e.g. posters, leaflets, pin badges or t-shirts) that people use naturally, can also provide a valuable design inspiration.

The issue is to understand to what extent both digital social networks and non-digital media publication practices can be repurposed as a framework for locative publication in digital public displays. The communication features supported by both of these practices should be understood according to target, duration, removal, visibility, media type and other parameters that may be identified as relevant.

1.1.2 The challenge of social expectations and content appropriateness

Despite the recognized benefits of opening digital public displays to user-generated content, this also brings new challenges related to shared control. In fact, sharing control with other people means to accept that others will put their content on our screens but still guarantee that published content matches the wider social expectations and practices of a place.

Unless there is an effective way to frame people's self-expression within the expectations of appropriateness for that place, sooner or later, abusive use will occur. Then, whatever the potential value generated from user-generated content could be, it would easily be overshadowed by the negative impact of inappropriate content, which would ultimately defeat the initial motivations for user-generated content (Davies et al., 2012).

The problem of content moderation on public displays has many similarities with on-line communities and social networking platforms. Those platforms are very reliant on user-generated content, but poor content curation can easily lead to greater noise, which will then lead to a less useful system and ultimately to its dismissal by most users. Despite several similarities, moderation of user-generated content on digital public displays is a different type of problem, with its own specific challenges.

Firstly, the physical scale associated with public display means that content is specific for that place and is only seen by those passing-by in the limited small area around the display. Secondly, considering the potentially diverse audience to whom the content will be exposed, there may be conflicting views about content appropriateness and people will be less tolerant to inappropriate content because they might feel ambushed by situations they did not seek (Hosio, Kukka, & Riekki, 2010). Finally, due to the high degree of endorsement associated with media posted on public locations, even when content is user-generated and clearly marked as such, people assume that the owner of the display has somehow approved that content and is therefore endorsing it.

Social networks also have changed the ways digital identity is used as it is now the core of those systems. People use digital identity to present themselves in social networks and associate that identity with all the published contents, exposing and expressing themselves. This notion of self-exposure can also be explored in situated displays systems. However, situated digital identities have a strong connection to the physical presence, as well as the interaction performed with public displays and the places where they are installed.

Thus, it is still a challenge to understand the concept of identity in the context of a situated display system. Firstly, due to privacy issues concerning the presentation of identity information in a public display, strongly related with self-exposure management, that is, the part of identity someone is willing to present in the displays. Secondly, how people's identity will be considered in the publication act, for content assessment and endorsement. It is particularly interesting to understand how people are going to use and manage their identity and take advantage of it for raising acceptance and increasing the reach of the content they want to publish. This is strongly connected to the notion of reputation a person has in the place or with the place owner, raising the need to understand and define reputation properties and how they are managed and used in the context of publication paradigms.

The content dissemination strategies in display networks can also take advantage of social connections as a form of social capital that increases peoples' publications reach. If someone is very committed and gains support from a number of peers and possibly locations, it should be possible to increase the reach of the published content over a larger number of displays and possibly for a longer time.

In fact, communication using displays takes place as part of a larger social context that can be used to characterize it. Authorship, ownership and social negotiation are examples of attributes of social context that need to be studied and described in order to incorporate them in publication paradigms. The main research challenge is to understand the role of social connections in publication paradigms, that is, how social connections drive the content published in the display of a particular place or places. Specifically, it is necessary to understand how those new publication paradigms promote moderation, reputation and relevance.

Moderation is in fact a fundamental issue in most publications posted in public spaces, where implicit social rules are usually applied. However, there are significant differences among the social rules applied, and those depending on the nature of the place. For example, the publication of a poster on a wall of a street has completely different moderation rules than the same poster in a café or in a school. Even between the school and the café the moderation can be completely different, as it is expected a more flexible posture in the café and a stricter one in the school. Also related with moderation there are other important features that raise challenges to address, including the role content viewers might have in the moderation process and how different is this role from the one place owners have. Instead of formal moderation processes, this should be done in a socially sensitive way that does not hinder publication spontaneity and provides an adequate alignment with the social dynamics around the displays.

It is also interesting to understand what properties of the publication are really considered in the moderation process, that is, how the publication is actually moderated. In fact, moderation can be done based on different aspects of the publication, such as the content; the author; the person that publishes; or any other source of information such as social recommendations from other persons or even from other places. This notion of network of influences and recommendations is another thread to consider as exchange of content and collaboration are among the actual practices of content publishing. This sort of social collaboration can be seen at different levels, from person to person till place to place, and should be explored to improve digital publication paradigms and practices.

1.1.3 The challenge of place-based content integration

The prevailing mind-set is that content creation for public displays is a professional activity that should be tightly controlled and performed only by experts. In fact, people have developed high expectations regarding the quality of the media shown in digital public displays due to the obvious similarities between broadcast television and the currently prevailing paradigm for public displays based on the narrowcast model.

This institutional perspective of display content has had major consequences on their usage scenarios and the perception they generate as a communication medium. In particular, it led to more formal communication practices, which normally do not leave much space for spontaneous creativity and situatedness. (J. Müller et al., 2010) report on how this more formal content may impact audience expectations regarding what is presented on digital public displays as being mostly boring advertisements and trivial content, and how this leads to display-blindness, in which passers-by pay little or no attention to public displays (Memarovic, Clinch, & Alt, 2015). Reports of display-blindness are present even in a context where the information was highly tailored to an audience (Patterson & Clinch, 2018), demonstrating this is currently an issue that does not promote interaction with the display as contents seem to be not relevant and people ignore them, also ignoring the displays (J. Müller et al., 2009). Therefore, it is a challenge to explore alternative ways to conceive the communication experience offered by digital public displays, in which place-based displays are conceptually included, as they reflect the physical and social setting where they are inscribed.

A situated publication occurs whenever there is a relationship between the content and the particular context in which it is being shown. That context defines the situation of the publication act and may be characterised by space, time or some other relevant features. All publication acts have a situation but what definitely makes the situation valuable is the extent to which it can be used to assess the relevance of content that should be presented at each display and the scope of the content across the displays' network. This may drive the presentation of digital content as it could theoretically be presented anywhere and anytime. That is why it is a challenge to understand what facets of publication context can be effectively used to make locality a central aspect of content publication.

The content dissemination strategies based on locality are also a challenging issue when considering the ways in which people take advantage of the properties of the system

to increase the visibility of their content. This is part of a balance between the aspiration of people to publish and the interests of place owner and the place in what content should be published.

This balance is in fact difficult to define and needs a better understanding. From the point of view of publishers, there is the challenge of how to define the scope of a publication. Traditionally, scope can be defined using a set of parameterizations in the publication act but this paradigm should be improved towards a more fluent and natural mechanism that makes the meaning of the publication to be the main focus for the publisher. From the point of view of the place and its owner, there is the challenge of how to assess the relevance of publications and use it to decide what should be published. Relevance might be considered in two different but related angles. One is centralized on the place owners, that is, their particular interests, and it might be associated with their personality. The other is centralized on the places, their physical and even social environment and how they will be used in the definition of relevance.

However, situatedness is not restricted to locality and has more dimensions associated, e.g. time. Time is actually relevant in some of non-digital content. For example, leaflets and posters of a particular event are more relevant before the event date and after that they are less important. They can possibly be hold and be used as a reminder of the event for those that have attended it. After the event, they will be even less important for the places where the leaflets and posters are left in order to promote the event. Most of them are probably thrown away as soon as the event takes place or are simply forgotten until someone notices the dates. Therefore, time is another issue to consider when studying publication processes. Publishers should be able to define any sort of scheduling for publications and it should be used by the system either in scoping and relevance.

Another challenge related to the presentation of situated content concerns the effects of publication practices in scenarios of extreme usage. Most of the studies on public displays evaluate their usage within a restricted number of places. This also involves a small number of stakeholders, such as place owners, users and content viewers. Moreover, the quantity of publications on the displays is also limited, not big enough to become a serious issue for places whenever there is a need to filter or select content to present in the displays.

This might in fact be an issue for place owners when faced with the decision to apply appropriate filtering strategies to select content and still ensure it is relevant and

appropriate, given the social expectations of the display surroundings. Even when those filters are appropriately configured, it is still a challenge to observe and understand the decisions made by the scheduling systems to select content to display.

1.2 Research Objectives and Contributions

The general objective of this research work is the identification of novel media publication approaches for public display systems that serve people's communication needs. While this may also require mastering some interaction techniques, the challenges involved go far beyond the mere issue of how to interact. Like any other form of communication, interaction through digital public displays needs a context that enables people to fully understand the process, the respective implications and the scope of their actions. Therefore, a publication paradigm should provide an abstraction for what happens when someone publishes something in a display. It should provide a complete comprehension of the publication process, supporting selective control of self-exposure; expressing the scope and context of publication act; and enabling practices that are well aligned with the social dynamics around the displays.

This overall objective can be refined as a set of more specific objectives, particularly focused on the key challenges of this research.

Objective 1: To understand, explore and characterize the role of current self-expression practices as metaphors for new individual publication paradigms for public displays

The first objective seeks to understand how existing publication practices for self-expression and individual publication with non-digital media can inform the design of new publication paradigms and tools for digital public displays. There is an enormous set of existing practices of self-expression and content publication within the digital and the non-digital world. The study of those practices may inspire the design of novel digital publication concepts and tools. These practices may offer people some simple metaphors they could easily explore to serve their specific publication purposes. This allows a step forward towards the exploration of how existing publication models could provide an adequate metaphor for a diverse range of publication scenarios in a way that people can easily appropriate.

Objective 2: To understand and characterize existing place-based communication practices as a design resource for place-based displays

The second objective aims to find different usages for public displays in order to explore them as a generic and open medium for place-based communication. This allows us to inform the design of new communication concepts of public display systems, considering places as communication contexts and public displays as open communication media. To accomplish this objective, we aim to identify current place-based communication practices with non-digital and digital media that can easily be repurposed, recombined and valued by the use of public displays. Non-digital place-based displays are already everywhere, serving many, very diverse and very concrete communication needs. Therefore, their in-depth analysis should provide relevant insights that are of interest for digital place-based displays.

Objective 3: To identify and to classify control and moderation approaches as a valuable set of practices to inform the design of moderation control strategies for display systems

The third objective aims to understand social negotiation practices around shared use of place-based media, and repurpose some of them to leverage the presentation of user-generated content in digital public displays. Social connections can play and important role in driving the content published in the display and guarantees that published content matches the social expectations and practices of a place, as well as the goals of the display owner. It is also important to understand how new publication paradigms promote moderation, reputation and relevance among significantly different social environments. This objective also aims to address the broad range of control sharing situations, their diverse requirements and the broad range of moderation techniques that can be applied. More than proposing any specific control and moderation approach, the goal is to offer designers of interactive displays a framework they can use to map their concrete control and moderation needs to the most suitable set of the existing techniques.

Objective 4: To identify emerging digital publication practices as a valuable source of real strategies that people use to publish and manage content in display systems;

The fourth objective is to identify emerging publication practices and the role of open displays networks as a communication medium. It seeks to understand how digital

public displays are evolving towards alternative media publication paradigms that can challenge prevailing assumptions. Focusing on the concept of place-based displays, managed independently by a local display owner to serve the communications goals of a specific place, we seek to identify different publication paradigms and understand the nature of the content used and how it can inform the design of new media publication paradigms.

1.3 Methodology

These research objectives are mapped to a research process with three different parts (Figure 1): exploration, specification and evaluation.

The results of the exploration part contribute to research objectives 1 and 2, mainly with exploratory work on self-expression and place-based communication practices. The exploration part is basically the exploratory work that informs all the other parts and activities related with the other research objectives.

The specification part seeks to understand the publication process in respect to specific facets, in order to produce more detailed specifications of publication paradigms. The results of this part address objectives 1 and 2, respectively in the specification of media appropriation metaphors others can easily understand; and the specification of communication concepts for open communication media. They also contribute to objective 3, to the specification of approaches to frame social negotiation in the context of publication practices.

The evaluation part addresses objective 4 and comprehends the evaluation of public display network systems in use, and the identification of emerging publication and communication practices.

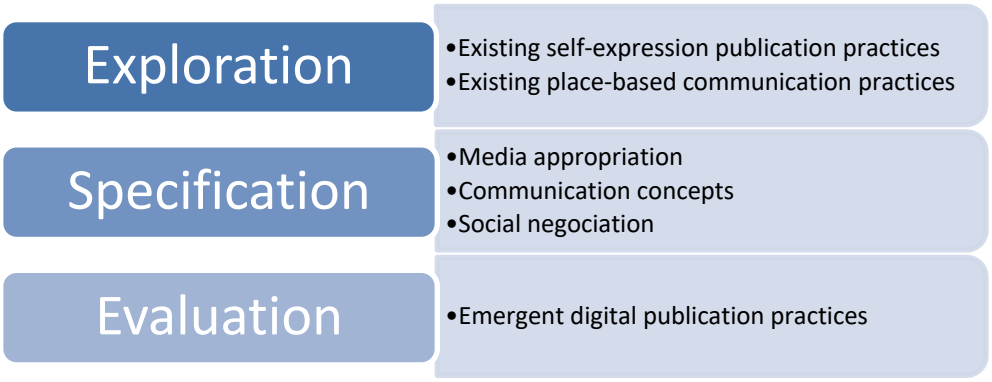

Figure 1: Research process and objectives

This research process is based on two key ideas:

- the use of existing publication paradigms from other domains as a resource for grounding the design of these new publication concepts, thus leveraging place-based content publication on metaphors and contexts that may already be familiar to most people;
- a very strong focus on the properties of generic publication paradigms that may drive multiple publication practices for user-generated content in digital public displays.

Both exploration and specification parts were supported by a set of specific studies that included observation of the usage of existing publication practices, complemented by semi-structured interviews with viewers, potential publishers of media content, and owners of the places where media content is published. The evaluation part was supported by a study that included the observation and reflection on publication practices over an existing network of digital displays.

All those studies seek for explanation of different research questions and follow specific research approaches with different techniques. More details about the research approach and the techniques of each study are described on the next chapters of this document.

The first study is detailed in chapter 3 and comprehends a structured analysis of existing non-digital self-expression practices. During the study different techniques were used for collecting data (ex. photos, text descriptions); semi-structured interviews using the collected data as support material; and a coding and consolidation process based on a Grounded Theory approach (Glaser & Strauss, 1967).

The second study, detailed in chapter 4, was based on direct observation of places to collect visual communication elements. The collected data was used to conduct semi-structured interviews. Both visual elements and segments of the interviews' transcription were used in a coding and consolidation process based on a Grounded Theory approach similar to the one used in the first study.

The third study, detailed in chapter 5, includes qualitative analysis of moderation situations and techniques referred in the research literature, and semi-structured interviews with people responsible for different types of places. The qualitative analysis was supported on a Ground Theory approach. The results emerged from the qualitative analysis were used during the interviews to place owners.

The fourth study, detailed in chapter 6, includes the analysis of real usage data from different installations of a display platform. The dataset is composed of events about the usage of the different media tools offered by the platform. It also includes screenshots of the actual media created and shown on the displays. The study comprehends qualitative analysis to the screenshots used once again a Ground Theory approach based on coding and consolidation. The study also includes a quantitative analysis to the metadata associated with the usage events.

Although diverse research approaches and techniques were used in the four studies, it is important to realise that they were used in the context of different problems, with different nature. In fact, the selection of the appropriate research approach for each situation not only allowed us to adequate it to the real needs of each study, but also enlarge the vision about the respective research object.

1.4 Scientific Publications

The work described in this thesis has generated nine scientific publications. Three journal papers and five conference papers. Table 1 presents a list of those papers and maps them with the chapters and research objectives of this thesis.

Table 1: Scientific publications and mapping with chapters and objectives

Objective / Chapter	Publication
3: Moderation / 5	1. Pedro Coutinho and Rui José, "A Risk Management Framework for User-Generated Content on Public Display Systems," Advances in Human-Computer Interaction, 2019. https://doi.org/10.1155/2019/9769246.
2: Place-based communication / 4	2. Coutinho, P., & José, R. (2019). Public displays as a multi-purpose medium for place-based communication: Lessons from current practices with non-digital displays. Submitted to Journal of Ambient Intelligence and Humanized Computing (under review)
4: Publication practices / 6	3. Coutinho, P., & José, R. (2019). Situatedness and emerging media practices in an open network of place-based digital displays. To be submitted to Journal of Universal Computer Science
1: Self-expression / 3	4. Coutinho, P., & José, R. (2015). Design Sensitivities From Public Expression Practices with Non-Digital Displays. In Proceedings of the 4th International Symposium on Pervasive Displays (PerDis'15) (pp. 139–145). https://doi.org/10.1145/2757710.2757738
4: Publication practices / 6	5. José, R., Silva, B., & Coutinho, P. (2016). Media sharing in an open network of place-based displays. PSF2016, Moutinho, Ana ed., Edições Universitárias Lusófonas
4: Publication practices / 6	6. Coutinho, Pedro, Rui José, and Bruno Silva. 2016. Understanding Media Situatedness and Publication Practices in Place-Based Digital Displays. pp. 154–60 in Proceedings of the 5th ACM International Symposium on Pervasive Displays - PerDis '16
3: Moderation / 5	7. Coutinho, P., & José, R. (2016). Risk Elicitation for User-Generated Content in Situated Interaction. In C. R. García, P. Caballero-Gil, M. Burmester, & A. Quesada-Arencibia (Eds.), Ubiquitous Computing and Ambient Intelligence: 10th International Conference, UCAmI 2016, San Bartolom{é} de Tirajana, Gran Canaria, Spain, November 29 -- December 2, 2016, Proceedings, Part I (pp. 481–486). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-48746-5_49
2: Place-based communication / 4	8. Coutinho, P., & José, R. (2017). Multi-purpose Place-based Display Systems: Implications from Current Practices with Non-digital Displays. In Proceedings of the 6th ACM International Symposium on Pervasive Displays (p. 16:1--16:7). New York, NY, USA: ACM. https://doi.org/10.1145/3078810.3078820
3: Moderation / 5	9. Coutinho, P., & José, R. (2017). Moderation techniques for user-generated content in place-based communication. In Iberian Conference on Information Systems and Technologies, CISTI. https://doi.org/10.23919/CISTI.2017.797578

1.5 Thesis Outline

This document is structured in chapters and they are organized in the following way:

Chapter 2 (Related Work) contextualizes the work related to this research, specifically related to the several dimensions around the publication practices within the context of digital public displays. In this chapter, several public display platforms are described, including the publication practices that are available to publish user generated content. The chapter also present research community contributions concerning the publication practices from the perspective of the relevant placeholders in the publication process.

Chapter 3 (Public Self-expression Practices) describes the exploratory work that frames current self-expression and individual publication practices and to what extent they can be repurposed for content publishing in digital public displays.

Chapter 4 (Place-based Communication) describes the usage of non-digital displays in semi-public places for their communication goals. It focuses on those usage practices and their implications for the design of digital place-based display systems.

Chapter 5 (Moderation and Risk Management) identifies a set of issues concerning risks of user generated content and moderation techniques to mitigate those risks. It addresses the issue of how to share control with users while still guaranteeing that content matches the expectations and practices of a place.

Chapter 6 (Media Practices with Place-based Displays) exposes current media practices in public displays network systems and explores ways those systems may evolve towards alternative media publication paradigms.

Chapter 7 (Conclusions) presents the conclusions of this research work, summarizes the key contributions and opens discussion for future research directions and opportunities.

2 Related Work

2.1 Overview

In this chapter we describe and analyse previous work in relevant research areas for the context of this thesis, which helps to position our contributions in the current state of the art. The chapter is structured around several conceptual dimensions; the description of a selection of display systems for each dimension; and finally, a global analysis, reflecting about the innovation we aim to introduce with the research work described in this thesis.

The description of the examples of display systems considered in this chapter aims to help in the contextualization of the correspondent dimension. However, most of the considered display systems could well be presented in the context of multiple dimensions, considering their large scope on covered research issues. Each of the described display systems is somehow open to the presentation of user-generated content and supports publication facilities. They also support different techniques for moderation of the published content. The systems described provide the context to understand the challenges the research community on public display has been facing to design effective display systems open to applications and publication of content from many sources.

2.2 Situated displays

Displays are part of the live and the environment that surrounds the human being. Many of these displays are in public spaces and are commonly used to display advertising, traffic signs, indicating directions and pathways, identification of spaces and places, etc. Other examples can be found in private spaces such as homes, where it is common to use the most diverse and unlikely surfaces as information displays, under which are usually placed notices and correspondence received, according to habits acquired in the family (Crabtree, Hemmings, & Rodden, 2003). Some of the aforementioned examples, especially those that are located in public spaces, exist in the form of static displays, whose content is permanently maintained until the substitution of the display itself. Although traditional displays still prevail in public spaces, the presentation of information has been gradually done through the use of digital displays (K O'Hara et al., 2003). This

type of publication allows a set of new multimedia experiences in the surroundings of the display, thereby promoting new and richer practices in their usage (J. Müller et al., 2010).

Digital displays act as points for presentation of information and, given its ability of presenting various sources of content and being controlled remotely through network connections (e.g. Internet, Bluetooth), it significantly increases the chances of adaptation to new contexts and new forms of interaction. This contextualization is widely exploited in several examples of use of what is commonly known as situated displays, or public situated displays, when the displays are placed in public spaces and are intended to be viewed and explored by the general public.

Research on digital displays, whether public or private, has certainly got a technological nature. It concerns the technology used on the display; the technology that supports the management of content and its scheduling; and all other kinds of technologies that support the interaction with it, as for example through the use of mobile devices (José, Otero, Izadi, & Harper, 2008). However, there are other trends of research, not necessarily technological, that aim to understand the role of public displays, digital or not digital. In these cases, displays are considered as collection of surfaces which people are confronted on their route and during their daily living, and where the publication of content occurs naturally in order to complete a particular action or task (Crabtree et al., 2003). The approach used by Crabtree et al. (2003) identify and study the actions done by people in order to present certain contents, regardless the kind of display used (digital or non-digital). It assumes the existence of a collection of displays somehow articulated, as if there were a well-defined network. The results of such approach can be exploited in the design of a network of public situated displays, in which users can publish contents in a natural way, similarly to what they do with non-digital displays. Although the context presented by Crabtree et al. (2003) applies to the domestic environment, this approach can also be found when considering displays located in public spaces (K O'Hara et al., 2003), exploring the social and interactional aspects of shared displays.

In particular, place-based displays, or situated displays, are described by K O'Hara et al. (2003) as focal points for social coordination, helping to create a shared sense of place, inviting people to action and setting behaviour expectations in public venues. As summarized by these authors: *"...they inform us about places, amenities, and events of interest and reflect the activities of others […]. They act as important cultural reference points in the construction of shared meanings, beliefs, desires and the memories of groups and communities*."

Situatedness is one of the perspectives of the interplay between technology and its placement and has long been recognized as playing a key role in the design of interactive systems. Dourish (2001) explores how embodiment, described as a physical presence in the world and a social embedding in a web of practices, can play a key role in the design of interactive systems. The idea of place as relative to a particular community of practice, suggests that distinct groups of people might be using the same space at the same time with very distinct purposes. McCullough (2004) also considers that the definition of place is closely related with people's particular appropriations of a space and therefore the "identity of a place" is what makes it unique or recognizable. According to Memarovic, Langheinrich and Alt (2011), to promote community identity cognition, displays should consider environment-originating content, that implicitly connects community members; and people-originating content, that encourages user-generated content and explicitly portrays community values.

Despite the widely acknowledged importance of situatedness as a key driver for the relevance of public displays, most public display systems are still far from attaining a meaningful level of connection with their placement. As pointed out by E. M. Huang, Koster and Borchers (2008), the vast majority of large displays in public areas are designed without proper consideration for the ways in which the display setting, i.e. space, the people around and the local activities, may affect the perceived relevance of those displays, thus yielding suboptimal situations, lower utility, and less attention.

A common approach to create displays with a strong connection with their setting is to explore a design perspective centred on a specific target place. According to this model and prior to the conceptualization of a communication concept, a designer would study the setting where the display is to be deployed. The study may address local practices, how the place is perceived by people and, possibly, the types of practices that it is meant to support. This initial study is then expected to inform the creation of media concepts that are sensitive to the various dimensions of the target place. This way, designers can make informed decisions that are sensitive to these issues and create a particular display experience to explicitly convey a specific sense of place.

This design approach has been extensively explored across many types of places. K O'Hara et al. (2003) describe how a situated display appliance showing basic room reservation information outside the meeting room could become an important resource for social action around the use of that space. Their observations highlight how the information on the displays was regarded as a resource for action rather than an absolute

rule, and also how local knowledge about activities in the office was implicitly used to interpret what the information of the displays really meant. Odom, Pierce and Roedl (2008) describe how the situated visualization of water consumption in dormitory communities can be used as a tool for promoting sustainable behaviours. The situated and communal nature of the display is described as a key element in peer-pressure and community awareness.

The Shannon Portal Installation (Gallagher et al., 2007), is an airport interactive installation designed to allow people to share their travelling experience based on their photos. The authors emphasize that when designing for public environments it is essential to understand the place in its entirety, including the system's physical and material qualities. Graham, Cheverst, Rouncefield and Kray (2005) describe field work done at a residential community care facility that investigated the setting and discussed technology designs with care workers. The result is described as providing a broader understanding of the care workers' needs and informing the design of public displays on how and where technology could be deployed. The Whereabouts Clock (Sellen, Eardley, Izadi, & Harper, 2006), that displays the approximate location of family members, or the HomeNote (Sellen, Harper, et al., 2006), that displays SMS messages and notes sent by family members, are also examples of situated displays providing awareness about the location or activities within a family. They serve as tools for coordination between the family members and implicitly reflect their daily routines.

2.2.1 BiebBeep

The BiebBeep system is a large touchscreen installed in a library and designed to augment the information and social function of this kind of particular places (Kanis, Groen, Meys, & Veenstra, 2012; Veenstra, 2011). The system supports user-generated and integrates it with context-specific information, such as the recent items in the library collection; events and activities occurring in the library and the region; RSS news feeds.

The information people can add to the display is restricted to content from social networks, as tweets from Tweeter, photos from Flickr, and videos from YouTube. The Library staff can also post content on the displays by using those social networks. They can upload more elaborated content through the use of a custom designed web-based CMS application.

The BiebBeep is aligned with the demands of current and next-generation users of a library, facilitating a smooth integration of the library and visitors' information,

promoting the social integration. The display is installed in the entrance of the library. People can also interact with the content and display closer looks of the information (Figure 2).

Figure 2: BiebBeep display system in the Library entrance (Veenstra, 2011)

The BiebBeep ran for more than a year and the evaluation revealed that all kind of users (library visitors and staff) mainly considered the system as an important tool for improve the information about the library's activities. The system also promoted social interaction, with people standing and using the display together, although it was mainly between people who were already familiar to each other. The most watched items were the photos and videos, rather that text content. However, the Twitter functionality (mainly text-based content) seemed to contribute to bring people from the library and the region together, something that probably would not occur without the mediation of the BiebBeep system.

2.2.2 Semi-Public Displays

The Semi-Public Displays (E. M. Huang & Mynatt, 2003) is a system to promote awareness between the members of a small, co-located group within a confined physical space. The objective was to improve coordination and collaboration through the semi-public presentation of lightweight information about group activities.

The Semi-Public Displays system provides four applications to support the display and the access to the information: *Reminders, Collaboration Space, Active Portrait, Attendance Panel* (Figure 3).

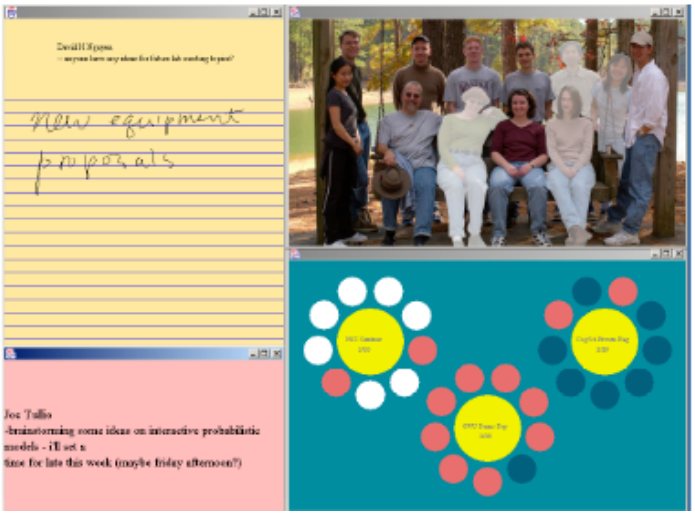

Figure 3: The Semi-Public Displays applications (E. M. Huang & Mynatt, 2003)

The *Reminders* application presents information about helping requests, extracted from status reports that were usually sent by email. This way, the information would be kept persistently visible in the environment, avoiding repeated requests usually sent by email. The *Collaboration Space* application provides a dynamic, captured space for posting items and related comments, that was editable and viewable by anyone at any time. The posted items were once more selected from internal status reports, and users were able to contribute posting comments with new ideas or edit previous ones. The *Active Portrait* application is based on a group photograph that represent an abstraction of the group activity, based on the presence and recent activities of each member of the group. The *Attendance Panel* application provides an abstracted view about the popularity to upcoming events, allowing someone to infer about group interests. This application was design to be appropriate for public displays, preserving user's privacy, as no personal details are shown.

The evaluation of Semi-Public Displays systems confirms its potential for effective and informative awareness applications designed to support the needs of small, co-located groups. However, when comparing Semi-Public Displays design with the design needs of large, loosely connected groups, the first one mitigates typical problematic issues related to the relevance of content and minimizes privacy concerns.

2.2.3 Joe Blogg

The Joe Blogg (Martin, Penn, & Gavin, 2006) is an artistic installation that explores the concept of situated displays as media for the creation of meaningful places. It aims to

understand how situated technologies affect the behaviour of people in the vicinity of the physical space, and if a collective sense of purpose would emerge from the individual contributions of content to post in the display.

The display was installed in the reception area of a school of the University College London (UCL). It allows users to post content via SMS or MMS sent by their mobile phones. The pictures sent by MMS were presented in two rectangular areas of the display, one for the picture that is actually being presented in the display, and the other rectangle for the earlier picture that has been presented. The remaining parts of the display were occupied with fragments of on-screen pictures, randomly selected and continuously renewed, to present movement enough to motivate interaction with the system. The text messages sent by SMS were presented in specific areas with dark background colour (Figure 4).

Figure 4: Joe Blogg installation display (Martin et al., 2006)

The possibility to interact with the system from other locations of the building suggests some inhibition during participation. It is interesting that some of those participants returned to the display to check if their messages had arrived, which may suggest a lightweight form of social accountability. Although there was no control on the posted content, no content inappropriateness issues were reported.

2.3 Context-aware displays

Context-awareness provides yet another way to approach the concept of place-based displays, by enabling displays to dynamically sense and react to the changing environment around them. This context-aware approach is something that has been explored in numerous ways. Farnham et al. (2009) describe how a sense of community and place attachment can be promoted by displaying media associated with the profiles of people present in a café. BluScreen (Sharifi, Payne, & David, 2006) uses Bluetooth detection to optimise advertisement selection according to the people around, as content that has already been shown when a particular Bluetooth device was present in the place is avoided if that device is present again, thus reducing the likelihood of the same content being shown again to the same person. H. J. Müller and Krüger (2006) propose a model for learning the spatial-temporal behaviour of users and then enable a situated display to estimate profiles that could be used for presentation, on the display, of the information that is most interesting to users.

The Peddler Interaction Framework (Wang, Boring, & Greenberg, 2012) incorporates continuous proxemic measures, such as distance and orientation; attention states, such as digression and loss of interest; and the passer-by's interaction history. The goal is to adjust the display's behaviour in such a way that maximises the ability to attract attention, maintain interest, create desire, and lead people to action. Instant Places (José, Pinto, Silva, & Melro, 2013) enables people to express their content preferences in the form of pins that are recognised when the user checks-in to a display using a mobile client. The displays will then preferably select the content sources associated with those pins. The Funsquare application (Memarovic, Elhart, & Langheinrich, 2011) presents trivia information in a way that reflects the current context around the display. Information such as the number of displays around the display is crossed with the display content to create a stronger connection with the display context.

2.3.1 e-Campus

The e-Campus (Friday, Davies, & Efstratiou, 2012) is a long-term public display testbed deployed at Lancaster University campus, UK. The project was required to serve as a laboratory for several researchers from different areas (Figure 5), encouraging multi-disciplinary research in the areas of digital signage, mobile and ubiquitous computing (Storz, Friday, Davies, et al., 2006). After a long period of fully operated system, there

are some research areas that should be highlighted, such as the system infrastructure for signage; the user interfaces to create content; and interactive applications.

Figure 5: e-Campus installations (Storz, Friday, Davies, et al., 2006)

The system infrastructure allows the management of a collection of non-touchscreen networked displays. The system provides an API for programming the network of displays, that includes the basic operations for scheduling content and visual transactions in a group of displays (Storz, Friday, & Davies, 2006).

One of the first projects exploring content creation and distribution over e-Campus infrastructure is the e-Channel system (Clinch, Davies, Friday, & Efstratiou, 2011). The objective was to developed a system that provided a simple way for enabling users to distribute content to a network of displays and control content on their own display.

The e-Channel system separates the roles of content providers and display owners. Content providers generate multimedia and web content in a wide range of formats, and organize their content in a logical container called “channel”. A content provider has full control of their channels, including facilities to add and remove content, as well as scheduling the time a channel should be active. Content providers have no control on where and when their channel’s content is displayed. On the other hand, display owners control a number of displays in the network. They control content on their display by subscribing channels. Display owners can also control when the display should be turned on or off.

Although the two roles are completely separate from one another, the same person can perform both roles, controlling the content and its presentation on the display. However, e-Channel system imposes no restrictions on how display owners subscribe channels and how content is published through channels, assuming that content moderation is a responsibility of content providers. As channel’s providers can change its content at any time, and given that subscribers cannot preview channel’s content,

subscription decisions are taken based on the channel description and the reputation of the channel source (Clinch et al., 2011).

An evolution for content creation and distribution over the e-Campus displays considers the vision of application store for interactive display applications (Clinch, Davies, Kubitza, & Schmidt, 2012). Within this vision, the stakeholders set includes the display and space owners, the viewers and the application providers.

The applications available in the store are managed independently in order to provide contents to be presented in the displays. The association of the application with the display can be done using the two expected classes of applications: applications for display owners, purchased by the owners in order to have high quality and appropriate content in their displays; and applications for display viewers, which can purchase an application for displaying content in one or more public display. Both classes of applications that are available from the application store express forms of control over the content and openness to content published by third parties. However, a higher degree of thrust is required from display and space owners when they are willing to host user-purchased applications.

The Mercury system (Clinch, Davies, Friday, et al., 2014) is an implementation of an application store, developed under e-Campus project evolution that provides web-based interface for application providers and display owners. To present content on the displays, another platform has been build, called Yarely (Clinch, Davies, Friday, & Clinch, 2013). Basically, it is a display-based scheduling and media playback software, that can be connected to multiple content sources simultaneously, that are not necessarily aware of each other, such as the content applications available in the application store.

The e-Campus testbed has also been explored for experiments on interactive applications. Those have been focused on allowing display viewers to user their mobile devices to have some level of control and being able to signal their preferences concerning the presentation of content in a particular display or group of displays.

After some disappointing experiences using interaction techniques such as SMS and earlier mobile phone applications, the approach based on Bluetooth Device Names (Davies, Friday, Newman, Rutlidge, & Storz, 2009) has been explored to allow users to make requests for content and to interact with applications by changing their devices' names (Figure 6). The Bluetooth names are basically valid commands to start services that are available to the users, such as maps (map of the campus), Flickr (photos), Youtube (videos), Google (search results), Tiny (web access) and Juke (play songs). The content

provided by those services is them prioritised over the ordinary scheduled content, displayed by default in the display network. Although there is no control mechanism over the commands that could entail offensive content to be displayed, the suitability of an application for deployment in a specific display is considered as an instrument to mitigate the risks of inappropriate content (Davies et al., 2009).

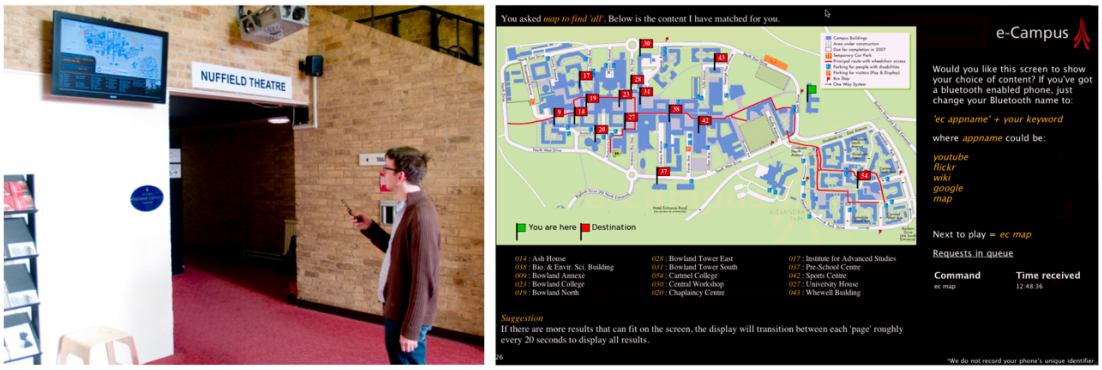

Figure 6: Bluetooth interaction with the e-Campus display (Davies et al., 2009)

A more recent approach for open displays to content suggested by passing viewers is part of the Tacita system (Davies, Langheinrich, et al., 2014). Tacita was designed to enable passing viewers to personalise content displayed on public displays, without having to reveal their identity or preferences to the display owners (Kubitza, Clinch, Davies, & Langheinrich, 2012).

The Tacita system provides users' interaction through an Android mobile client application, that allows them to discover nearby displays and to view a list of available content applications (Figure 7). Users can enable applications and define a set of parameters passed directly to the content application providers rather than sent to the display. The Tacita system uses a scheduling model that prioritises requests from applications triggered by users when within the proximity of particular display.

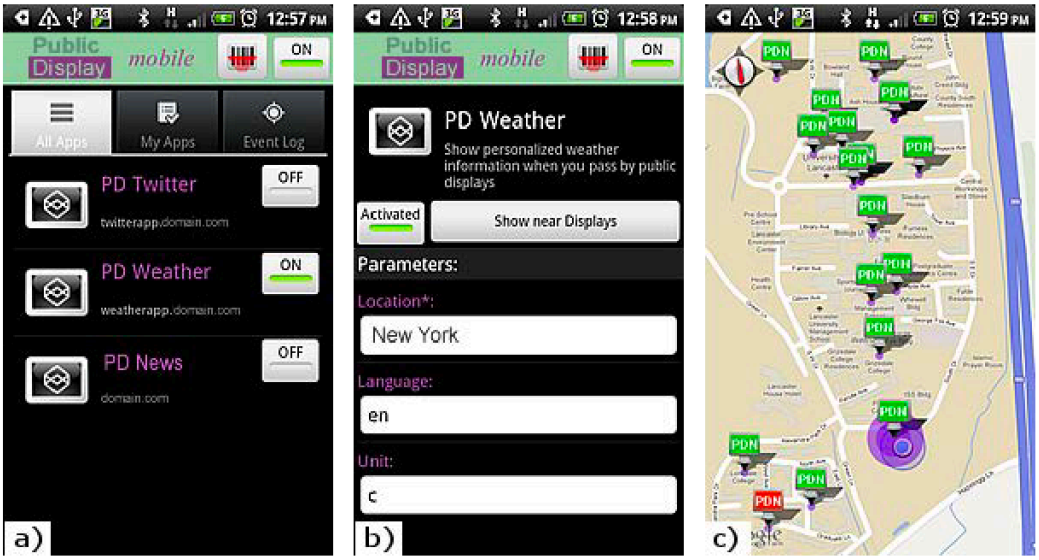

Figure 7: Mobile Phone Client Application UI using Tacita (Davies et al., 2014)

The e-Campus testbed is still being used for recent experiments that focus on the role and potential of the displays as memory augmentation tools to support teaching and learning activities in university environments (Mikusz, Clinch, Shaw, Davies, & Nurmi, 2018).

2.3.2 UniCast, OutCast and GroupCast

Unicast, OutCast and GroupCast systems (McCarthy, Costa, & Liongosari, 2001b) provide three approaches for exploring and using peripheral awareness in different workplace contexts. Unicast was designed to be a personal display within an individual office. OutCast was designed to be a personal shared display placed outside office door. GroupCast was designed to be a shared display in a public area of an office building.

The UniCast application allows users to specify content to be displayed on a dedicated peripheral display, located within their offices (Figure 8). There are different types of content available, all provided by user-configurable modules running on the display, and all these preferences are stored in the user's UniCast profile. The system behaviour is tied to a presence detection infrastructure supported by infrared badges. Depending on the user's sensed location the system changes between the modes home, displaying content based on the configurable modules; and away, either presenting the user's current location or a predefined message.

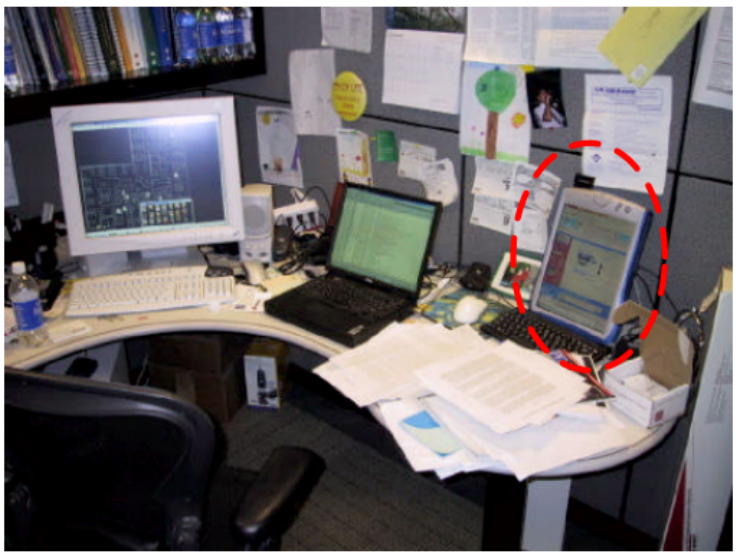

Figure 8: UniCast display within an office (McCarthy et al., 2001b)

The OutCast application is directed to co-workers near a specific office door (Figure 9). It displays information about the user of the office (the office owner) that is intended to be viewed by others. The OutCast design was motivated by a behaviour that is pervasive throughout the office environment when content such as papers, articles, cartoons, photographs, schedules, notices are posted on office doors (McCarthy, Costa, & Liongosari, 2001a).

Figure 9: OutCast display outside an office (McCarthy et al., 2001b)

OutCast presents content added and edited the same way as UniCast content. The content is about the office owner and includes personal biography, projects information,

calendar, photographs, quotations, among other. All this content is displayed when OutCast is working in a passive mode. In the active mode, OutCast allows users to interact with the display to browse through content or leave a text message to the office owner, using the touchscreen interface of the display.

The GroupCast application was intended to be a semi-public peripheral display to promote informal interactions and conversations in a workplace (Figure 10). The GroupCast display was installed in a hallway and the displayed content is of interest to at least one of the people sensed near the display. GroupCast relies on user profiles from UniCast, as they represent users' own interests in customizing content to be displayed regularly in their office.

Figure 10: GroupCast in context of use (McCarthy et al., 2001b)

Experiences with the three systems have been conducted for several months and the evaluation results reveal interesting observation from systems' usage (McCarthy et al., 2001b). In UniCast, most users run the application on a display that is peripheral to their primary display. The UniCast most popular module was the Web Pages module, that allows users to specify any web site to stream content to their displays. The informal feedback from OutCast users suggests that the system was usually used when the office owner was away. The OutCast users also reported that the office owner's location information and calendar were the most liked features. The least liked and used feature was leaving a text message, as users were uncertain about the reliability of this feature

and still tend to leave messages using post-it notes rather than bits (McCarthy et al., 2001b).

2.4 Community and urban public displays

The use of public displays in urban contexts is criticized as being focused on advertising and disconnected from local communities. The Urban Screens movement (Struppek, 2006) promoted worldwide initiatives to address the use of urban displays as a way to contribute to a lively urban society. Their promoters advocated a stronger binding of the screens to their communal context to promote local identity and engagement; civic and cultural expression; community building; multiculturalism and public engagement. Struppek (2014) observes that the use of urban media has been promoting smooth business solutions in which public space becomes a theatre stage with carefully produced and enjoyable infotainment. As an alternative, she claims that urban media should provide an alternative tool to promote communication and the sense of community in order to create a new interaction context for a democratic society.

Moreover, Foth, Tomitsch, Forlano, Haeusler and Satchell (2016) argue that displays should be key touch points between "the city" and its civic body, the citizens. In particular, they argue that public displays, as urban interfaces, have unique capabilities for meaningful civic engagement. They should be able to reach a diversity of citizens and break away from the echo chambers and filter bubbles created by the automatic content selection algorithms that control most of our digital activity.

2.4.1 UBI Hotspots

The UBI Hotspots (Ojala et al., 2012) infrastructure is set in the city of Oulu, Finland, and it constitutes a large scale public display network with several indoor and outdoor hotspots. The displays are available for public use and all are equipped with a touch screen that allows user interaction to trigger explicit actions (Figure 11). Each display system is combined with two cameras; a loudspeaker; an NFC/RFID reader for user authentication; and it has available multiple wireless networks.

Figure 11: UBI hotspots displays (Ojala et al., 2012)

A hotspot has two operational modes: passive broadcast and interactive (Linden, Heikkinen, Ojala, Kukka, & Jurmu, 2010). In passive broadcast mode the screen is totally dedicated to the UBI-channel, a digital signage service broadcasting local advertisement in the form of videos, animations and sequences of still photographs. The display changes to interactive mode when someone is detected in front of it or when someone touches the display. In interaction mode, display splits between the UBI-channel and a customizable UBI-portal, that includes a set of interactive web-based services, that are tailorable for each hotspot. Both modes operation can be observed in Figure 12.

Figure 12: UBI hotspot operating modes (Linden et al., 2010)

The UBI-Portal presents a broad range of web-based applications and services, including local up-to-date news; a map-based service with a collection of geo-referenced local information, such as restaurants, cafés, libraries and the location of the other UBI Hotspots; and multimedia content (images and video), including user generated content uploaded from personal mobile phones. The uploaded images are tagged with appropriate

tags and stored in Flickr. The uploaded videos are stored in YouTube. Both images and videos can be flagged by the community and temporarily removed for inspection by a content moderator.

The interaction with the UBI-portal services is also supported by distributed application user interfaces on personal mobile devices (Hosio, Jurmu, Kukka, Riekki, & Ojala, 2010; Linden et al., 2010). The devices can be connected using several technologies, such as NFC/RFID tags, QR codes, Bluetooth, SMS, and users are allowed several interaction tasks, including content upload and download, and uploaded content management. The deployed applications include the UBIAlbum, that is an application for managing images users upload to the displays (add/remove tags, remove images, etc); the PlaceMessaging, that allows users to post notes containing text and images from their mobile phones to the display, so they can be displayed in each display's specific board. More recently, there is another indoor installation, called UbiLibrary (Kukka, Heikkinen, Kytökangas, Tanska, & Ojala, 2018). It uses the UBI Hotspots infrastructure in the lobby of a public library, and opens the discussion on the physical location of the display, and its influence on to the interest surrounding people may have in the installation.

The motivation for sharing display's contents with others in urban context is essentially economic, due the high cost to set up and maintain an infrastructure, such as UBI Hotspots (Ojala et al., 2010). However, it raises interesting issues related with the control and moderation of that type of content. In fact, the majority of the services typically depend upon third-party content, which is beyond the administration control.

2.5 Media practices from non-digital displays

Place-based communication is already everywhere, albeit based on non-digital media. The situatedness that seems to be lacking in most digital systems, seems to be very natural when it comes to their non-digital counterparts. Therefore, the study of current practices with analogue media can provide an important source of insights on how to design situated digital displays that can efficiently support place-based communication.

The study of current content management practices with analogue media has already been explored as a research approach to inform the design of digital displays. Alt et al. (Alt, Memarovic, Elhart, Bial, & Schmidt, 2011) studied content management practices associated with paper based Public Notice Areas (PNAs). They address the motivations venue owners can have to share their public boards and also their approaches

for controlling that content. They seek to understand what type of content is left there, how the control of content is made and the ways used to entice the publication of new content. Their work uncovers some of the practices behind the operation of these non-digital boards and discusses their role in the design of future generations of globally networked public displays. Similarly, Melro et al. (2013) have studied existing media sharing and moderation practices with the distribution of paper leaflets on cafés. They identified that media acceptance criteria are very different between venues and far more sophisticated than what may be anticipated by simplistic rules of appropriateness. In fact, they found the existence of informal, but well-established, forms of social negotiation that determine social expectations and content acceptance criteria. These are both in-depth studies aiming to understand the role of external entities in specific types of communication practices.

A characterisation of the key dimensions and design elements that may improve the integration between digital displays and their physical and social setting is proposed in (José, Otero, & Cardoso, 2014). This work studied many different types of public displays, mostly non-digital ones, to uncover the multiple ways in which the notion of situatedness can be captured, become readily available as a design resource and frame the design of the system. The result is a list of situatedness dimensions (location, spatial, activity, community, perceived ownership, and place) that display designers may pursue to reason about situatedness support in a new display system. The situated behaviour of any display would thus be the outcome of various forms of adaptation across multiple situatedness dimensions.

2.5.1 Digifieds

Digifieds (Alt, Bial, et al., 2011; Alt, Kubitza, et al., 2011) is a digital version of a public notice area. Traditional public notice areas contain multiple types of content, such as classifieds, event, announcements, advertisements.

Users of the Digifieds system can use different interaction techniques for creating, posting and retrieving content (Alt, Shirazi, Kubitza, & Schmidt, 2013). For creating content (Figure 13), they can use the on-screen keyboard to type text and then combine it with uploaded images or videos from a USB stick. Users can also create content using the mobile phone client, which allow them to prepare content to be published once they are close to a display. Another alternative for creating content is thought a web client, where people can create content away from the display.

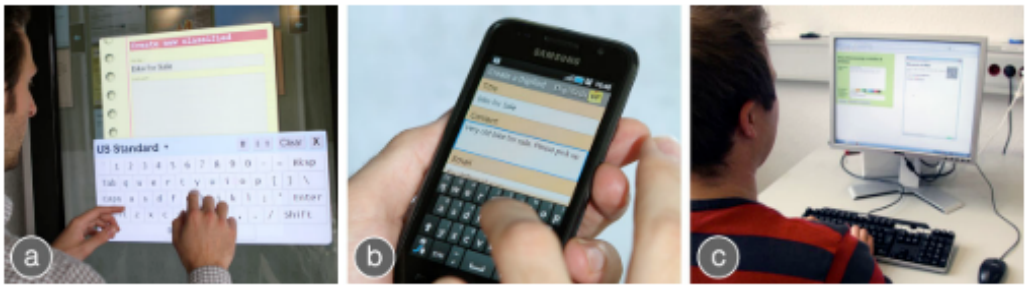

Figure 13: Creating content for a Digifieds display (Alt et al., 2013)

All the content created directly using the touchscreen facilities of the display is stored in the system and is immediately available to be displayed. Content that is pre-generated can be passed to the display using different technologies. Users can touch the display with their mobile phones in the position they want content to appear. An alternative way is based on the provided alphanumeric code to activate previously generated content. Another way for posting content is using QR codes that are generated after users create content using their mobile phones or the web site. The available interfaces for posting content are presented in Figure 14.

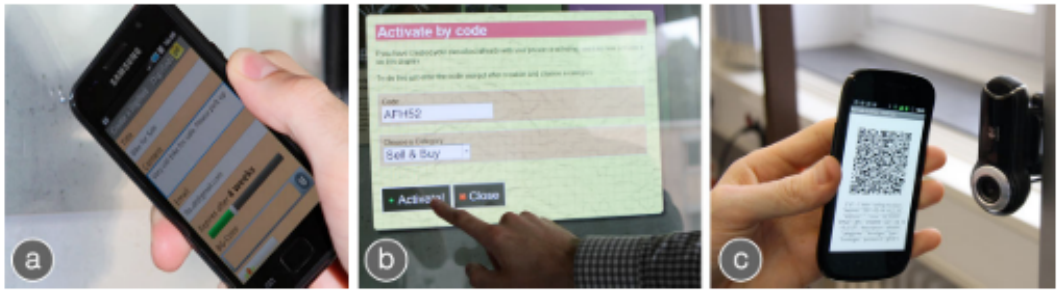

Figure 14: Posting content on a Digifieds display (Alt et al., 2013)

The Digifieds system also allows users to take content away from the display with them (Figure 15). They can touch in the display with their mobile phone and retrieve the content, similarly the way they use it for posting content into the display. They can transfer content to their mobile phones by scanning the QR codes or using the alphanumeric code available next to the post. Another alternative is sending the content by email, entering the email address directly in the touch display. Finally, users can print content using the printer installed next to the display.

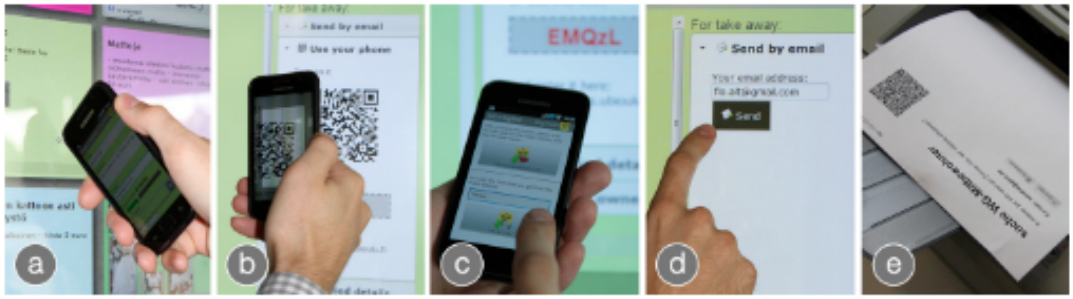

Figure 15: Retrieving content from a Digifieds display (Alt et al., 2013)

The evaluation of Digifieds system has been made through different perspective and focus. Considering the interaction modalities, an interesting result is that the multiple means of content production are actually required and useful, as the preferred interaction technique often depends on the current situation (Alt et al., 2013). The multiple ways of interaction for posting and collecting digifieds present in the system have been considered as a positive factor to enable the interaction from persons with different age and technological skills; as well as to allow persons with different interests and different content quality requirements to publish the desired information.

In particularly, direct interaction with the display provides the highest usability and resembles the functionality of the traditional non-digital public notice areas that still can be found in several places. However, the mobile interaction techniques are ideal for privacy-aware users because they allow to enter sensitive information without being observed by the other users in the display surroundings.

Considering the content posted on Digifieds, as it occurs with traditional public notice areas, both content providers and viewers envision locally relevant content (Alt, Kubitza, et al., 2011). The relevance of content depends on the location of the display and the viewers, and in many cases the content providers and viewers share the same place. However, whenever this is not possible, it is necessary to develop better ways to distribute content to the intended places.

2.6 Self-exposure and identity management

The concept of identity is considered throughout multiple contexts and disciplines with diverse meanings. It is a concept used in psychology and social sciences, associated with the concepts of self. It is also used in areas such as information systems and computer

science, more closely related to the issues of access and control to a set of digital services and resources.

The presentation of self in the real world has been explored since the work developed by Goffman (1959). This novelty work considers the management of self as a manipulation of physical settings and personal characteristics (such as appearance, language, gestures) to construct the desired image of the self on others. Thus, presentation of self is basically the intentional and tangible exposure of a part of the identity, which includes two different, but related, aspects: the individual and the social aspects.

The individual aspect concerns the way someone is exposed in front of others. The social aspect is related with the social associations that each one has, particularly through membership in social groups. While individual identity can be useful for the characterization of self ("me"), the identity by affiliation is particularly relevant in the characterization of "us" (Schau & Gilly, 2003).

An alternative approach to the classification of identity is proposed by Wiley, characterized by operational values and ideal values (as cited in Schau & Gilly, 2003). Operational values are attributes that correspond to expressions of daily behaviour of an individual or group. For example, using particular brand and clothes' style; using gadgets; using pins, stickers, tattoos. The ideal values are related to the set of attributes to which an individual aspires but does not actually hold, suggesting that the identity of an individual could go beyond the actual reality. The presentation of identity based on the ideal values is more complex to realise in physical environments, considering the social pressure done by real people in the vicinity (Schau & Gilly, 2003).

Self-expression is understood as a way to expose any of the identity attributes by use of forms of expression. It is an additional way of reveal the self and is usually done with confidence, making people more likely to reveal some attributes of their identity. Self-expression involves the manipulation of signs, body representation and experiences, in order to create a desired image of self and present it to the others (Goffman, 1959; Schau & Gilly, 2003). It can also involve the usage of objects which are again considered as attributes of identity (Goffman, 1959; Zimmerman, 2009).

As physical presence is not considered in virtual environments, the strategies of self-expression may be substantially different from those used in the physical environment (Schau & Gilly, 2003). However, the motivation for self-expression is similar in both virtual and physical environments, as the ultimate goal of the individual is

still to construct an identity to expose (Boyle & Johnson, 2010; Papacharissi, 2002; Schau & Gilly, 2003; Zhao, Grasmuck, & Martin, 2008).

The management and maintenance of the exposed identity has different challenges in physical and virtual worlds. In physical environments, identity management is performed based on real situations of the person, for example, the location and the persons in vicinity. In virtual environments, entity management requires a different approach, based on content published and virtual relationship with things that may be virtual, and thus easier to get then in the physical world. In fact, the identity management in virtual environments allows people to create an identity based on associations with certain objects that they desired, but not necessarily have got in the physical environment (Schau & Gilly, 2003; Zimmerman, 2009).

The self-expression in virtual environments has been studied in several contexts, from personal web pages (Papacharissi, 2002; Schau & Gilly, 2003) to social networks (Boyle & Johnson, 2010; Zhao et al., 2008). Using personal web pages, people can control the information to present, although it is presented the same way to everybody and there is no control on who accesses that information. In social networks, self-expression is mandatory for the effective use and active participation (Boyle & Johnson, 2010). People use social networks to disclosure an identity that is very similar to the one presented in physical environment (Boyle & Johnson, 2010; Ellison, Steinfield, & Lampe, 2007). In fact, in social networks, the virtual identity is permanently observed and controlled by others, including people that were already close to each other before the connection in the social network.

In his work on self-expression, Goffman (1959) argues that the presentation of the self is contextualized, based on certain physical situations, and in front an audience that is usually predictable by the person. In virtual environments, as for example the social networks, these situations are not totally controlled by the person, as identity's information is available to others and the person may not be aware of this. Self-expression on situated digital displays combines some features present in both physical and virtual environments, which creates an interesting opportunity for research in this area.

2.6.1 Instant Places

Instant Places is a long term installation that started with a Bluetooth version (José et al., 2008) and was later extended to a display-centric platform for media sharing and

people's identity representation in public displays (José, Pinto, Silva, Melro, & Rodrigues, 2012).

The Bluetooth Instant Places display system was designed to study situated interaction around shared public displays by using Bluetooth presence and Bluetooth naming. The system aimed to evaluate those interaction techniques, but is also aimed to evaluate emergent social practices in real usage scenarios.

The Bluetooth Instant Places infrastructure support the display of situated content that results from implicit and explicit Bluetooth presence. The implicit behaviour results in the user's name being presented in the display, once their Bluetooth device presence is detected. The explicit behaviour is available to users whose names were already presented in the display. This could be done using predefined commands that could be embedded in the Bluetooth name. Users change their Bluetooth names to well-formed commands that inform the infrastructure to trigger specific actions. There are available commands to display photos by providing a Flickr username; and commands to associate tags to the user's identity. Those commands are sent and interpreted by applications as a mean of interaction with the display, once people approach it.

The display presents two different visualizations (Figure 16). The first displays information about current Bluetooth identities and associated photos and tags, for those who explicitly set up commands. The second visualization arranges the identity information on the left-hand side of the display in order to present a tag cloud based on all the words used in the Bluetooth names. It presents the most popular tags in the cloud and also use them to periodically search on Flickr for photos to be exposed in the centre of the display.

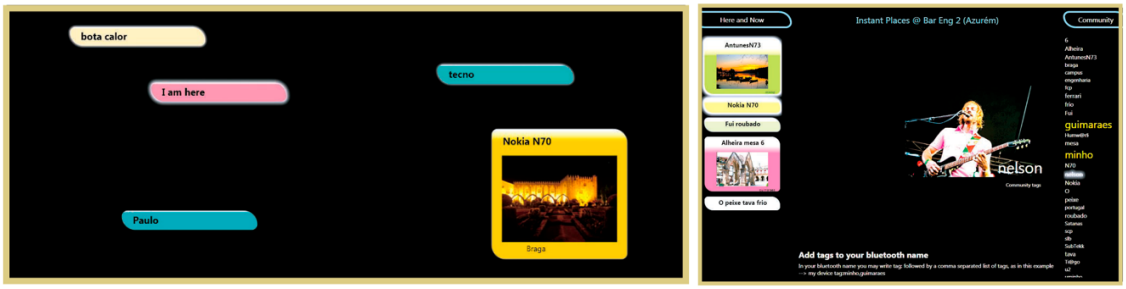

Figure 16: Bluetooth Instant Places display visualizations (José et al., 2008)

The system was deployed in a University Campus bar and during the experiment it shown that, although the simplicity of the approach, it effectively prompt situated

interaction. In fact, the techniques that are used have an extremely low barrier and are immediately available to the people visiting a specific place. Moreover, this study has also shown interesting and creative forms of social practices, especially for posting messages about the service in the particular place, or messages to the other people in the room.

Instant Places has evolved to a version that enables people to extend and manage the projection of their identity in the infrastructure public displays (José et al., 2012). This version of Instant Places explores the concept of locative signs for supporting the systematic creation of user-generated content. People are able to publish two types of locative signs: pin badges and posters.

A pin badge is a locative sign associated to an institution, cause, campaign, sport team, artist or brand. People can associate a set of pin badges with their Instant Place profiles, as a mean of identity and possible expression. In fact, a pin badge is composed by a set of properties (ex. tags, content sources) that can inform the applications about sources of content to be presented in the display. A poster is a media item with content for public displays that can be created and distributed to specific displays. They represent a mean for self-expression, as people can create content and publish it in the places they consider relevant for presentation. Both pin badges and posters information can be used by application to present relevant place-based content (Figure 17).

Figure 17: Applications content based on pins and posters data (José et al., 2013)

Instant Places is supported by three major concepts: places, personal identities, and display applications (José et al., 2013). A place might have one or more displays and represents a symbolic entity that provides a meaningful context for situated social interaction. A place owner controls the content presented in the display and may include user-generated content as a way for visitor's engagement with the place.

A personal identity is an explicit representation of people in Instant Places. Managing their personal identity, either by attaching pin badges to their identity and publishing posters, people are allowed to control self-presentation in public displays. The identity is present in a place once the user checks-in the Instant Places mobile client.

The display applications are available to place owner for subscription. Once selected, a display application is included in the display scheduler for periodic presentation. The display applications have access to a system API that includes calls to retrieve the currently checked-in user's data, such as pins and posters. Using this data, applications can adapt their presentation behaviour according to the situated context.

Instant Places has been installed in several places, including two departments, a library and a bar in a University Campus; three cafés in a city; two schools; and a public library (Figure 18). A study has been conducted during six months and involving those displays, inviting people to use the system through instructions that appeared occasionally in the places.

Figure 18: Installations of the Instant Places system (José et al., 2013)

The results confirm that people understand pins and posters as a self-expression publication practice. In fact, people understand pins' roles as an expression of personal preferences, and even express the desire for more personal pins. However, either users' engagement as well as the association of pins' choices with the displayed content, revealed below initial expectations. This seems to be related to the limited and closed collection of pins; and difficulties using the system, mainly related to design decisions.

On the other hand, posters generate more user engagement. The published content confirmed a strong motivation for self-expression and a concern about the quality of the published content, especially to differentiate to other types of content. The study also confirmed the importance of repurposing content as a publication practice.

In relation to situatedness, the study revealed a tension between strong locative content and content that could be disseminated to several places. Considering posters' publications, some users expected their content to be quickly disseminated to all locations, even those they were not physically in. On the other hand, some users were not comfortable with the idea that posters they created to a specific location could be displayed in other locations.

Other dimension of situatedness revealed in the study is related with the period of content presentation, especially posters. Users tend to set the maximum allowed time for presentation without any concerns about the implications on displaying outdated content, except with the posters announcing scheduled events.

The moderation of content was also studied and the results confirm that moderation practices differ substantially between place types. Some places, such as schools, perceived moderation as fundamental; other, such as bars, were more relaxed about moderation. Some places were even comfortable with no moderation, given they could have post-moderation techniques available.

The study also confirms a tension between the users and place owners' perception of valuable content for a specific place, suggesting the need for filtering content that might not be appropriate for the place. And this facility may also be important when considering applications that display thrusted content, such as the case of pins presentation. In fact, even though pins could only be selected from a well-known and closed collection, the simple presentation of inoffensive pins in some places could be considered provocative.

While the system does not provide any support for friends or any other sort of social connections, participants in the study have expressed their willingness to integrate different forms of social associations, suggesting that social connections can play a key role in the perception of content appropriateness and in supporting new forms of socially-mediated content exchange. The study also suggests that more sophisticated publication paradigms should be considered in relation to the connections between people and places and between places, exploring locative properties of the publication acts.

2.7 Interaction in digital public displays

The interaction with digital public displays cannot be considered as the ultimate phase of the overall process that leads to it. Michelis and Müller (2011) present a model of the different phases of interaction (Figure 19), where initially people are considered as passers-by without any intention to interact with the display. After that, they can notice the display and potentially react to its presence, moving on to the next phases of the interaction process. These include two different forms of interaction: one called subtle interaction, whenever interaction is based on gestures or movement; and the other called direct interaction, whenever there is a more depth engagement with the display, and usually people is placed in front of it. Those two forms of interaction can occur multiple times and with multiple displays, when available. The final phase includes all the follow-up actions after interaction, which can include any sort of observation of other people interacting with the display, or the accomplishment of any other activities related with the previous experience.

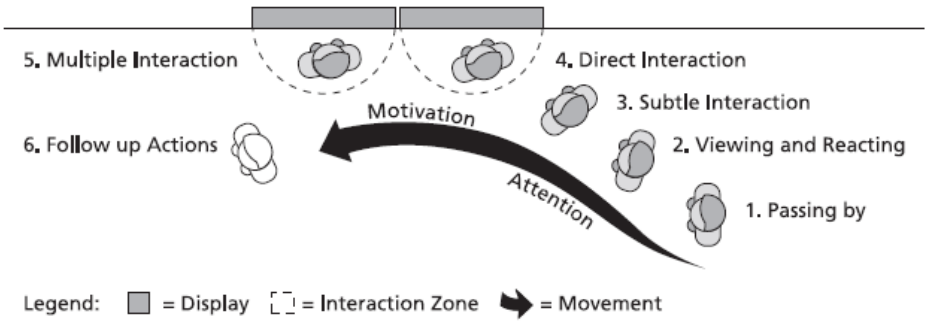

Figure 19: The audience funnel (adapted from (Michelis & Müller, 2011))

Although this model presents some issues concerning the public nature of interaction with the displays, and only considers one or multiple displays placed together, it may well be used as an overall framework of the several interaction phases. This would allow to study the role of interaction in the process of content presentation and publication in public displays.

Despite all the potential of digital displays for presentation of multimedia content and the interaction modes they support, the level of attention and use of digital displays do not always conform to the expectations created (E. Huang & Koster, 2008). This confirms that the design and implementation of digital display systems present their own

challenges, mainly related with the acceptance by users. Those challenges go beyond the explanations provided by research in human-computer interaction (J. Müller et al., 2010).

The observations done by Huang and Koster (2008) are not conclusive about the correlation between the attention given to a display by their viewers and the content presented on it. According to these authors, people do not substantially modify their attention on a particular content in relation to another one, regardless the way contents are updated on display; the positioning of the displays; and other factors not necessarily related to the content itself. Even more surprising were the findings on the attention shared between the content on digital displays and content presented on traditional display forms, such as leaflets or posters. In fact, traditional media of presentation and disclosure of information in public spaces continue to be used and compete with the content on digital displays for the attention of passers-by. Traditional media take advantage when compared with digital displays, especially when content of digital displays is updated periodically, not allowing any form of interaction or control by people (E. Huang & Koster, 2008). Apparently, people still prefer to look at posters posted in shop windows or manipulate leaflets than waiting for the same information in a digital display.

The interaction modes supported by digital displays is one of the issues influencing their effective use and new forms of interaction need to be found. In fact, people still prefer having control over the information they want to watch and read, manipulating and observing the traditional media of dissemination with different paces, skipping quickly what does not interest them and keeping their attention for longer periods of time on what they are interested (E. Huang & Koster, 2008). That is, people prefer more dynamic experiences with the medium that presents content in order to control what really interests them to see. Such rich experiences with traditional media of dissemination can inspire new forms of interaction for digital displays and is a key issue being addressed by the research community.

J. Müller et al. (2010) suggests the use of know metaphors as a mental model in order to facilitate and improve the interaction beyond the traditional poster metaphor, embedded in digital or non-digital displays. According to them, the mental models people use to perceive the display and the surrounding environment are essentially the posters, windows, mirrors and overlay. All these models are associated with metaphors familiar to people. The poster metaphor is based on the advertising model from traditional posters in paper, augmented by some methods to select the information to be presented (for example, more details or more presentation time of the same content). The window

metaphor is used to create the illusion of a remote connection to another reality or location. The mirror metaphor seeks to integrate people's reflection in the display's content, enhancing their interest and therefore promoting the interaction with the display. Finally, the overlay metaphor pursues the integration of the display content in the physical environment surrounding the installation, creating a harmonious combination to promote interaction.

The interaction modes used by digital displays are another important dimension to understand interaction of people with the display. An extensive range of techniques has been explored to support interaction with digital public displays (see (Ballagas, Rohs, Sheridan, & Borchers, 2008) and (J. Müller et al., 2010) for an overview). There is a large set of interaction modes that try to simplify the usage of digital displays, varying from sensory technology, that allows predicting the intents of users whenever in the vicinity of the display; to mobile technologies that allow the remote control of the display and its content. This also enables the integration of devices of personal nature with displays of public nature (Dix & Sas, 2008; Sas & Dix, 2008).

The interaction modes are classified by J. Müller et al. (2010) as explicit and implicit. In explicit interaction, users have the ability to specify explicitly that they want something to be displayed, obviously considering all the constraints imposed by the display and applications running. In implicit interaction, the actions users do may be considered as inducing changes in the display. For example, the presence of a person in front of a display may start an implicit interaction, which may lead to a change in the content of the display.

The comparative study of several display technologies lead J. Müller et al. (2010) to the identification of multiple modalities of interaction and combine them with the mental models (metaphors), creating the taxonomy presented in Table 2. It establishes an important reference for the design of platforms and applications for digital public displays.

Table 2: Taxonomy for public displays (adapted from (J. Müller et al., 2010))

		Mental Models			
		Poster	*Window*	*Mirror*	*Overlay*
implicit / explicit — **Interaction Modalities**	*Presence*	Hello.Wall, BluScreen		Palimpsest, Videoplace, Vision Kiosk	
	Body Position	Cylindrical Screens			
	Body Posture				Jumping Frog
	Facial Expression		Hole-in-Space	eMir	
	Gaze	ReflectiveSigns			
	Speech				
	Gestures	Interactive ambient public display, Pendle		Magical Mirrors	Diaper Selector, Traveling Tic-Tac-Toe
	Remote Control	Touch Projector			
	Keys	Opinionizer			
	Touch	City Wall	ShadowBoxing		

2.7.1 CommunityWall

The CommunityWall (Grasso et al., 2002; Grasso, Muehlenbrock, Roulland, & Snowdon, 2003) is an interactive large screen display installed at Xerox Research Centre Europe. The installation purpose was to support communication across communities and raise social conversations. It uses the metaphor of notice boards, displaying notices (documents or news, and opinions on them) about current community activities (Figure 20).

Figure 20: CommunityWall in use and a displayed item (Grasso et al., 2002)

The members of the community post plain text or web pages with images, using different methods such as email, bookmarklets (similar to a web bookmark), scanned

paper, and a PDA application. As the display was touch sensitive, people could interact with it, and execute actions on the displayed items, such as view item details; sent items by email; print items in the nearby printer; rate items; write a comment on a specific item.

The content scheduling was based on a number of priority rules, that include items' attributes as type, date of posting, rating, number of comments, display time. The priority of recent uploaded items was boosted to ensure that they would be seen at least for a while, irrespective of their other attributes. This change occurred during the project, to motivate users, as they were found to pass by the display to see their recent posts (Snowdon & Grasso, 2002). They usually got disappointed because the initial priority rules give no guarantees that a new item would be displayed immediately after being posted.

An interesting conclusion derived from the CommunityWall several experiments' evaluation concerns the changes on the senses of trust and ownership. The initial identification mechanism asked users to previously select their picture from a collection of 15-20 pre-defined users, in order to be able to interact with the display. This worked well and was based on trust and responsibility, given the small group of people (Snowdon & Grasso, 2002). Although the display was seen as truly shared device belonging to everyone and therefore to no one, when the experiments were expanded to about 100 members, the motivation to watch information was higher than the effort to submit useful content (Grasso et al., 2003). The posts started to be not reliable and junk comments arise, indicating that new identification mechanisms and access control were required.

2.7.2 eyeCanvas

The Plasma Poster Network underlying infrastructure (Churchill, Nelson, Denoue, et al., 2003) was used in other deployments, including eyeCanvas public display (Churchill, Nelson, Denoue, Helfman, & Murphy, 2004). It is an installation set in a public and open community space, an internet café and art gallery, to be used as a large screen interactive bulletin board, promoting the engagement of people with the display and the place (Churchill, Nelson, & Hsieh, 2006).

Content posted on the eyeCanvas display could be selected by place owners. However, users of the eyeCanvas display could interact with the system and even post limited types of content. They could browse content using a carousel-based interface to control a slideshow of images and text information, and then present a detailed view of that information. Users could also subscribe distribution lists by entering their email

address, and can use the scribble application to left comments and create artwork (Figure 21).

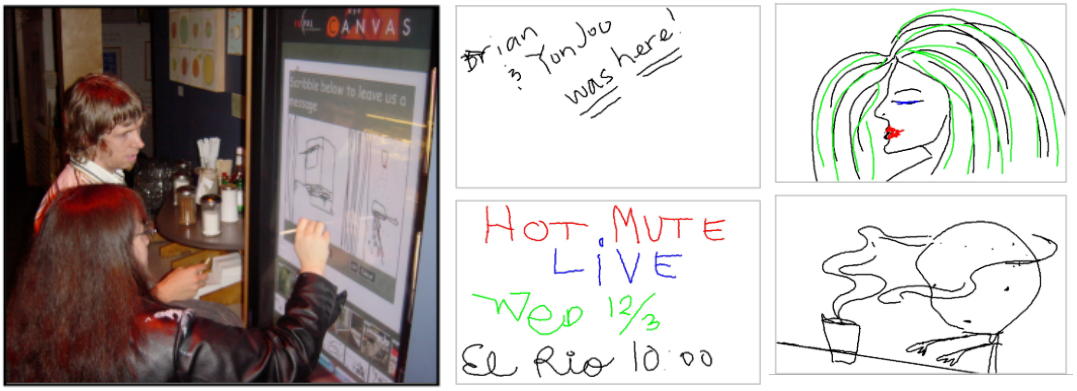

Figure 21: eyeCanvas users leaving messages and scribbles (Churchill et al., 2006)

The most popular theme of content presented in the display was related to artistic material by artists with art work physically located in the art gallery. The scribble application was also very popular and 1466 messages or scribbles were posted during 2.5 months. Half of those posts were drawings, perfectly aligned with the interests of the community in the space. Although the openness for user generated content the scribble applications allows, there were registered few inappropriate contents. The posted items were checked daily and deleted if considered inappropriate. Almost all the inappropriate contents were posted on weekend evening, which seems to confirm that the lack of inappropriate content was related to peoples' concern about being witnessed in the creation of inappropriate material, making witnesses acted as social sanctions (Churchill et al., 2006).

2.8 User generated content

The engagement of people with public displays is challenging and has been considered as one of the most difficult tests to the success of an installation involving one or more public displays. This is even more challenging whenever the engagement should be considered as situated, that is, occurring in a particular location. Schroeter, Foth, & Satchell (2012) emphasize the importance of combining people, content and location as a mean to promote the engagement with public displays and how the correct combination is crucial and creates an opportunity for exploring new publication paradigms in public displays. J. Müller et al. (2009) refer the generality of the content shown on public as one

of the main causes for display blindness, where people stop paying attention to the displays because they do not expect to find relevant content. Hosio, Goncalves, Kukka, Chamberlain and Malizia (2014) claim that displays are often created without paying enough attention to place owners, their real-world contexts and their effective communication needs. They highlight the importance of addressing the value proposition of public displays, and particularly their ability to be appropriated for the very diverse, highly contextual, and, to a certain extent, very simple needs of place owners.

The difficulty of persuading people to get involved in the publication of content or simply participate was stated by Elaine M Huang, Mynatt, Russel and Sue (2006), while observing large groups of people in the presence of a shared display. They realize that individuals are not generally motivated to provide content or have difficult identifying appropriate content for a specific situation, thus leading to displays that are uninformative and consequently unattractive because of a paucity of content. J. Müller et al. (2010) describe how public displays may be perceived as a stage in which people will only act if they feel confident about their actions and in full control over the presentation of self. Considering that user-generated content on public displays is mainly about self-expression and a desire to share content with others, it is absolutely fundamental that people are able to perceive the associated value and fully understand the respective publication process. Brignull and Rogers (2003) report on how the perceived interaction of others next to the display can have an important role in inviting people to interaction, what they call the honey-pot effect. They even mentioned the introduction of novelty and ambiguity, especially in marketing domains, as a way to promote engagement. Moreover, people will only remain motivated to interact if it is clear what the system has to offer them (Brignull & Rogers, 2003), so interaction modalities tends to be a short-term solution as novelty quickly fades away.

Allowing user generated content on digital public displays is broadly recognised as a key feature for peoples' engagement with the system. The idea of creating displays that reflect the local community in which they are inscribed has been explored from many different perspectives (Taylor, Rouncefield, Cheverst, & Izadi, 2008), with particular incidence in work environments as a means to disseminate information or provide awareness about group activities (Greenberg & Rounding, 2001; McCarthy et al., 2001a).

A very broad range of techniques has been studied to enable display systems to accept content originating from users. One of the earlier examples, the Plasma Poster (Churchill, Nelson, Denoue, et al., 2003), allowed people to submit photos, text, and web

pages to a public display using email or a web form. Hermes (Cheverst et al., 2005) explored the use of Bluetooth to enable users to send pictures and other media to a display. The use of Bluetooth names as an interactive feature has been described in (Davies et al., 2009; José et al., 2008) as an essentially opportunistic alternative that is easily available to enable user-generated content on a broad range of mobile devices.

While publication paradigms are inherently associated with some form of interaction with the media space of the public displays, they clearly go beyond the mere issue of how to support that interaction. To a certain extent, any form of user-generated content for public displays is always embedded with some type of publication paradigm that drives the conceptual model behind the process. In previous work, these publication paradigms have been implicit within the properties offered by particular applications, such as mediate socialization in public spaces (McCarthy, Nguyen, Rashid, & Soroczak, 2002; Rogers & Brignull, 2002), share content of interest to a group of people (McCarthy et al., 2001b), support collective music selection around the display (Kenton O'Hara et al., 2004) or to simply let users manifest interest in particular topics (José et al., 2008). This approach is strongly coupled with the semantics of specific applications and does not provide a generalizable paradigm that users can learn to use in many different displays and settings.

Strategies for content publication on public displays have been extensively studied in the context of specific display systems (Alt, Bial, et al., 2011; Alt, Memarovic, et al., 2011; Davies, Friday, Clinch, & Schmidt, 2010; Langheinrich, Memarovic, Elhart, & Alt, 2011; McCarthy et al., 2001b). These studies involve the issue of moderation and access control, but they also identify less obvious challenges, such as the need for flexibility with regard to content creation, content expiration, and clean-up procedures (Alt, Bial, et al., 2011). The Funsquare application (Memarovic, Elhart, et al., 2011) presents trivia information in a way that reflects the current context around the display. Memarovic, Langheinrich, Cheverst, Taylor and Alt (2013) presents several examples of projects and systems that demonstrate the usefulness of this openness in the engagement of passers-by and other actors with the displays and the environment where they are placed.

Collecting user generated content from social media platforms is referred in (Hosio, Kukka, & Riekki, 2010) as a mean to provide hugeness and richness of content to present on public displays. This approach is also explored in (Hosio, Kukka, Jurmu, Ojala, & Riekki, 2010), providing a continuous stream of updated content still preserving socially meaningful content to the physical space in the surroundings of the display.

2.8.1 WebWall

The WebWall (Ferscha & Vogl, 2002) is a framework developed to provide seamless WWW access over visual displays in public spaces. This framework was designed to be independent with respect to display and access technologies. This way, the framework is able to integrate different display technologies and provide access by different internet (HTTP and email) and mobile technologies (SMS and WAP).

The objective of the WebWall research work was to explore the potentials of ad-hoc communication in public spaces using a wall metaphor supported by large, shared displays (Ferscha, Kathan, & Vogl, 2002). They seek to enrich public spaces with digital communication and interaction means, allowing people to share multimedia information (e.g. notes, images, videos) with others and interact with the applications screening on the displays (e.g. opinion polls, auctions, games).

The scenarios designed to evaluate the framework considered a set of services (Figure 22). The most basic one was for instantly post notes in a specific WebWall. The notes are simply text messages that can be sent by email or SMS, and could be viewed by all the persons in the surroundings of the display. Replies to a note could also be sent by viewers and, based on the selected reply mode, they were presented in the same display or sent directly to the author of the note.

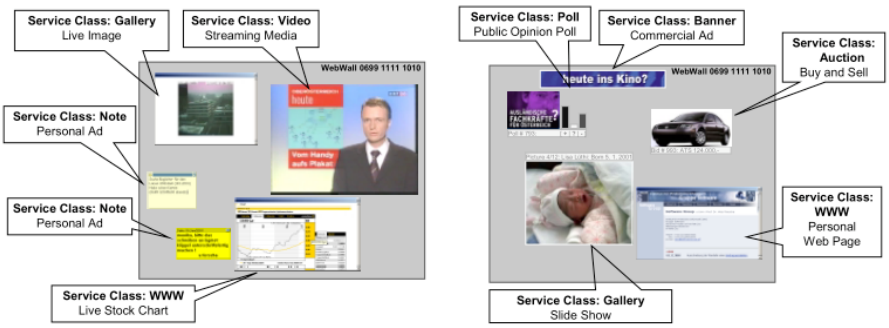

Figure 22: WebWall services (Ferscha & Vogl, 2002)

Other services included a web-based client for publishing videos and images to be displayed as multimedia content in a WebWall. There was also a service that allows users to publish web content, including personal web pages, simply given an URL. All the services for posting user-generated content associated the user defined name (the one in the user profile) to the content.

Although there was an association between content and its author, no other mechanism to discourage posting inappropriate content was considered in a WebWall. Moreover, there was no way to quickly remove inappropriate content or allow the community to get involved in the identification of this kind of content and do any proper corrective action.

2.8.2 Community Collage (CoCollage)

The CoCollage (McCarthy et al., 2009) is a place-based social networking system designed to promote a sense of community and increase place engagement. It was deployed and evaluated in a café, and the display showed social media (photographs and short text messages) related to the people physically present in the place (Figure 23).

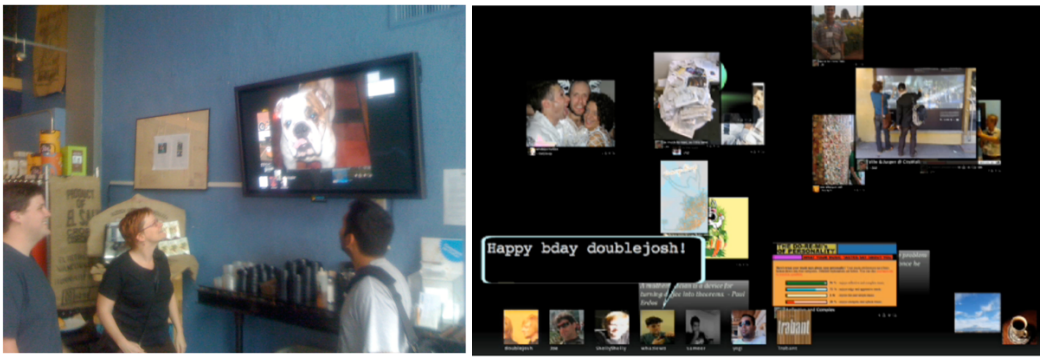

Figure 23: CoCollage display in a café (McCarthy et al., 2009)

The interaction with CoCollage could be done through a web site where users could create and maintain an online user profile, with some information as name, loyalty card identification, avatar, birthdate, greeting message and a collection of social media content items. The collection of media content could be explicitly defined by uploading image files or entering text in free text fields. It could also be implicitly defined as RSS feeds associated to social media streams (e.g. Flickr photo-sharing service). Users could also use the web site to send messages directly to the CoCollage display.

The web site allowed registered users to check other's profiles and to view a chronologically ordered history of content items that had been shown on the CoCollage display. Any item from the user's profile or the history stream could be voted, commented or flagged as inappropriate by any user. The flagged items were immediately removed from the display until final evaluation by system administrator, which could black out or restore the items, or even ban users from the system.

The display presented information about the presence of registered users in the surrounding space, providing a queue of avatars and usernames. Users could notify the system with an explicit check-in action, either using the loyalty card in a card reader attached below the display, or via the proper functionality in the web site.

CoCollage display showed content items based on a balance of several factors, including the item's add time and last presentation time. It also considered the voting results, the number of comments, and the last check-in of the item's author in the system. In fact, the check-in information was always considered as items from users who were present were generally preferred to items of users not checked-in.

The evaluation from this research project shows that CoCollage provided community awareness, and enabled interaction and conversation between people in third places (not home, neither work), increasing the sense of community (Farnham et al., 2009).

2.8.3 Hermes Photo Display

The Hermes Photo Display (Cheverst et al., 2005) is presented in two versions, both deployed in the Computing Department at Lancaster University, UK. Version one is an extension of the Hermes office doorplate system (Cheverst, Fitton, & Dix, 2003) and enabled users to send pictures to the display using MMS or email. Version two of Hermes Photo Display also supports direct interaction with the touchscreen display or indirect interaction with co-located users via Bluetooth connection to their mobile phones. Using these two interaction modalities, users were enabled to send, receive and browse pictures on the display (Figure 24).

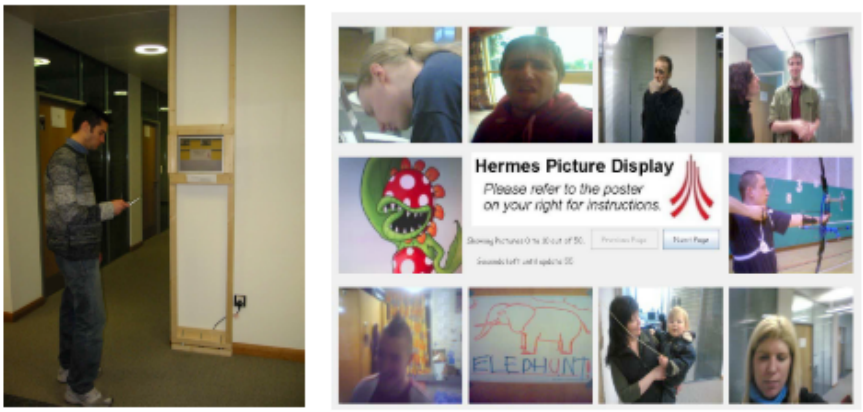

Figure 24: The Hermes Photo Display (Cheverst et al., 2005)

The research objective beyond the deployment of this system was to identify the key challenges of working with Bluetooth technology for interaction; and get insights into general user acceptability issues and the potential for such kind of display to support and promote the sense of community.

The results identify some technical issues related with Bluetooth that increase the time required for the interaction in front of the display. In fact, the interaction within a certain distance to the display was identified by the users as an important feature to improve the overall experience. Users seem to be not totally comfortable on standing in from of the display for such a long time.

Users also identified some issues related with content appropriateness. Although there were no moderation techniques implemented, users were aware of the consequences of inappropriate content and identity two simple moderation approaches to implement in future versions: any user should be able to request for content removal; and users should be able to remove content they had previously sent to the display.

A more recent installation of the system have been done in Wray village with an updated version of the Hermes, called WrayDisplay (Cheverst, Taher, Fisher, Fitton, & Taylor, 2012), installed in public spaces (Figure 25).

Figure 25: The WrayDisplay prototype in post office and café (Cheverst et al., 2012)

In order to facilitate the uploading of content, new interaction modes have been introduced, such as a website to allow the local community to upload content, and even flatbed scanners in order to further open up opportunities for posting content to the display. Issues related with moderation were considered by designers, on whether content moderation should be required for the uploading of content, and how it should be achieved in a scalable manner, which may ensure the control by the community being served. They decided to implement explicit moderation processes in order to maintain the trust of the community.

2.9 Content moderation

Engaging people with public displays also means sharing ownership while staying in control of how much the display can be appropriated. Previous work on community-oriented displays has often assumed predefined profiles (Grasso et al., 2002; McCarthy et al., 2001a), but when considering the potential participation of anyone coming to the display, the *a priori* identification of possible contributors for a display becomes overwhelming.

The lack of appropriate mechanisms for handling these issues means that even if an individual wants to publish some content in public displays it would, in most cases, be extremely challenging to negotiate the technical and economic hurdles of placing that content on a particular display (Davies et al., 2012). Presenting user-generated content on digital public displays arises problems related with inappropriate content that generate tensions with the interests of the display owners (Clinch, Davies, Kubitza, & Friday,

2014), so these new forms of generating content requires new strategies for control and moderation.

The need for moderation and other control mechanisms has already been widely acknowledged in previous research, and clearly identified as a requirement for open displays networks (Davies et al., 2012). Examples of possible conflicts on content being published were reported in (Hosio, Kukka, & Riekki, 2010), apparently within a motivating session for taking pictures to be published on public displays.

The wide range of public display systems and their particular publication requirements lead to the emergence of many different approaches on moderations. A broad study of pre-moderation techniques is presented in (Greis, Alt, Henze, & Memarovic, 2014), addressing issues related to people's expectations regarding the content moderation process. A distributed post-moderation process involving the collaboration of University staff is described in (Elhart, Memarovic, Langheinrich, & Rubegni, 2013), which allows display owners to keep control over content publication, even when it comes from third-party applications. And in (Elhart, Langheinrich, Davies, & Jose, 2013) it is suggested that applications need to provide additional information to display owners, based on content's description but also on ratings from other display owners or even display viewers.

Moderation is also referred in (Taylor et al., 2007) as they studied how moderation could be delegated to users that act as trusted curators for a specific content category. Alt, Kubitza, et al. (2011) study the use of a report abuse functionality in the Digifieds system, which is extensible to the community, allowing the distribution of moderation's effort by a wider set of stakeholders. Social accountability is referred as the key driver for moderation in the Plasma Posters Network (Churchill, Nelson, Denoue, et al., 2003) as a simple policy that prevents inappropriate content to be displayed. This notion of social moderation is extended in (Storz, Friday, Davies, et al., 2006), suggesting the use of social media on public displays not simply for creation of content, but also for moderation in a long-term basis. A crowdsourced moderation process is suggested in (Goncalves, Hosio, Ferreira, & Kostakos, 2014), that encourages the crowd in the surroundings of the display to get involved in moderation activities.

Publication practices around traditional public notice areas have been studied as a design inspiration for the emergence of new practices around digital displays (Alt, Kubitza, et al., 2011). They address the issue of the motivations that place owner can have to share their public boards and also their practices for controlling that content.

The Instant Places framework (José et al., 2013) enabled people to express their content preferences in the form of thematic pins that are recognised when the user checks-in to a display using a mobile client. This study uncovers different types of practices associated with the moderation of user-generated content. Even within the presence of systems that prevent disclosure of certain contents that may lead to conflict, users end up trying to manipulate the publication system in order to add something to that content and make it less consensual, as it is reported on the usage of Bluetooth name in combination with Flickr images for publishing content in Instant Places (José et al., 2008).

The Ubinion service (Hosio et al., 2012) appeals to civil participation of young people to give personalized feedback on municipal issues. They explore users' generated content directly entered in the public display and the use of social media's 'liking' and comment facilities for selecting and moderating that content. Results suggest this kind of service can be used to collect feedback from otherwise passive and disconnected users and also engage them in a community-based moderation.

2.9.1 Plasma Posters

The Plasma Posters (Churchill, Nelson, Denoue, et al., 2003) are plasma displays with interactive overlays that enable direct touch interaction, developed for a community of a research laboratory to informally share information. It was supported by the Plasma Poster Network, an infrastructure to store multimedia contents and post them to all registered Plasma Posters. This project's objective was blurring the boundary between content sharing in the virtual and physical domains, promoting unplanned social interactions around content that was generated online, within small organizations (Figure 26).

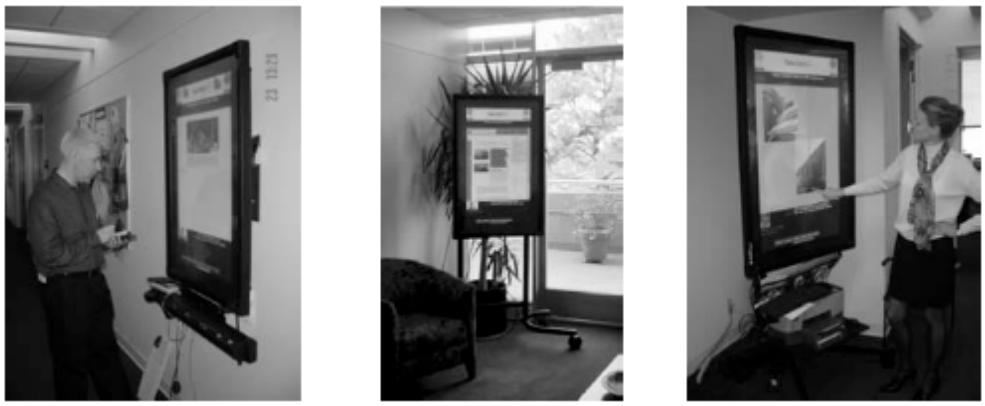

Figure 26: Plasma Posters in different locations (Churchill et al., 2003)

The Plasma Poster Network supported a non-centralised content broadcasting. Content that was presented on the Plasma Posters was based on explicit posts from users of the system or content automatically retrieved from a collection of intranet web pages.

The infrastructure supported content publication through applications that allowed authenticated users to send items such as photos, videos, texts. Users sent those items as email attachments or posted them from a web application. These two selected means of interaction were considered in order to minimize the effort and the expertise required to use them, which would be considered as a barrier to publish content in the network. Users could interact directly with the display to browse the available content and control its presentation. Users could also forward the post content to other users and send notes to the author of the post.

Another interesting feature of this infrastructure was possibility to keep postings in the user's profile, making it possible to review and repost any published content. Some metadata associated with posting was also recorded in the user's profile, which allowed the automation of the content presentation lifecycle.

During the Plasma Posters six month initial deployment there were only three issues related with posting potential inappropriate content and usually prevailed a shared sense of content appropriateness (Churchill, Nelson, Denoue, et al., 2003). This confirms the initial design decision of supporting only a minimal moderation policy, considering that social accountability would ensure appropriate content to be posted. In fact, the restricted physical and social environment allowed people envision the audience of the content, making it more difficult to be socially inappropriate. A comprehensive reflection on the Plasma Posters installation also confirms that judging content appropriateness becomes more problematic when it is easier for people to post content in places they have never

visited, simply because it is easy to post socially inappropriate content, even if unconsciously (Churchill, Nelson, & Denoue, 2003).

2.9.2 Jukola

Jukola (Kenton O'Hara et al., 2004) is an interactive Jukebox device that allows the democratic selection of music to be played in a public space. The music was stored as MP3 files in a database, aggregated with information or images about the songs that are retrieved from well-known web sites.

People in the space could use two different interfaces for interaction: a public display and a handheld device (Figure 27). The public display was a touchscreen that allowed people to browse through the music collection and nominate songs to be played. The nominated songs were subject to voting by other people present in the public space, that could use the interface on the handheld device for that purpose. The most voted song at the end of voting round would be played.

Figure 27: The Jukola user interfaces (Kenton O'Hara et al., 2004)

The Jukola system also provided a web application with multiple objectives. One was for raising awareness on the music ambience for the place, as people could view the playlist for a specific period of time. Another one was to promote conversation about recently played music, especially when the music was associated to particular occasions and events of special importance to a person or group of persons.

Another key objective of the web application was to provide music upload capability to the people in the space. For the purpose of the conducted experiment and considering the copyright restrictions, the MP3 file upload was limited to those unsigned

bands that wanted to exposure their material (Kenton O'Hara et al., 2004). However, before being available in the Jukola database, all the uploaded MP3 files were subject to a vetting procedure used by staff in the place.

The upload feature was used by numerous local bands. Although this feature was available remotely from the place, much of its value was still derived from the subsequence visits to the bar to check if the music appeared on the public display or if it was played. The experiment reported some excitement on the possibility of the music appearance, but also expressed disappointment if it was rejected by the place's staff (Kenton O'Hara et al., 2004).

2.10 Discussion

Table 3 synthetises the description of the display systems considered as example for each dimension presented in this chapter. The table is organized by features that are particularly relevant to the research issues considered in this thesis. It presents the general motivation for the installation; the type of place where the installation occurred; the offered publication facilities; and finally, the moderation approaches, concerning the presentation of user generated content.

These systems demonstrate how multiple concepts of situatedness can be explored with digital displays and also how a properly conducted design approach is able to incorporate into the displays a broad sensibility to physical, social and aesthetic concerns. However, the effort needed to conduct such design processes is considerable and the results are not always easy to generalize to other places. Another limitation concerns that the communication concepts are mainly created in design and may not leave much space for appropriation in new and unexpected situations, which are common in non-digital displays.

Table 3: Open display systems: comparative analysis

Display System	Motivation	Place	Publication Facilities	Moderation
Plasma Posters	Social interaction and community	Semi-public space (Research Lab)	Post multimedia content Post intranet web pages Browse content	User registration Social accountability
eyeCanvas	Social interaction and community	Public space (café/art-gallery)	Post comments and scribbles	Social accountability
Joe Blogg	Social interaction and community	Semi-public space (University school)	Post pictures and text	Social accountability
Jukola	Social interaction and community	Public space (café/bar)	Upload music Nominate music Voting on nominated music	Vetting uploaded music by staff
WebWall	Social interaction	Public space	Post multimedia content Post web content Comment posts Voting	User registration Content associated to user
Hermes Photo Display	Social interaction and community	Semi-public space (University department) Public spaces (Wray)	Send, receive and browse pictures Website for content uploading (Wray)	Social accountability Explicit moderation (Wray)

Display System	Motivation	Place	Publication Facilities	Moderation
Semi-Public Displays	Awareness, coordination, collaboration	Semi-public space (Research Lab)	Post requests Post comments Activity awareness Upcoming events' popularity	User registration Social accountability
CommunityWall	Social interaction and community	Semi-public space (building)	Post content (text, images, web pages) Comment posts Rating content Browse content	User identification Social accountability
UniCast, OutCast and GroupCast	Awareness Social interaction and community	Semi-public space (building)	User configurable content modules Text messages (OutCast)	User registration and profiles Social accountability (OutCast text messages)
Community Collage (CoCollage)	Social interaction and community, place attachment	Public space (café)	Post items (images, messages, social media content) Vote, comment and flag (as inappropriate) items Check-in (presence)	User registration Social accountability Content moderation by users and administrator (can ban content and users)
BiebBeep	Awareness Social interaction and community	Public space (library)	Post social networks items (text, images, videos) Web pages via CMS (staff)	Social networks accountability

Display System	Motivation	Place	Publication Facilities	Moderation
Digifields	Awareness, Community	Public space	Post content (text, images and videos) Post pre-defined content	Social accountability (physical presence) Pre-defined content
e-Campus	Awareness, Community	Public space (campus)	Request personalised content Subscribe channels Subscribe content applications	Channels and application reputation Channels and application subscription mechanisms
UBI Hotspots	Awareness, Community	Public spaces (indoor/outdoor)	Post content (text, images and videos)	Social accountability Content moderator Application based control
InstantPlaces	Awareness, Community	Semi-public spaces	Media items (images and text) Locative signs Profile based content	User registration (check-in) Pre-defined collection of content items Place-owner pre and post-moderation

Existing digital signage systems are essentially designed to deliver centrally created content without much consideration for people and their social practices. Considering the environment where the displays are installed, there is a sense that public displays should be situated and thus transformed into a richer medium for user-generated content and a locative channel for self-expression and creativity. In our work, we explore this same trend, although we address the scale of the individual place. On the other end, many socially aware displays have been prototyped, but only on a single display, single concept model that was not meant to scale to widespread deployment. In our research work, we envision uncovering social interaction concepts that can scale to multiple users and multiple display scenarios and serve a vast and open-ended set of communication purposes.

Context-awareness display systems provide facilities for content adaptation to context changes. This ability to sense and react to their environment is an obvious path for situated displays and is very much aligned with the field of context-awareness, albeit in this case, focusing on the shared context of place. Even though it seems highly intuitive to think that certain contextual variables can affect what should be the most appropriate content to be shown at any particular time, this is far from trivial, unless the choices are really very limited. In a realistic environment, with an open-ended set of content alternatives and many contextual variables to consider, the problem becomes very complex as it requires a deep understanding of the context around the display and many independent criteria that need to agree on the content of a single display. Training is also very complex, because most displays are not naturally interactive and therefore do not produce engagement metrics that could be used to assess the potential merit of different adaptation approaches.

As summarised by Dourish (2004a), context is not necessarily delineable as we may not be able to define in advance what counts as context; or stable, as the definition of what is relevant may change over time. While some optimisations might be viable, it is probably unrealistic to expect that a multipurpose display system would be able to exhibit a place-based behaviour just by sensing, interpreting and dynamically reacting to the physical and social setting around it. Like context-awareness in general, this approach faces a clear gap between what can be sensed and perceived by the system, and what is perceived by people, as the situation around the display.

Dourish (2004b) describes the concept of embodiment as a physical presence in the world and a social embedding in a web of practices. In our research work, we also seek

to confirm that this social embedding is crucial for visual place-based communication practices, as they are strongly related with the communication goals of many different entities with diverse connections with the place. Moreover, we are also focused on place-based communication and the key motivations and practices of place owners for placing visual displays at their places. Part of our motivation in this research work originates from the perception that most public display systems are very far from attaining that connection with their placement, which seems so natural in their non-digital counterparts.

Although there are examples of display systems inspired in non-digital usage display elements, they are limited in the extension of the types of elements and even the type of places where the elements are displayed. For the effective design and development of multi-purpose place-based display systems we argue the study of current usage of non-digital displays in semi-public places has to be extended in order to analyse visual display elements and uncovering the key motivations and the main practices behind those non-digital displays. This would allow to identify usage dimensions and fundamental embedded practices that provide structure to reason about the design of place-based digital displays.

On the other hand, there is also the need to extend the publication practices studies to the perspective of the people in the surroundings of the display. Examples of those situations can be found in the descriptions of the display systems presented in this chapter. However, they tend not to be inspired from other forms of self-expression, apart from the traditional and more obvious ones. This is a limitation that we seek to uncover in this research work, extending the study of these practices to other forms of public expression and considering how current public expression practices with different types of non-digital content could be repurposed for public displays. The insights from this work should provide a new understanding of how user-generated content may become a commodity and offers inspiration to seek new forms of self-expression using public display systems.

There is a wide range of interaction techniques for digital public displays, but there are currently no well-established techniques that people may expect to find across any public display they may face. Given the diversity of alternatives, interaction is likely to be supported through multiple techniques, rather than by any particular one. As a consequence, actually moving forward to open publication practices on public displays will clearly imply going beyond the specifics of particular interaction mechanisms, and

allow multiple interaction alternatives to be used on well-known communication paradigms.

The application of interaction modalities considering the well-known interaction mental models makes the interaction process easier to understand for the users of the displays and also contributes to a better understanding of the content being displayed. However, this is mainly proposed for scenarios where there is only one display or multiple displays in the same physical location, in which people are more aware and in control of the consequences of their actions with the display. On the other hand, most of these scenarios do not consider publication acts, which means that users' actions are not related to any form of user-generated content to be presented in the display.

In relation to moderation of user-generated content, despite all the contributions in approaches and techniques for moderation, the current state of the art has not yet provided a systematic framework for approaching the issue of moderation from its many perspectives and help to define the control sharing strategy for a concrete scenario. In fact, there is no broader perspective on the risks associated with user-generated content and they are not related with current moderation techniques. Both should be under a common framework where they could be analysed as part of an integrated solution to the issue of control sharing on a concrete scenario.

2.11 Summary

This chapter has presented a broad description of the related work in several dimensions. It considered dimensions related with the nature of the display system from the place perspective, such as situated, context-aware, community and urban. It also considered dimensions concerning actions users can do on public digital displays, such as self-expression, interaction, user-generated content, media practices, and moderation.

The insights from these different dimensions, contextualized with examples of existing display systems, are a valuable contribution to guide and motivate the present research work. Despite the variety of existing display systems, the related work suggests that having public displays that can be used as a communication medium requires much more than interaction support, and essentially depends on publication paradigms that can manage user expectations and mediate the possibly conflicting goals of the various stakeholders involved.

3 Public Self-expression Practices

3.1 Overview

The use of large displays as an open communication media for individual creativity and self-expression makes them important channels for social coordination, congregating co-located people around common topics. Opening a display to user-generated content requires appropriate content publication paradigms that are able to frame individual communication within the scope of established practices that people may easily understand and appropriate to accomplish their communication goals.

This type of framing is crucial for both the individuals exposing their media on the displays and for the owners of those displays. For individuals, publication paradigms should convey a clear abstraction for understanding what will happen when they publish something on a display. An appropriate publication paradigm should support a selective control of self-exposure and a proper expression of the scope of publication actions. For display owners, publication paradigms should provide a way to frame people's self-expression within the expectations of appropriateness of the place. Even though they may be sharing their displays with others, they still need to be able to control the boundaries in which that sharing occurs. Instead of formal moderation processes, this should be done in a socially sensitive way that does not hinder publication spontaneity and provides an adequate alignment with the social dynamics around the displays.

However, this framing is not yet supported by digital display systems and, is in most cases, it would be extremely challenging to negotiate the technical and economic hurdles of placing content on a particular display (Davies et al., 2012).

The motivation for this part of the research work arises from the observation that people already engage in very diverse practices of public expression and that many of those practices rely on some form of non-digital display. A t-shirt, a lapel pin, a poster, a sticker or even a tattoo can all be seen as objects of conscious or unconscious display that correspond to statements for others to see, regarding the self, or the self as affiliated to particular social groupings, organizations, personal values or supported causes. They serve to express identity, to promote causes, to support a football team, a subculture, a religion, or a political party. Interestingly, these practices can even help to characterise the places where they occur.

These forms of public expression can be particularly relevant as a design inspiration for situated digital displays. Firstly, because they already exist, they are based on metaphors and usage contexts that are familiar to most people. Secondly, because they rely on locality and social connections, they already reflect different types of social sensitivities that may also be repurposed for digital displays.

In this particular part of this research work, we study various practices for public expression to uncover design sensitivities that may inform the design of new publication paradigms for digital displays. More specifically, we aim to uncover the key elements that characterize those practices and sketch a design space of publication concepts. The underlying expectation is that display practices that are already deeply embedded in our society and are familiar to most people may provide a valuable resource for inspiring the design of locative publishing in digital public displays.

3.2 Research Design

In order to reach our goals, we have conducted a structured analysis of existing public expression practices that rely on the use of some form of non-digital display, e.g. posters, lapel pins or t-shirts. We followed a research methodology comprising three phases. In phase 1 (Exploration), we created an extensive collection of photos and descriptions of public expression practices. In phase 2 (Interviews), we interviewed 25 people about their perspectives on the public expression practices represented in the photos. In phase 3 (Consolidation), we coded the interviews to identify emerging properties and design dimensions associated with the various forms of public expression. From this process, we extracted a set of design sensitivities that can be arranged around three key dimensions: Perceived Authorship; Appropriateness; and Collaboration.

3.2.1 Phase 1: Exploration

In the exploration phase, we started by collecting from our everyday reality, images of various forms of public expression practices. The opportunistic nature of this process was meant to broaden our initial range of practices and thus the scope of the analysis. To complement this initial stage, and especially to provide more depth to the analysis, we also collected additional data and photos from the web. At this phase, most of the sources were web-based and collected using simple queries based on public expression names and the typical situations where they occur. The resulting collection included 46 photos

and 30 descriptions of the practices related with the photos. Even though we do not claim completeness, we believe we have covered the most significant scenarios of public expression that rely on the use of non-digital displays.

Most of these practices are widely known concepts. For the purpose of this study, we aggregated them around the following 12 categories: tattoos; stickers; posters; magnet signs; lapel pins; flyers/leaflets; postcards; business cards; wearables (t-shirts, hats, scarves); graffiti; protest posters and banners; face painting. These are also represented in Figure 28, where we combine one photo from each category.

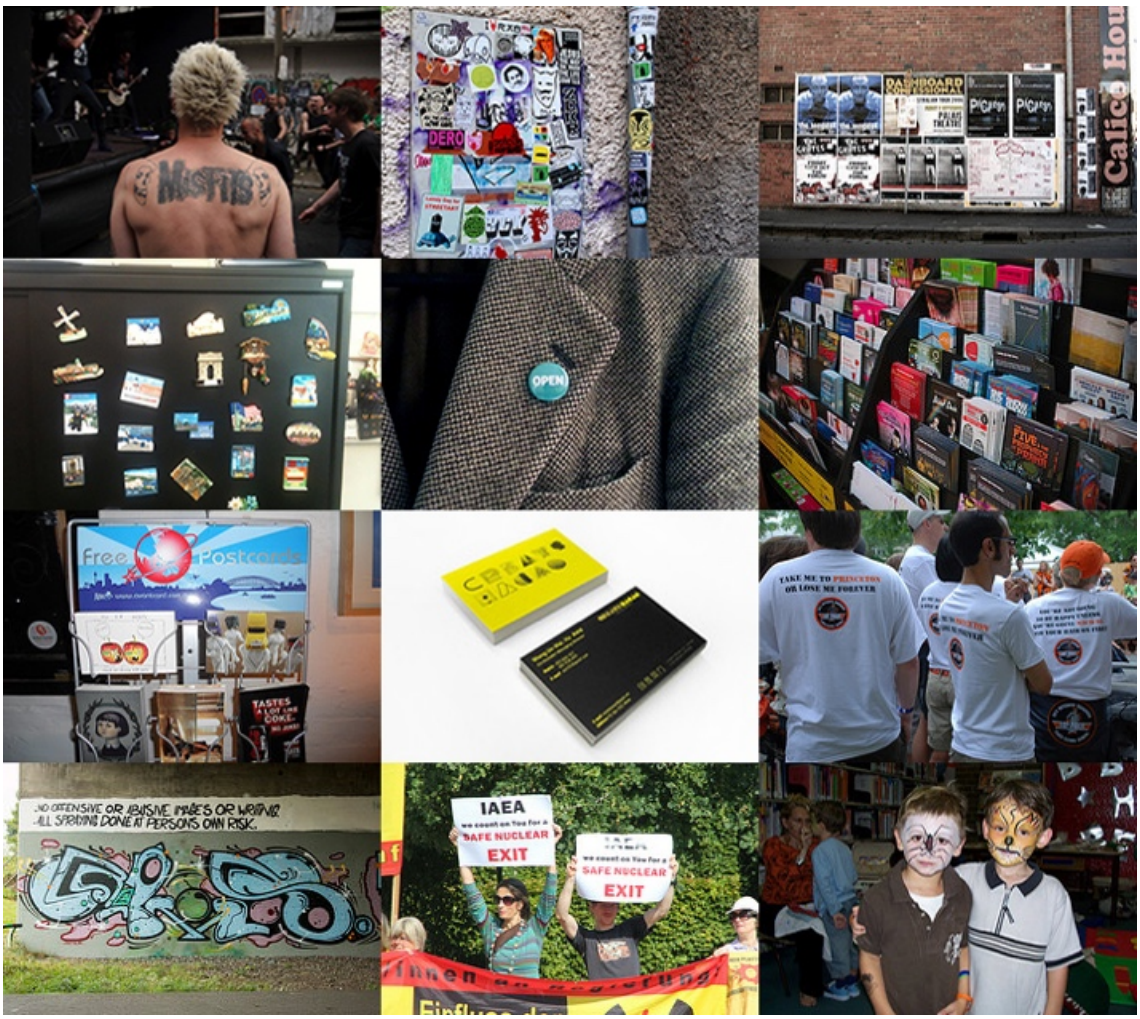

Figure 28: Public Expression Practices

3.2.2 Phase 2: Interviews

We then organized a set of interviews to complement the information we had gathered to get a more personal account of how people perceive the use of these public expression practices. Participants were recruited at three different academic institutions,

and included students, professors and other members of staff of each institution, aged 18-50 (average 35-years), 18 were men and seven women. The interviews took place at the locations where each participant had been recruited.

For the interviews, we prepared a set of 12 cards, one for each of the practices. Each card represented an image with a detailed view of the materials used, e.g. a sticker, and then, two to four additional images depicting specific usage situations, e.g. stickers being used in a signpost.

Each interview was focused on one expression practice, with the respective card being used throughout the interview to provide context to the conversation. The assignment of the cards to interviewees was based on a round robin scheme to ensure that all the cards were used the same number of times.

The interview was semi-structured (questions are presented in Annex A), starting with an invocation of the participants' experience with that form of public expression. It would then address usage motivations and sensitivities. Since most of the interviewees seemed to be familiar with the expression practices presented in the cards, it was often the case that some of the questions were not explicitly made, because the answer was spontaneously provided as part of the opening questions.

Each participant was subjected to two interviews, i.e. one interview for each of the two cards assigned, which together lasted no more than 30 minutes. They were audio recorded and all the materials were then transcribed.

3.2.3 Phase 3: Consolidation

In the final phase of this study, we applied a coding process to our qualitative data, i.e. the transcripts of the interviews and the descriptions of the expression practices that we had gathered during the initial exploration phase. The coding process aimed to identify in the text any properties associated with the motivations, scope and usage sensitivities of each of the practices.

The analysis was based on a Grounded Theory approach, trying to identify: codes, concepts (collections of codes of similar content that allows the data to be grouped) and categories (broad groups of similar concepts that are used to generate a theory). As a result of this analysis we have generated 1087 coded segments corresponding to 121 codes. We then conducted a consolidation process based on an affinity diagram of the 121 codes. The process began with the creation of paper labels corresponding to the code

descriptions. These labels were then distributed and discussed with members of the research group to form aggregations around emerging topics.

As part of the consolidation process, we identified three main clusters that frame the emerging design sensitivities: perceived authorship, appropriateness and collaboration. These design sensitivities will provide the key structure for the presentation and analysis of the results.

3.3 Perceived authorship

The first set of design sensitivities is concerned with the perception of who is promoting a particular form of public expression. This is central for the correct interpretation of the meaning of the message and also for its credibility.

We found references to at least three different roles that complement each other in a broader view of what authorship means in these cases: the author itself, i.e. the original creator of the content; the publisher, i.e. the one who creates an expression of the message on a particular medium; and finally, the owner of the medium, which is the person that controls access to the display medium. The interplay between these three roles is very nuanced and very often they are conducted by only two or even only one entity. A person writing a political message in a white t-shirt and wearing it on a political demonstration is performing those three roles. In the case of a person asking a shop to post on their community board an announcement to a global campaign, the three roles are being played by three different entities and authorship of the message is diluted among all of them.

When an entity allows the use of a medium it owns to be used for a particular form of expression, there is also some degree of endorsement of that message and perceived authorship will be shared between publisher and medium owner.

For expression practices where the person is carrying the publication medium, e.g. a t-shirt or a lapel pin, there is no need to negotiate access to the medium. However, because the association of the message to the individual is very direct, that person must be willing to assume any implications that may result from the personal exposure involved. For example, a person wearing a t-shirt with a certain message, creates a clear endorsement of the message and it is just not enough to say that the t-shirt had been an offer or that the person did not even cared about what it said:

> *"When a person goes through this kind of people with stickers, we should think that this person is solidary with the related cause"* P10.

Participants were well aware of this implicit endorsement and clearly considered it when deciding whether or not to engage in some form of public expression, as exemplified in this statement about a campaign sticker:

> *"It had to be an important cause that would make people say: yes, it is worth supporting it"* P2.

Participants also expressed how the endorsement of others had an important effect in the effectiveness of the message:

> *"Others see that someone has collaborated with the campaign. They may help as well, I don't envision other reaction ...."* P7.

For expression practices where the medium is external to the publisher, e.g. distributing leaflets or attaching stickers to street furniture, there is a need to negotiate access to the medium. However, here too, a venue accepting community posts will be perceived as endorsing that content to some extent, and the medium owner cannot ignore that people will make this association. Still, there are some ways to control the strength of this perceived authorship. Publishing content without a clear reference to the author or publisher makes the endorsement stronger, as there is no indication that there are other entities involved. Stamping it with an explicit approval seal or placing it in an institutional area, accessible only to explicitly authorised content, can also strengthen the endorsement:

> *"Usually, in these venues, posters must be previously authorized.... someone must have some way to access and lift the showcase and affix the poster"* P2.

Likewise, it is also possible to downplay this endorsement by placing third-party content in a designated area where it can be clearly perceived as community-sourced:

> *"Some of the posters were placed in the school. We asked the school principal and he showed us the places to do it"* P12.

By reducing the degree of endorsement, these strategies can substantially increase the range of content that may be accepted as appropriate.

Authorship is also related to reputation, since the identification of a particular author with a certain reputation eventually results in higher impact than the same content

without any reference to the author. This can also have an impact on the perception of appropriateness, as discussed in the next section.

3.4 Appropriateness

The second set of design sensitivities is concerned with the appropriateness of public expression practices in particular social contexts. This notion is highly ambiguous and clearly subjected to many social interpretations.

When the person is carrying the media itself, appropriateness is directly linked with the social environment where the person might be. Because there is a strong personal association with the message, and because it might be hard to anticipate social contexts, people develop multiple practices for selectively control individual exposure whenever the message might be sensitive. Situated control, whereby the person can adjust exposure individually and over time, considering the personal assessment of the evolving circumstances, is thus recognised as an important practice, as exemplified by this description of the preservation of a sticker in a wallet while the person who was using it is in a situation not recommended for use:

> *"It could be taken out, preserved and placed again in the presence of a group of friends. It could be stored in a wallet, stuck behind a card, a bank card ... I can make it five/ten times, because then it loses the glue and will no longer be a sticker"* P8.

When the medium is external to the publisher, e.g. leaflets or stickers, there is an explicit act of placement that associates content with the specific locations where that content is deemed appropriate. This is a common practice, and even though boundary situations may be frequent, social conventions and shared practices largely define common expectations about appropriateness that strongly reduce the potential for conflicts.

Participants have clearly acknowledged that authorisation should be requested prior to the placement of content, even when there is an expectation that a venue is willing to accept content from its community:

> *"I think that in all the venues that are private, we should ask authorization to do it to the person who owns it"* P2.

However, this moderation process is often far from a detailed monitoring approach on the content to be published and instead seems to be anchored on a sensible use of social protocols that can deal with the ambiguities of specific publication circumstances.

The first is the set of evolving practices, which with time may create strong expectations regarding the appropriateness of particular types of content:

> *"In this case it was not necessary because we were within an academic environment and as the publication was related to an academic event, authorization is almost automatic, but sometimes I guess authorization is required"* P4.

This might even create the expectation that authorisation is no longer needed:

> *"here, there is a first person that sticks a sticker and then the others see it and also want to do it and leave their stickers stuck there..."* P1.

The second element is the identity of the publishers and the strength of their connection to the venue. A venue owner will be much more likely to accept content from a regular customer than from someone dropping by just for the purpose of distributing the content. Accepting content from the community helps to strengthen that community and build social capital for the venue. It is positive, even if the venue owner does not value the content itself. The exception is when content is seen as offensive by some members of the community. In this case, and even if he does not share that view, he is likely to remove it:

> *"Sometimes there are movie posters that shock people. In this case, the place owner can take them out as there may be a particular kind of persons who can be shocked and automatically will leave, and that place will end up with less people"* P13.

It thus seems that moderation criteria are not so much about the preferences of the venue owner or about any objective view of content appropriateness. It is essentially about place making and finding the right balance between possibly conflicting views of different members of the community. This need to avoid conflict may, for example, involve practices such as accepting content to avoid explicit refusal, but then strongly limit its visibility or publication duration:

"In a typical poster, the place owner probably accepts it and may appreciate the idea as it does not affect the atmosphere in the venue. If it's a poster with some sort of negativity, the place owner may avoid refusing it, but then he will take off the poster" P12.

These social protocols seem to work well because publishers are also highly aware about them. This was often mentioned in the interviews and normally in association with a sophisticated sense of appropriateness. Participants expressed that trying to publish anywhere, regardless of any sense of appropriateness, would be socially awkward and even negative for the message:

"I think that in the case of posters there are places where it's not good idea to post. For example, in religious places it will not be good idea to have those things. It would not work on those places. The person would never try it in this kind of places" P13.

The need to be physically present and talk with the place owner, also introduces a very practical sense that if there is a time cost associated with the contact with place owner, then it makes sense to optimise the process to the locations that look more promising.

Some forms of public expression may be associated with a location without the approval of the location owner, common examples being graffiti or tagging. While objectively unauthorised, these forms of public expression are not necessarily without rules, albeit implicit. To start with, they normally avoid, in their own interest, situations where they could be seen as so inappropriate that they would be immediately removed. Instead, they try to hit an implicit acceptance zone, where the owner is not bothered enough to act on the issue. This may also be interpreted at the light of our findings in regard to perceived authorship. Because in these cases the perception of endorsement is minimal, the unauthorised publication is most likely to be ignored. In many cases, content is not even inappropriate, but a moderation process would simply be unfeasible:

"Yes, we have to request authorization, for example in public spaces similar to the ones in those images. The problem is to whom" P7.

3.5 Collaboration

The final group of design sensitivities regards the role of collaboration. Public expression is quite often a process that involves multiple people, with various degrees of coordination and mutual awareness. Collaboration can be a very effective way to increase the impact of a particular form of public expression.

In a co-location scenario, collaboration involves a group of people in the same time and space sharing a similar message, possibly through multiple forms of public expression. This may either be a loose coordination, e.g. football supporters on game's day or the result of a more coordinated effort, e.g. protesters in a political rally.

The collective and simultaneous nature of these forms of public expression becomes also a form of group identification and plays a key role in determining appropriateness of the message, which may quickly fade away when the collective context disappears:

> *"In this situation [person wearing a t-shirt to support a cause in a public demonstration], it is normal to use these t-shirts because that is when people are more motivated to do it, but I don't see them wearing those t-shirts on a daily basis" P4.*

In a distributed scenario, a form of public expression is shared between people in different space and time contexts, and may be used to significantly expand the reach of the message.

When this is part of a coordinated effort, there might be teams and well defined dissemination strategies. Campaigns are examples of coordinated collaborations, where there might be a strategy to define the places where it will happen and how the various stakeholders will coordinate to maximise impact:

> *"We shared the areas we had to cover (the strategic points) between three persons and each one head towards the dissemination point"* P4.

The existence of a distribution plan does not rule out spontaneity and campaigns, especially with causes, which may often attract people who identify with them and are motivated to participate:

> *"It has already happened when we took a set of leaflets to a café and the owner distributed them in other busier café and ask for more to place in his own venue"* P7.

Distributed collaboration is also possible without coordination, although it can work better when time is not critical. For example, lapel pins and many other forms of merchandising can be used by many people without any connection between each other and over time maintain awareness about a subject:

> *"There are specific pins for campaigns such as those for cancer. I think it would be easier to get people involved. For example, if I'm happy to help I ask for one and this way I would show I'm solidary with the cause"* P6.

3.6 Implications for Digital Displays

The most fundamental difference between the studied practices based on non-digital displays and what may become the corresponding practices for large digital displays is the role of physical constraints. All the public expression practices that we studied rely to some extent on the scalability that physical constraints inscribe into the respective social protocols. This is especially true for appropriateness, where current practices rely very heavily on that for setting the respective publication scope, e.g. selecting where to ask for permission to post a leaflet.

On the contrary, in a digital environment, publication could potentially occur anywhere at nearly zero costs. Therefore, new concepts will be needed to preserve a scalable sense of locality and social relevance. Digital counterparts should strive to introduce some other form of social currency that represents the commitment of publishers. This should enable social negotiation around content, as well as social connections, to remain an integral part of the processes that define the scope of publication and set appropriateness expectations.

Even though there are differences of scale imposed by the physical media used in most of these practices, there are also many similarities with the spread of content in web-based social networks. The first is the separation of roles between a message creator (just a few or even just one) and the role of the many distributors of that message. By minimizing the effort needed to collaborate, many more people can get involved, which would otherwise not have the time, the expertise or simply the decision to collaborate. Lapel pins, postcards, activist t-shirts, stickers or merchandising are all examples of public expression practices that follow this principle. Even if the effort is minimum, collaborating in the distribution of a message is also implicitly a form of social display.

Therefore, these forms of public expression will only work when the message is aligned with people's values.

In regard to authorship, most of the sensitivities described can have a correspondence in the digital world. However, the notions of downplaying endorsement may be harder to achieve given the high profile of large digital displays. Displays exhibiting content from many sources should be designed to clearly highlight the source or the author of each content item. This is important for the correct interpretation of the respective message and may also help to downplay endorsement and thus facilitate acceptance of a broader range of content. This, however, should also take into account the need to preserve selective control of public expression situations. Our results in the present study highlight the importance of situated control and this means that any form of implicit exposure associated with physical presence near a display should have proper control procedures.

3.7 Summary

Existing practices for public expression provide a valuable design inspiration for open publication in digital displays. In the study on public expression practices with non-digital displays, we uncovered a broad range of those practices and identified a set of design sensitivities arranged around three fundamental themes: authorship; appropriateness; and collaboration. This contribution provides a starting point for exploring new paths towards digital displays that can effectively become valuable communication media for everyone. However, more research is needed to understand the relevance of each of those design sensitivities as a valuable design element for large digital screens.

This new understanding of how public expression practices can be repurposed for public displays is a contribution for enabling public display to migrate from a situation where access to the screens is tightly controlled to a situation where user-generated content could become a commodity that would drive entirely new services and business models around public displays (Davies et al., 2012).

4 Place-based Communication

4.1 Overview

Digital public displays are present in urban environments and are used as a pervasive communication medium. However, when compared with mobile and social media, they are still considered a much more complex medium, thus difficult to be naturally integrated as channels in any digital strategies. The classical use cases of digital public displays are very narrow and are mainly associated with advertising, marketing, branding and supporting processes. They represent a limited set of the contexts in which digital public displays could be used as an effective medium for situated communication.

This part of the research work seeks to uncover alternative usage paths for public displays. Our goal is to move beyond current assumptions and inform the design of new communication concepts of public display systems. More specifically, we explore the idea that the true killer application for public displays might be in their role as a generic and open medium for place-based communication. There are two fundamental implications emerging from this approach: a focus on places as communication contexts and a perspective of public displays as multi-purpose communication media.

A focus on places as communication contexts essentially means approaching a public display as a communication channel for its specific physical and social setting. This is in contrast to common narrowcast approaches, where public displays are seen as a distribution point for centrally created content. The role of a place-based display is to give public visibility to information that is somehow relevant for the place where the display is deployed. The notion of relevance for the place brings in the additional implication of a place owner with its own communication goals and seeking to use screen displays as an additional channel to pursue those goals.

A perspective of public displays as multi-purpose communication media means assuming their ability to support a broad and open-ended range of communication goals. Rather than trying to uncover the next killer application, we want to find simple communication practices that can easily be repurposed, recombined and valued by the use of public displays. The ability to easily appropriate public displays for whatever communication goals might be relevant at a particular place and time, would be a huge source of value for place owners. No matter how simple those usage scenarios might be,

as a whole, they could have the potential to be much more valuable than any single usage display.

When considering this line of research, it seems clear that it needs to be anchored on a deep understanding of current place-based communication practices. As represented in Figure 29, place-based communication is already everywhere in many diverse forms, shapes and materials.

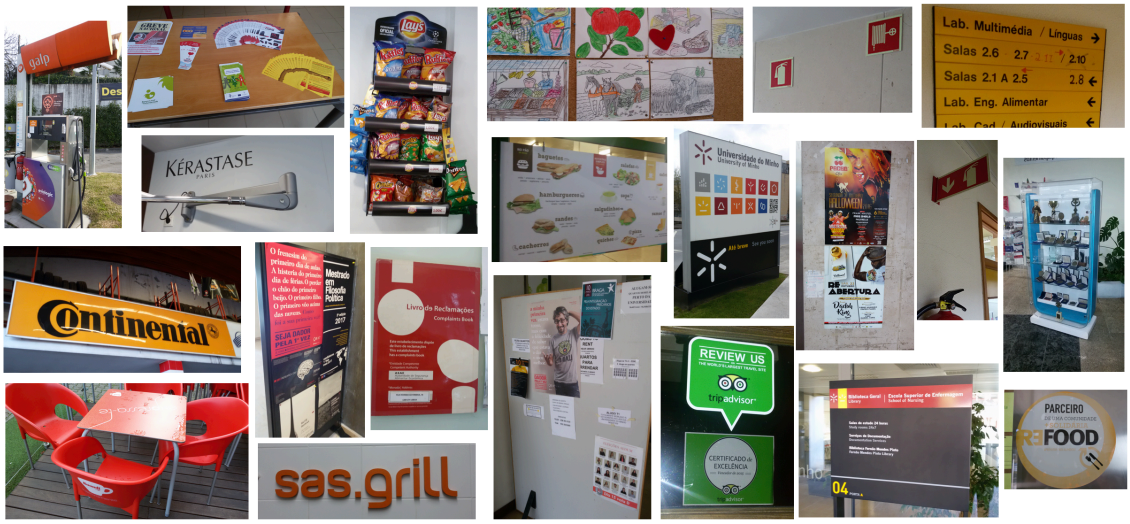

Figure 29. Current place-based communication practices.

Any semi-public place is embedded with a broad range of visual content, and that content is there because it serves some specific communication purpose of the place owner. Considering that place owners already are intensive practitioners of place-based communication, they should be the right source to inform the design of digital place-based displays. The key challenge, however, is that place owners often have difficulties in understanding the medium and have no clear ideas on how to take advantage of digital public displays for their communication purposes. They lack previous practices or even meaningful references with digital displays. Their only references are Digital Signage screens, which are normally focused on the classical use cases; TV, which is a broadcast model; or information kiosks, which offer particular interactive services in public settings. Therefore, instead of trying to get them to envision new and unexpected appropriations of a future technology, we decided to focus on their current practices with place-based communication using non-digital displays.

Effective practices with place-based communication are still essentially in the non-digital world. They are being intensively used every day to serve a need that is very real,

and largely independent from any specific medium. Therefore, an in-depth understating of those practices should provide a relevant reference for practices that may also be of interest for digital place-based displays.

The objective of this research topic is thus to uncover the key goals that characterise the usage of non-digital displays in semi-public places, the key practices behind those displays and their implications for the design of digital place-based display systems. Towards this goal, we have studied existing practices with non-digital displays across 40 places of various types. We have analysed existing elements of visual communication and conducted interviews with place owners to get insights into the communication practices associated with those non-digital displays. The contributions of this part of the research work are as follows: the identification of the major usage dimensions that characterise common forms of place-based communication; the analysis of their relevance across different types of place; the identification of the primary role played by externally sourced content in place-based communication; and the characterization of current practices associated with place-based media. These contributions provide structure to reason about the diversity of value-propositions for place-based displays and explore practices that may be leveraged for an effective use of digital public display systems.

4.2 Research Design

Our research methodology was based on direct observations at 40 places, across three cities in Portugal, and subsequent interviews with the respective place owners. Place selection was based on a diversity criterion in regard to place purpose and organization size. Figure 30 depicts the various phases that composed our research methodology.

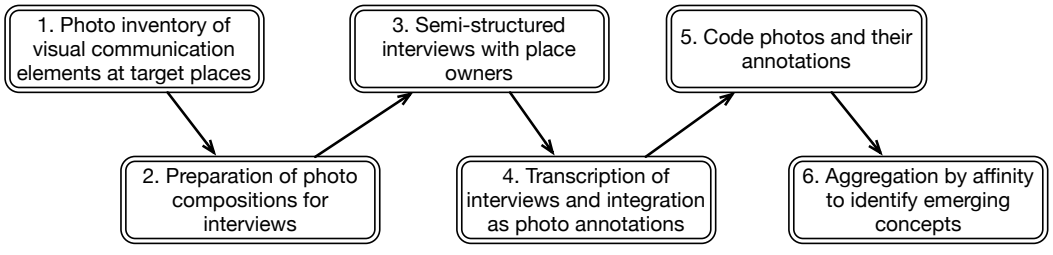

Figure 30. Phases of the research methodology.

The first phase in our research methodology was an inventory of the visual communication elements at each of the places in our study. For the purpose of this study,

we defined place-based content as any visual content that is explicitly exposed in a place. This is a simple definition, but it is also a very objective one that is not affected by any research bias or subjective interpretations of what is or is not relevant to the place. If it is there, we just assume it serves some direct or indirect goal of the place owner. The inventory was thus created by taking photographs of any unique visual communication element available at each of the target places. When confronted with the somewhat blurry borders of what exactly should be considered a communication element, we were as comprehensive as possible, but decided to exclude elements that were only merely decorative and also products exposed in common product shelves. We did consider, however, special product displays, normally offered by the respective brand, which aim to increase the visibility of specific products.

After the photo session, the photos taken at each place were briefly analysed and quickly arranged in several compositions of between five and ten related photos, as exemplified in Figure 31.

Figure 31. Example of a photo composition.

These ad-hoc compositions were not part of any classification attempt. They were only meant to optimise the interviews with place owners, allowing multiple related photos to be analysed together. During the interviews, place owners were encouraged to talk about the whole group or about any of the photos in particular.

We then arranged an interview with a person who had the role of place owner at each of the places in our study. For the interviews, we used the respective photo compositions as a context to analyse their place-based communication practices. The interviews (the interview questions are presented in Annex B) were semi-structured around the following set of topics:

1. creation of the visual element (by whom and where);
2. communication scope (specific to place or equally relevant at multiple locations);
3. expected life cycle of the content;
4. content maintenance (by whom, how often);
5. primary motivation to have that content element exposed at that place.

All interviews were recorded, transcribed and integrated as annotations to the respective photos.

The photos and their annotations from the interviews were then used as input data for a coding process, in which two researchers have been involved, decreasing any bias due to individual interpretation of the source materials. The coding was meant to classify all the visual elements according to their communication goals and also to signal any other distinctive practices. During this coding process, it quickly became obvious the relevance of many practices involving external entities. Based on those early insights, we decided to explicitly analyse the role of external entities in place-based content. We first formalized a number of codes for different roles of place owner and external entities and we then conducted a new coding phase where we specifically classified visual elements according to those codes. This method resulted in multiple codes per each visual element, not only because there were different dimensions of analysis, but also because, in some cases, there could be more than one purpose associated with each element.

Table 4 summarises the data produced as part of this study. It identifies the types of place where data has been collected and for each of those place types, it shows the number of specific places, the number of visual elements that have been observed, the average number of visual elements at each place and the number of codes generated during the coding process. In total, we have produced 21109 codes describing relevant insights from the photos or the respective interviews.

Table 4. Study data per place type.

Place Type	#places	#elements	avg elem. /place	#codes
Cafe	7	384	55	2640
Auto	5	363	73	2151
Retail	5	429	86	2269
University	5	723	145	4537
Restaurant	4	431	108	2371
Notary	3	77	26	432
Public Office	3	314	105	1632
Clinic	2	98	49	537
Hairdresser	2	47	24	285
Library	2	266	133	1536
School	2	507	254	2719
All places	**40**	**3639**	**91**	**21109**

After the coding phase, the two researchers conducted a merge exercise in which the many small categories emerging from the coding phase were aggregated by affinity into a set of higher-level concepts. There were three top-level categories emerging from this process, more specifically: usage dimensions, external content and content management practices.

The collected data provided us with important findings across different perspectives of place-based communication practices with non-digital displays. More specifically 7547 of the codes were explicitly referring to usage dimensions, and the remainder were either about the role of external entities or about particular practices associated with place-based content management. Those three emerged dimensions will provide the key structure for the presentation and analysis of the results.

4.3 Usage dimensions for place-based communication

A key goal in our study was to uncover the different purposes that are being served today by non-digital displays and use them as hints into possible novel uses for digital public displays. Figure 32 identifies the set of usage dimensions emerging from the coding and merging process. It also shows the number of codes associated with each of those dimensions, which, correspondingly represents their relative weight within the total set of observed practices.

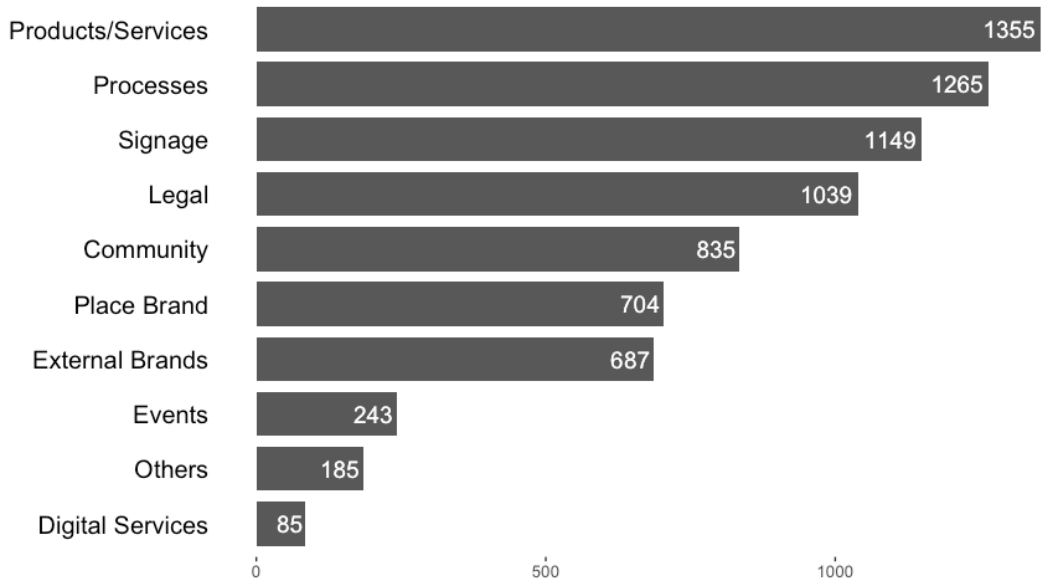

Figure 32. Usage dimensions and their relevance.

We will now describe the range of communication practices that compose each of these usage dimensions.

Products/Services: Displaying information about locally available products and service was the dominant dimension among the places in this study. Many of these places were commercial spots and, thus, strongly driven by the need to increase product purchases. The use of product signage, special merchandise displays, and product lists is part of well-established point of sale marketing techniques that are recognised as having a major effect in product sales. However, this communication dimension was also common outside the more obvious retail spaces. For example, in places like public offices or universities there is a strong communication effort to announce locally available services. Even though they are less commercial in style, those visual communication elements were serving the same purpose.

Processes: Public displays can play an important role in improving conformance with local processes. In particular, they can present situated information about those procedures to either place visitors or local workers. Key examples emerging from this study include information about available payment methods, opening hours or specific rules, e.g. a “no smoking” sign. They can also help to coordinate people around local processes, e.g. queueing information.

Signage: This category includes classical signage elements with a specific spatial association within the place. They serve to identify specific locations within the place, or the directions to those locations. They can also signal the existence of other points of interest or safety related items. This is often standard pictorial communication with a strong spatial connection. Moving these signs to other locations, even within the same place, would normally affect their meaning. Other types of signs without this spatial association, such as a video surveillance sign or a no smoking sign were classified as part of processes.

Legal: There are multiple regulations that include the obligation to publicly display certain information elements. This is often about certificates of compliance with those regulations or information that is supposed to be known by the public, e.g. how to submit a legally bounding complaint about the service. This information needs to be there, but is normally displayed in a very discreet way because most of it is not perceived as very relevant by either place owners or place visitors.

Community: Community content includes a broad set of externally sourced content that is being presented at these places on pro bono grounds. This seems to be partially motivated by the wish to genuinely contribute to the public good, e.g. with information about local cultural events, public health campaigns or other types of initiatives that may be of interest to the local community. On the other hand, part of these communication materials seems to be framed under existing institutional partnerships where there might be some mutual exchange of benefits between the parties. In some cases, the partners' information is even displayed in a specially designated area where it can more easily be associated with its specific source.

Place Branding: Place Branding works as a way to reinforce place identity. This includes traditional elements of corporate image, such as a brand name and logo, but also other elements that reinforce the values of the place brand, e.g. a photo of a local farmer displayed in a fruit shop. It is also very common to display content that helps to build credibility for the local brand. This is accomplished by publicly displaying awards, endorsements seals or media clipping.

External Brands: Global and national brands have strong motivations to be present at specific places that represent their key customer touch points. However, place owners can also benefit from that association. They may recognise intangible benefits in the

association with a well-known brand or they may actually gain material advantages directly, either in product sales, discounts or merchandising. For example, many brands offer valuable branded items to be used at the place, e.g. glasses, chairs or even a fridge for beer bottles. These items provide direct value to the place, while serving the marketing goals of an external brand.

Events: This involves information about events that will happen on premises, but also information about events taking place in the region. Given that external events are actually the most common use case, event information is in many ways similar to community content. It is seen by place owners as a service that they are providing to their community because they feel this information is of general interest to their visitors. They also see it as a way to strengthen a partnership with the entities organizing those events. They need to ask place owners for permission to post information about their events and accepting it is seen by place owners as a sign of good will that may ultimately improve the relationship.

Digital Services: This involves information about the digital layer of the place, e.g. advertising the Facebook page or the TripAdvisor reference. This is an obvious way to promote the usage of those services when people are physically at the place and are thus much more receptive to actually visit those services.

We obviously found many other usage dimensions that did not directly matched any of the previous dimensions, and were not large enough to compose a representative aggregation. Some examples include entertainment; take away materials, e.g. brochures or contact cards of the place itself; and expert information in the form of suggestions and hints related with the activity of the place. For example, a clinic may present posters with medical advice as a way to increase awareness about issues that may correspond to new business opportunities.

Overall, these results show the diversity of purposes associated with visual place-based communication. Regardless of the relative weight of the different dimensions, these results suggest that place-based communication is really about simple and flexible communication practices that can easily be appropriated for a broad range of goals. These different usages of non-digital displays exist because they provide value to the place owners promoting them. Their presence in the place is a key indicator of their relevance.

4.3.1 Dimensions of place-based communication across place types

The usage dimensions identified in this study have emerged from data generated across multiple place types. A fundamental line in this analysis is to consider to what extent these usage dimensions are affected by the nature of each place, and, in particular, to what extent the diversity of usage dimensions remains the same when we consider the narrower scope of each particular type of place. To gain a deeper understanding about this relationship, we analysed the relative distribution of usage dimensions across the different place types in our study. To dilute the effect of the different number of codes for each place type, we transformed the values in a percentage distribution. The results are illustrated in Figure 33, where each vertical line corresponds to the percentage distribution of the various usage dimensions in relation to the total number of usage codes for that particular type of place.

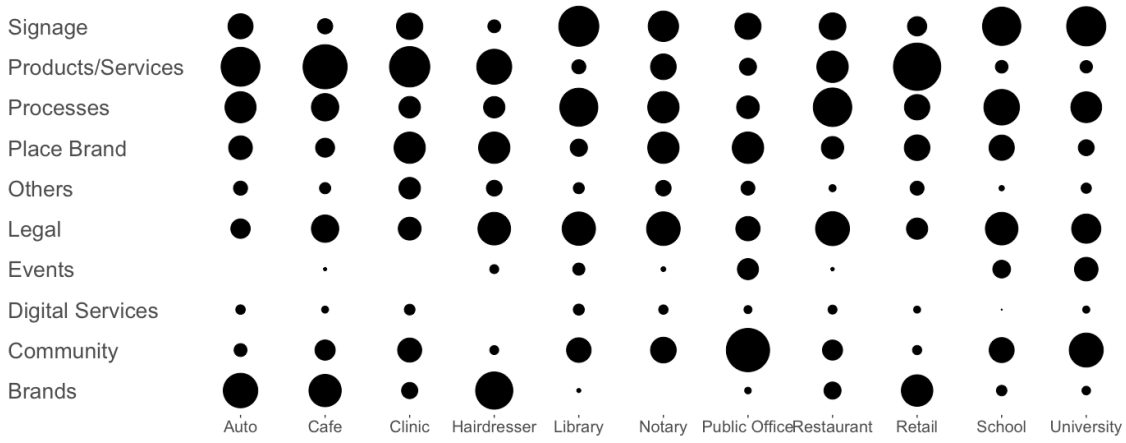

Figure 33. Percentage usage dimensions per place type.

The first observation is the considerable differences associated with the relative weight of each usage dimension for each of the types of place in our study. It is very clear that the relative weight of those dimensions in the visual communication of places is not uniform. The results associated with each vertical line may be interpreted as representing the unique usage signature for a particular place type. The overall diagram provides a comparative view of the diversity of usage patterns that can emerge at those different types of place and clearly highlights the diversity of usage signatures.

However, there are two more fundamental observations to be made: the first is that most usage dimensions seem to have a relevant presence across most place types; the second is that for any particular place type there is always a significant number of

predominant usage dimensions. These two observations are related and they seem to indicate that place-based displays should not focus on a specific design created for a narrow expectation of use at a specific type of place.

When we consider any of the place types in this study, we can observe that, if we created a display that was exclusively focused on the predominant usage dimension at that place, we would be ignoring the large majority of relevant value propositions that already compose the current spectrum of place-based communication for places of that particular type. This seems to confirm the key idea that place-based communication should be approached as serving a broad range of usage dimensions, regardless of the place types. The whole range of usage dimensions should be regarded as a common usage map from which places should be able to dynamically appropriate those that were more relevant to serve their own unique and diverse combination of communication needs. This might provide a new and scalable path for multi-purpose place-based design.

This is even more relevant when we consider that communication needs are not static. They change over time and they can be severely affected by on-going circumstances. This will occasionally raise the need to serve less common communication purposes. For this to be truly possible, the medium must be ready to be easily appropriated for whatever new purposes that might emerge.

4.4 The role of external sources in place-based content

A major insight, whose relevance became quickly obvious at the early stages of this study, was the major role played by external content and external entities in place-based content. We defined place-based content as any visual content that is explicitly exposed in a place, and this naturally includes content that was not created by place owners. During the coding process, we specifically classified all visual elements according to the role of external entities in place-based content. As part of that exercise, we identified different roles, such as the initiative to create content, its creative design or the respective production. In between strictly local and strictly external content, there were multiple hybrid approaches, including content that is created externally, but is meant to be completed or personalized by place owners. Given the existence of these multiple variations, with somewhat subjective interpretations, we settled on a definition of external content that is focused on the initiative to create the content. We thus defined place sourced content as content that was created through the initiative of the place owner, and

externally sourced content as content that was created through the initiative of some external entity. This definition is independent from the many other possible views of the role of external content. For example, it does not define whether content is mainly serving a place owner goal or the goals of an external entity. In many cases, it serves the goals of both. It is also independent from content creation. For example, a place owner can take the initiative to create content, but, then, commission the creation of that content to an external entity. Likewise, external entities may take the initiative to create content that is meant to be completed or customized by place owners, e.g. branded chalk boards for menus.

To support this analysis, we combined our data about external content with our data about usage dimensions. This generated, for each of the 7547 usage cases described in the previous section, a classification describing the source of that content as being the place or an external entity.

Overall, external content (5006 codes) represented 66% of all code instances, with place-specific content (2541 codes) accounting for only 34%. Table 5 represents the usage dimensions in our study with the total number of codes, as well as the number of external and place sourced codes. The table is arranged according to the percentage of place sourced content.

Table 5. Codes per usage dimension.

Usage dimension	#codes	#externally source	#place sourced	%place sourced
Processes	1265	600	665	53
Place Brand	704	370	334	47
Signage	1149	659	490	43
Products/Services	1355	865	490	36
Digital Services	85	62	23	27
Legal	1039	763	276	27
Events	243	189	54	22
External Brands	687	548	139	20
Others	185	154	31	17
Community	835	796	39	5
All	**7547**	**5006**	**2541**	**34**

The first observation is the existence of considerable differences between the various usage dimensions in regard to the weight of place sourced content, ranging between 5% for community content and 53% for content describing local processes. This relationship between usage dimensions and the weight of place sourced content seems to be a natural one, when we consider the characteristics of the various usage dimensions. For example, Processes are normally local rules and procedures, which even though not necessarily unique, are normally expressed in local terms. On the contrary, community content is inherently sourced in the community and is thus almost entirely sourced externally.

However, the most relevant observation from this data might be the predominant role of externally sourced content in place-based communication. Processes is the only usage dimension where place sourced content slightly exceeds externally sourced content. On average, place sourced content accounts for only 34% of all visual communication elements.

These results are a clear indication of the major role played by externally sourced content in place-based communication. While this might, at first, be seen as a contradiction to the whole concept of place-based content, it may also be seen from the perspective that the ability for any place owner to select the unique combination of external content that should be shown locally is also a form of place-based communication. It represents much of what that place is and also its unique set of connections with its own community and its partners.

4.4.1 The role of external sources across place types

A similar analysis can also be made in regard to the relationship between place types and the source of place-based content. Table 6 shows the place types in our study with the total number of codes, as well as the number of externally and place sourced codes. The table is arranged according to the percentage of place sourced content and represents how the ratio of place/external content was affected by the characteristics of each place.

Table 6. Codes per place type.

Place Type	#codes	#external	#place	%place
School	825	355	470	57
Notary	191	84	107	56
Auto	930	522	408	44
Restaurant	828	504	324	39
Hairdresser	139	85	54	39
Clinic	198	130	68	34
Public Office	593	403	190	32
Library	465	334	131	28
University	1341	1011	330	25
Retail	855	646	209	24
Cafe	1182	932	250	21
All	**7547**	**5006**	**2541**	**34**

When we observe the weight of place sourced content in regard to the type of place, we can see that this is now much more uniform than was the case with usage dimensions. The weight of place sourced content is now ranging between 21% for cafes and 57% for schools. This relationship between place types and the weight of place sourced content is naturally related with the weight of the various usage dimensions across each place type, as already represented in Figure 33.

What these results clearly indicate is that the predominance of externally sourced content is also relevant across all place types. Even though the specific nature of that content can change considerably according the predominant usage dimensions at each of those place types, the use of externally sourced content for place-based communication is a common practice across all place types in our study.

4.5 Communication practices for place-based media

As part of the interviews with place owners, we were also able to uncover a set of relevant practices associated with place-based communication.

4.5.1 Collaborative practices with external entities

A key finding, which complements the findings from the quantitative analysis, was the identification of numerous collaborative communication practices involving place owners and external entities. These collaborative processes can be very sophisticated, especially when they aim to advertise products and services. For example, place-based marketing materials can be tightly controlled by external brands. Their representatives can visit the place, specifically, to install, verify or repair those materials. They may actively define where and how the materials will be placed, define a very specific display calendar for particular posters and then make occasional visits to verify compliance with those communication specifications. Place owners (PO) seem to be very aware of the importance of taking these rules seriously:

> *"We cannot miss it, we must be constantly verifying that we are doing everything as we were told. If something gets broken, we need to warn them and they quickly come here to replace it"* PO7;

> *"We don't realize that, but they have people coming here to verify if we are actually doing it"* PO21.

Even though this might look like an intrusion of external entities in the ownership of the place communication, it seems to be appreciated by place owners who acknowledge this as a win-win situation. It can be very effective in helping to boost sales and it is something for which they would not have the necessary resources to do it by themselves:

> *"We realize we could sell more if we had more advertising to our own products, but we do not have the resources to do that, and therefore we end up doing it only with the content provided by external brands"* PO7.

Advertising products sold at the store is also often a way to achieve commercial benefits from the brands that sell those products:

> *"We have a better discount from this brand when we accept to give in store visibility to their marketing materials"* PO21.

This dependence on external sources was also found with signage and legal content. In this case, the challenge is to keep up with the evolving legal obligations, which determine that particular information needs to be on public display at those venues. Given

the complexity of those regulations and their frequent updates, some of the places in our study, rely on specialized external entities to guarantee conformance. Those external entities identify the information to be presented, bring in the respective materials and attach them to wherever they need to be, without the place owner having to worry about those requirements:

> *"They visit us three times a year to verify everything, but if there is new legislation and something needs to be changed they come here and immediately replace what needs to be replaced"* PO7.

While quantitative results had already shown the weight of externally sourced content in place-based communication, these findings help to understand some of the underlying motivations and also to uncover the existence of very common collaborative content management practices between place owners and external entities.

4.5.2 Embracing community content

We also found many content management practices associated with community content. Community members can be seen as external entities, but content management practices and motivations are very different from the previous ones. There are many content providers and content is continuously being renewed by the many independent entities composing that community. Place owners seem to perceive community content as a public service offered to the community, which can help them to assume a central role in those communities:

> *"They can see content placed by others and that can be interesting. It brings people in, either to place the content or to see it"* PO5.

Even though many external entities can ask permission to display their content at any place, it seems like most of these requests originate from a reduced number of frequent requesters. These regular content distributors seem to have the expectation that their content will be allowed at that place. Likewise, place owners seem to have clear expectations on the nature of the content posted by these regulars:

> *"They are usually the same and with the same type of content. Those ones, we do not even ask anymore and we do not pay much attention to what they are displaying. If it is someone we do not know we check it to make sure it is appropriate"* PO5.

Considering the inherent diversity of community content, and how it can lead to significant visual noise, some places try to frame this diversity under a more structured communication style. They can, for example, define standard templates for external announcements and then ask everyone to produce their announcement under that format. This only works for certain types of content, especially more informal ones, but can still provide a sense of community content without the risks of a chaotic appearance when multiple entities are sharing a single space with completely different communication materials:

> *"We want to show those initiatives with some visual coherence. Before, each one had its own poster format and that was a lot of visual noise. It also generated multiple conflicts with one poster covering another. We made it more uniform and also more structured. We now use colors to express the nature of the announcements, e.g. green for environmental topics, yellow for education and blue for arts. People are now getting used to that communication language"* PO11.

4.5.3 Appropriation and spontaneous publication

A key property of non-digital displays is that they can easily be created by place owners to answer any emerging communication needs. This ability to quickly show information when it really needs to be shown can be extremely valuable and may occasionally justify the spontaneous and improvised creation of content, something that can easily be achieved using only a common sheet of paper and a pen. However, this level of improvisation seems to be perceived by most places as somewhat unprofessional and something that would hinder the place brand. Therefore, many places developed intermediate approaches, where this circumstantial content is already prepared, but is only displayed when it becomes relevant:

> *"…whenever one of our products has been sold but remains in the store for a while, we immediately put a sold sign. This might not be the most good-looking solution but what is really important is to show that piece of information to avoid possible conflict situations"* PO19.

These intermediate approaches are also used with materials that are specifically designed for quick editing, such as chalk boards. Even though their content can easily be

created on the fly, there are place owners that prefer to avoid the inherently improvised nature of content that is continuously being replaced:

> *"We have different boards prepared. Only one is exposed at any moment, but we can change them whenever needed. Instead of deleting and recreating the content from a single board every day, we can make their content more elaborate than what would be possible if we had to create it from scratch every single day"* PO5.

The findings suggest that the huge potential of immediate publication afforded by simple visual elements that can be created on the fly is clearly balanced against the negative perception generated by improvised content.

4.5.4 Display blindness is not just for passive viewers

Previous research has highlighted how people can learn to ignore public displays, a phenomena know as display blindness (J. Müller et al., 2009). Interestingly, we have found a similar effect affecting the place owners who are themselves the people responsible for managing the visual display of information at those places. At least in 10 interviews, we had situations where the place owners would hesitate to acknowledge a particular photo as corresponding to a content element at their own place. The key implication is that outdated content can easily go unnoticed for a long time:

> *"I know it is there, but I never remember to change it and I had not realised [until seeing it in the photo] how deprecated it was"* PO11;

> *"This is information that is no longer very relevant to have here, but we get so used seeing it that we no longer notice it"* PO11.

In some cases, deprecated content can be explicitly maintained in exhibition because the place owner felt it could still be valuable, and a more recent content is not yet available:

> *"It is still interesting. We leave it there until a new one arrives, so that the stand does not look empty"* PO30;

> *"Machines evolve, the references corresponding to the model also evolve, but the advertising posters may remain. What you see is not the brand or specific model, but the concept or purpose of the product: for example, the machine*

cut, a punch ... and the person gets the idea that this type of product is available at the store" PO19.

In other cases, the new content is already there, but instead of throwing the old materials away, they are removed to a secondary location, where place owners feel they could still be useful, e.g. spaces where fewer people pass and which otherwise would have no content:

"These are still relevant posters and in these secondary locations they can add some colour to locations which otherwise would be very empty" PO19.

At least one place kept an archive with their older posters:

"We keep them for future memory. They tell our story and it is nice to see the evolution. We have had once an exhibition with posters from the past" PO30.

These findings suggest a tolerant view of what would normally be seen as deprecated content. This is an area where digital content can be very different, because it can be automatically removed upon an expiry date. Still, this digital content can also involve some creation effort and generate the same type of emotional attachment that drives people into repurposing old posters for secondary locations or even keep them as an archive. It may suggest design sensitivities that consider the existence of second line content, which is no longer given the normal visibility, but can still get occasional presentation opportunities as part of the local media space.

4.6 Summary

Non-digital place-based displays are already everywhere, serving many, very diverse and very concrete communication needs. Understanding the practices behind this massive use of place-based visual communication can constitute a fundamental step towards the design of disruptive digital place-based display systems. In this part of the research work, we have uncovered a set of practices related with this use of non-digital visual displays for place-based communication.

A first contribution of this study is the identification of the different purposes that are being served today by non-digital displays. We have identified the major usage dimensions that characterise common forms of place-based communication across the 40

places in our study, mores specifically: Products/Services, Processes, Signage, Legal, Community, Place Branding, External Brands, Events and Digital Services.

A second contribution is the characterisation of the relevance of these usage dimensions across different types of place. In particular, we have shown that for each of the place types in our study, there is a particular composition of usage dimensions, which can be seen as forming a unique usage signature for those place types. However, the most relevant finding is that for any particular place type there is always a significant number of predominant usage dimensions, and never a single dimension that clearly outstands all the others.

A third contribution was the identification of the primary role of externally sourced content in place-based communication and the characterization of some associated practices. Considering that externally sourced content constitutes on average 66% of all visual elements registered in the 40 places of our study, we have shown that place-based communication is not just about locally created content. Moreover, we find well-established collaborative practices between place owners and external entities to integrate and manage external content exposed in the places of our study.

Finally, we have characterised other common communication practices associated with non-digital place-based communication. We identified relevant practices in regard to medium appropriation and spontaneous publication, display blindness by place owners and content maintenance and renewal. These findings may provide design sensitivities to be considered when addressing similar issues in the design of digital public displays.

5 Moderation and Risk Management

5.1 Overview

Current display systems are essentially a world of closed display networks, where only a few people are allowed to post content in narrowcast models. To become a powerful medium for personal expression and situated communication they need to move towards more open models, in which user-generated content can play a more prominent role.

Despite widespread acknowledgment of the potential benefits associated with user-generated content, there is also major awareness regarding the fundamental challenge of how to share control with users while being able to guarantee that content published on public displays will stay aligned with the wider social expectations and practices of each place. In fact, the negative impact of inappropriate content makes user-generated content on public displays to be feasible only when considering the presence of some form of content moderation strategy.

This need for content moderation on public displays is shared with many other types of on-line communities and social networking platforms. Those platforms are strongly reliant on user-generated content, but poor content curation can easily lead to greater noise, which will then lead to a less useful system and ultimately to its dismissal by most users. This is also an obvious problem for public displays, but despite many similarities, moderation of user-generated content on public displays is a slightly different type of problem with its own specific challenges.

The first and most striking specificity is that the public nature of public displays makes content moderation particularly sensitive. This is content that will be exposed to whoever is passing-by, which can be a potentially very diverse audience, with very different backgrounds, age profiles and values. At least some of these people are likely to have more sensitive views on what might constitute appropriate content for a public or semi-public place. When faced with what they regard as inappropriate content on a public display, they might feel ambushed by a situation they did not seek. This is very distinct, for example, from a Facebook page, where one may expect to find views that resonate well with the respective audience, even if they could be seen as totally inappropriate by many others.

A second specificity is the high degree of endorsement associated with media posted on public locations (cf. chapter 3). Even when content is user-generated and clearly marked as such, people assume that the owner of the display has somehow approved that content and is therefore endorsing it. They will say that the display at that place was showing certain content, rather than say that a particular person was inappropriately posting certain content to that display. This places additional responsibility on the display owner, who is expected to act as a place maker and ensure that the display will work according to place expectations.

A final distinction is the physical scale associated with public displays. Content published on a place-based public screen is usually specific to that place and thus limited to a small area, where it will only be seen by passers-by. Even in crowded venues, this is always a much smaller scale than what happens in most Web services. In a way, this might seem like a benefit because the potential impact of inappropriate content could also be smaller. However, it also means that there is no critical mass for complex moderation techniques. Most display owners are likely to have very little time for content management, and there will not be enough users to support any forms of large scale crowdsourced moderation.

This part of the research describes studies concerning the issue of how to open public displays to user-generated content, while mitigating the risks associated with inappropriate content. The essence of our research approach in this particular theme is inspired by risk management strategies. Risk management (ISO, 2009) is a systematic process to identify, assess and prioritize risks, so that proper actions can be taken to minimize, monitor, and control the likelihood and/or impact of unfortunate events.

Risk management is a wide topic on its own, with multiple standards, research topics and a broad set of practitioners across many industries. Organizations of all types and sizes face external and internal factors, which may have a major influence in their ability to achieve their objectives. Risk management is an iterative and systematic process for dealing proactively with those uncertainties and their impact.

The ISO 31000 standard (ISO, 2009) provides generic guidelines and terminology for risk management by organizations. This standard is expected to provide a common approach to managing any type of risk, and is not industry or sector specific.

Risk management is also becoming increasingly important within Information Technologies. In particular, software development projects are known to involve many execution risks (Flyvbjerg & Budzier, 2011). The emerging discipline of software risk

management (Boehm, 1991) attempts to identify, address, and eliminate risk items before they become either threats to successful software operation or major sources of software rework. The use of information technology (IT) in organizations is also subject to various kinds of potential risks (Bandyopadhyay, Mykytyn, & Mykytyn, 1999). Risk management can play a critical role in protecting an organization's information assets from IT-related risks. It is the tool through which IT managers can balance the operational and economic costs of protective measures and define the strategy for protecting the IT systems and data that support their organizations' missions (Stoneburner, Gougen, & Feringa, 2002).

Risk management principles can be applied across many application domains, but they are primarily conceived for the needs of larger projects. These means that existing standards and tools are not a good match to the specific needs of content moderation on public displays. However, the generic principles of risk management provide a consolidated body of knowledge and terminology that can offer the consistency and depth that is needed to approach content moderation as a risk management process.

In our case, we aim to conduct a systematic elicitation of the risks associated with user-generated content on public displays and analyse the possible role of multiple moderation techniques. While previous work has studied specific moderation techniques for particular risks (Alt, Memarovic, Greis, & Henze, 2014; Melro et al., 2013; Memarovic, 2015; Taylor et al., 2007), we aim to provide a systematic identification of those risks and techniques. We also aim to address the broad range of control sharing situations, their diverse requirements and the broad range of moderation techniques that can be applied. More than proposing any specific moderation approach, our goal is to offer designers of interactive displays a framework they can use to map their concrete moderation needs to the most suitable set of moderation techniques.

Our methodology combines a qualitative review of previous work on publication paradigms for large screen displays and interviews with potential displays owners. Based on data gathered from these two sources, we propose a comprehensive list of the key risks associated with user-generated content; a prioritization of those risks according to the perception of potential display owners; a list of the major categories of pre-moderation and post-moderation techniques; and an overview of the acceptance by place owners of those various moderation techniques. Overall, these contributions are relevant steps towards a more general approach to risk management when bringing user-generated content to public displays.

5.2 Research Design

Our research design is framed by risk management methodologies, which provide the scaffolding upon which we organised the specific research activities of our work. To formulate content moderation challenges as a risk management problem, we start by defining risk as the effect of uncertainty on objectives. In our specific problem domain, the key stakeholder is a place owner, whose objective is to offer valuable content to its visitors by incentivising people to provide that relevant content themselves, leveraging their effort and possibly their connection to the local community. This objective can be affected by uncertainty regarding the lack of content publishers, but also, and especially, by the possibility of having irrelevant or even inappropriate content on their displays. Visitors are also stakeholders because they can be affected in their objective of having a nice experience at a venue. This may happen if they are confronted with the presentation of inappropriate content or simply annoyed with irrelevant content.

Despite the broad diversity of risk management standards, methodologies and frameworks, most risk management approaches involve some variation of four fundamental components: Risk identification; Risk analysis (assessment and prioritization); Risk-reducing measures; and Risk monitoring (Bandyopadhyay et al., 1999). In this particular part of the research work, we will consider how the first three can be used as a framework for managing the risks of user-generated content on public displays.

Risk identification involves the characterization of the potential threats and the assessment of the vulnerability of critical assets to specific threats. Within the scope of our problem domain this mainly involves the identification of concrete types of threats associated with user-generated content. To support this identification, we have conducted a systematic elicitation of the threats associated with user-generated described in previous research.

Risk assessment and prioritization aims to determine the magnitude of the risk associated with the various threats. This involves determining the expected likelihood of each risk (high, medium, low) and the respective level of impact (high, medium, low). The respective magnitude is normally estimated as the product of these two variables. To support the estimation of risk and impact we used data obtained from interviews with place owners.

Risk-reducing measures involve the identification of ways to reduce the risks that have been identified and a prioritization of those measures based on risk assessment and strategy. In our case, this involves the systematic identification and characterisation of alternative moderation techniques and their assessment. To support the identification of moderation alternatives, we have used our analysis of previous research. To assess their acceptance by place owners, we have used data from place owner interviews.

Our research design was thus determined by the need to obtain grounded data for the various elements of our risk management framework. This was essentially based on two major activities: a qualitative analysis of the literature and interviews with place owners to understand their perspective about potential risks and mitigation strategies. We will now describe these procedures in more detail.

5.2.1 Qualitative analysis of the literature

A key data source in our research design was a qualitative analysis of moderation situations referred in the research literature. Similar approaches have recently been adopted by the digital displays research community (Du, Degbelo, & Kray, 2017). Using specific search tools, such as Google Scholar, Science Direct, Scopus and Web of Science, we performed an exhaustive literature search. The search criterion was focused on papers with less than 10 years, addressing openness and moderation issues in the context of public displays. In this process, we selected 26 scientific publications (listed in Annex D) addressing different facets of this topic. These 26 papers were analysed using a qualitative analysis methodology based on Grounded Theory. We used a coding tool to code any text segments referring to moderation processes, including the different techniques, general concerns and motivations. The result was a collection of 100 coded segments corresponding to 23 unique codes.

We then conducted a consolidation process, based on an affinity diagramming where we aggregated the various codes into major categories. The result was the identification of 5 top-level concepts, corresponding to the various perspectives of moderation arising from the literature survey, more specifically:

- heuristics (concretes experiences on moderation usage);
- inappropriate content (references to various concepts of inappropriate content);
- moderation approaches (references to moderation approaches and techniques);

- moderation evaluation (evaluation of the impact and consequences of moderation in publications' quantity and quality);
- motivations (underlying motivations for moderation processes).

This research activity produced two major contributions to our study. The first was a thorough perspective on the various types of risk associated with user-generated content across the research literature. This was the major input for the first part of our risk management approach, which is risk identification. The comprehensive view of the risks generated by this process revealed itself to be far more extensive than what could have been possible just from asking directly to places owners. As we have discovered during the interviews, their mind-set is strongly biased towards offensive content. The second major contribution of this literature analysis was the identification of a diverse set of moderation techniques. This was the major input for the identification of risk-reducing measures.

5.2.2 Interviews with place owners

The other major data source in our research was obtained through a set of 36 interviews with people responsible for different types of places (the interview questions are presented in Annex C). The goal was to get a deeper understanding of their perception about the risks of user-generated content and about the moderation techniques they were more willing to use to mitigate those risks.

The first part of the interview was focused on risks. The interviews started with the presentation of the key threats emerging from the literature analysis. This presentation was based on the display of content images representing concrete situations associated with each of those risks (Figure 34). The goal was to make sure that participants could easily perceive the concrete nature of the risk and not just some abstract interpretation, allowing them to actually reflect on what these risks were and what they could meant for their own places.

Figure 34: examples of images associated to the risks presented in the interview

Participants were then asked about their own assessment of the risk (likelihood that a specific risk event could occur) and the respective impact (how harmful or undesirable it would be if it happened), always considering the specific context of their own places. Participants replied using a 5-point Likert scale where they could classify risk situations according to their likelihood (from the "rare" to the "almost certain"); and potential impact (from "negligible" to "extreme"). To avoid any learning effects, the order in which the risks were presented varied from interview to interview. Participants were then asked to give their opinion or make any other comments about those risks.

In the second part of the interview, we aimed to obtain the perception of these place owners about which moderation techniques they would be more willing to use to control user generated content. Place owners were asked to consider a scenario of a digital display in their own venue, where visitors were allowed to publish their own content. In this scenario, the place owner would always have the capability to remove any content at any time. The set of moderation approaches used in the questions corresponded to those emerging from the literature analysis. Place owners were asked about their acceptance level regarding each of those moderation approaches. Participants replied using a 5-point Likert scale where they could classify their acceptance level (from "strongly disagree" to "strongly agree" on using the moderation approach). Participants were also asked to comment on the possible use of each of those approaches in their venues. The interviews were recorded and later transcribed for qualitative analysis. Extracts from those

interviews are included in the results as participant citations and provide important complementary insights into their own perspective on these topics.

The results of our study are organised according to the four main contributions:

- **threats of user-generated content** identify the key threats resulting from user-generated content on public displays;
- **risks analysis** assesses the place owners' relevance on the various threats;
- **moderation techniques as risk reduction measures** is the identification and selection of risk-reducing measures;
- **acceptance of moderation techniques** analyses the potential acceptance of the various techniques by place owners.

5.3 Threats of user-generated content

A first contribution of this part of the research work and a stepping-stone for our proposed framework is a thorough identification of the key threats resulting from user-generated content on public displays. Generically, the main threat is the possibility that inappropriate content ends up being shown on the displays. The challenge, however, is to go beyond the diffuse and contextual nature of appropriateness. While most people could quickly point out concrete examples of clearly inappropriate content, they would normally find it very hard to clearly state what exactly distinguishes acceptable from unacceptable content. Humans are very diverse in the relevance they attribute to different values, and this will ultimately lead to conflicting views on what may or not be appropriate content. As a result, moderation is often about place making and seeking the right balance between conflicting views of different members of the community. Humans are also very sensitive to context and the corresponding implications for expected behaviours. In situations of everyday life, appropriateness can thus be highly ambiguous, subjected to many social interpretations and also very fluid.

A general framework for risk management in user-generated content should take a comprehensive approach to these issues and provide a thorough overview of the many subtle issues involved. To uncover those many and potentially very subtle threats, we use the qualitative analysis methodology described in section 5.2.1. For this particular contribution we coded any references to situations where user-generated content was described as a source of harmful or undesirable consequences. We selected those coded segments and recoded them according to the nature of the respective threat. We have only

considered the threats where the publishers were using the normal features offered by the service. We have not considered any hacking possibilities or intentional misuse by legitimate system administrators. The consolidation process allowed us to identify a set of seven risk categories: Offensive content; Spam; Soft Hacking; Etiquette breach; Editorial conflict; Copyrighted material; and Personal exposure. These categories where then used as the structure for place owner interviews, where we were able to complement the identification of those risks with deeper insights on how they are perceived by those place owners. The final characterisation of these seven categories highlights the wide range of challenges involved and may help to approach risk management from a broader perspective.

5.3.1 Offensive content

The possibility to see offensive content posted on the public display is the most obvious fear associated with user-generated content. Regardless of its specific nature, we consider offensive content as content that most people will perceive as disturbing and clearly inappropriate for most public contexts. Without proper control, sooner or later someone will end up posting explicit material, e.g. adult content, horrible injury or ostensively aggressive messages. However, even lighter forms of content may in certain contexts be seen as offensive or clearly inappropriate, e.g. swear words or excessively informal language, as participant P6 stated about verbal language used in his venue:

> *"The impact is high because I have clients who speak correctly, but I also have clients who speak swear words and, when they talk, the other people around get disturbed".*

An interesting point is concerned with the attribution of responsibility when a user posts offensive content. In the place owner interviews, it was clear that they believe people would be able to distinguish between their content and offensive content:

> *"People know me well enough and would not put stuff like this here, and if they did, it would not be associated to me"* P13;

> *"The impact would be moderate because people would not associate the content with us and would perceive that it had been placed there without our consent"* P24.

Still, even if they see it as being the result of an obviously malicious and intentional act by a third-party, there is still the issue of the extent to which viewers are going to interpret that publication as a gross failure of the duties of the display owner. Place owners seemed to have mixed views on this topic, as stated by participant P25:

> *"There are always the jokers... Belonging the screens to our service, there could be complaints about inappropriate content... but people would not associate it with the service, although the responsibility of the content is always of the service".*

This particular threat is unique in how it is so strongly present in people's minds. If we had based the identification of threats solely on interviews with place owners, we would probably not go much beyond this particular risk. The impact on the image of the place can be so negative that avoiding offensive content is normally seen by display owners as their key concern in regard to user-generated content.

5.3.2 Spam

One of the most recurring problems in social media platforms is spam, which includes more or less obvious forms of advertising. Very often, content being posted as genuine content is actually just a disguised way to promote people, businesses or content sources, often including branded images with URLs or other contact information. In most cases, spam content will not be perceived as offensive and occasional spam content can even go unnoticed, as stated by P31 concerning the impact of spam in a hypothetical display in his venue:

> *"I believe the impact is moderate because people no longer care much about spam content".*

Still, a system that is not able to handle spam properly can easily see the value of user-generated content being undermined by the noise produced by widespread spam.

Again, a major challenge is how to define the boundaries of what is appropriate and what is spam. A previous study on the distribution of paper leaflets in cafés has shown the diffuse nature of what is acceptable (José et al., 2013). While place owners can be very sensitive to content from possible competitors or content that could be seen as undifferentiated advertising, they can be very open to specific types of content. For example, event announcements or nearby attractions were regarded as acceptable because

they were seen as being relevant to their guests, as referred by P5 about the relevance of third-party content:

> *"When we present here information from others, people will expect this to be a place where they find interesting information. That would bring more people, those who publish and those who find value on what is published".*

Interestingly, many display owners would accept content from competitors, as long as it was part of a reciprocal relationship where the competitor would also accept their content. The role that these tacit connections can have in defining what gets accepted shows how these decisions can be highly subjective and strongly embedded with local knowledge.

Spam is already common with non-digital media, but, the natural constraints of physical existence mean that publication costs are proportional to the scale of publication. This represents a natural barrier to the scalability of abusive behaviours. Also, with non-digital media, publication occurs in overt mode, where people can be seen posting their content. A shift to a digital medium would break away from physical constraints, significantly exposing displays to more continuous and intensive spam pressure. In a digital environment, publication could potentially occur anywhere at nearly zero cost, and this is one of place owners' concerns. P11 refers to the risks of existing spam campaigns:

> *"Given the aggressiveness of these campaigns (on windshields, on street furniture, on our own shelves) ... if we could have this medium [public display] available, people would take advantage to make this kind of advertising";*

and P24 stated:

> *"If there is no security mechanism (control), it will almost certainly happen, especially by outsiders who would see it as an opportunity to easily advertise what they want".*

The challenge is thus to be able to bring back some sense of locality to the publication opportunities. This would be fundamental to bring some scalability to any control sharing procedures. Therefore, new concepts will be needed to preserve a scalable sense of locality and social relevance. Digital counterparts should strive to introduce some other form of social currency that represents the commitment of publishers. This should enable social negotiation around content, as well as social connections, to remain an

integral part of the processes that define the scope of publication and set appropriateness expectations.

5.3.3 Soft hacking

In this study, we are not considering the risks associated with security breaches, but there are many forms of hacking that simply try to explore the borderlines of normal system usage to accomplish what may be described as a slightly marginal behaviour.

This tends not to be offensive, because the key motivation is the reward for being able to beat the system. It will, however, be something that is provocative enough to show that the frontier is being crossed, something that most place owners would regard as being a serious issue, even if it was done just for fun. P11 in relation to the *likelihood* and impact:

> *"The likelihood is always high because this is an attractive place where many people pass by. The impact is also high because they may be disobeying a regulation […] even if for the fun of the person who would publish and for the challenge of publishing something for other people to see. This is because people from different age groups come here".*

Several place owners explicitly referred the possible use of soft hacking as a door for promoting competing places:

> *"Taking advantage of what belongs to others is serious!"* P10;
>
> *"If it was advertising to a similar business, it could even be more serious"* P5;
>
> *"If it was another café, impact would be maximum"* P9.

This risk is particularly relevant when there are automated moderation procedures involved. For example, in Instant Places (José et al., 2008), users could post words on their Bluetooth names that were then used for selecting images from Flickr. Even though it was difficult to get the system to fetch an image that could be provocative, some users applied considerable time and creativity to the challenge. While this is not necessarily armful, it still needs to be considered, at least to the extent that it is possible to guarantee a robust borderline and avoid opening the door to more serious and ill-intentioned efforts.

5.3.4 Etiquette breach

In addition to offensive content and spam, there are many other forms of posting that may be regarded as violating the rules of etiquette for posting in that context. In general, in corporate or institutional environments, any content falling under the category of Not Safe For Work, may easily be perceived as an etiquette breach, even if it is content that can easily be found in other less formal public contexts. Whether they are written or not, etiquette rules should be shared and embraced by the community. The concrete ways in which someone may breach the local etiquette will depend on those rules, but common examples include posting off-topic posts or trolling. A troll is a person who publishes deliberately provocative messages to cause trouble, start a contentious topic, derail a discussion or incite an emotional response from others. This is not necessarily offensive, it is just inappropriate and regarded as undesirable behaviour by the community, as reflected in concerns of participants:

> *"This would be serious because it would generate great discussion, considering the people who come here. I think it would be unlikely anyone would come here and publish, but if they did, we would have a huge discussion. So, the problem would be more for the discussion that it would generate and not necessarily because of the content"* P7;

> *"This is a quiet place and people who come here are peaceful, so I think it is unlikely to happen. The impact is moderate because I do not think content would be associated with us... it would be more for the discussion that could generate"* P26.

This is in line with policies from on-line forums, which frequently ban topics, such as religion or politics, because of the strong emotional and heated discussions that these topics may generate.

5.3.5 Editorial conflict

A particularly subtle threat is when it whole problem comes down to an editorial perspective. An editorial conflict happens when a user posts something that is perfectly acceptable, certainly not abusive, perhaps even appreciated by the audience, but which somehow fails to meet what the display owner had envisioned as appropriate, as mentioned by participant P11:

"There may be a positioning conflict (e.g. Religion). I admit that people next to the display could even assimilate this type of content as normal, but I, as President, do not think that is appropriate".

Regardless of the specific moderation mechanisms, opening displays to user-generated content is essentially an act of sharing. It means that the display owner is no longer the sole responsible for thinking the display content and needs to give some space to other views on what the display should present. This suggests approaches that build strongly on active user participation and high levels of appropriation. If the system is not open enough to offer a compelling value proposition to users, they may not have enough incentives to post their content. However, even when there is a genuine interest in user-generated content, a display owner may still want to maintain some discretionary control on what goes into the displays:

"Using content that is generated by others would be nice... but if that would undermine what I had thought for the screen, it would be serious!" P10;

or participant P26 concern on the corporate image to be preserved:

"I think it's unlikely to happen, given people coming here, but I would not like it because it comes out of my interests. I have a concern with the image and it could be damaged with this kind of things".

For example, in previous work with schools, developed within our research group (Otero, José, & Silva, 2012), these different visions were very clear. There was a continuous tension between the topics that students valued and what school teachers, who had the role of display owners, perceived as valuable for the school context.

These tensions between publishers and display owners can be particularly frustrating for both parties because the whole problem emerges from unspoken implicit rules that even the display owner will have difficulty in stating explicitly. Other than for those situations that may fall under the umbrella of lack of etiquette, most display owners will not be able to specify a priori what their editorial rules are, apart from the basic position that everything should have to be related to the business of the place:

"If someone came here to put anything, it would have to be something to do with the business" P20.

This is in line with the findings on non-digital community boards, where previous research has shown that their creators did not have a pre-defined profile for those boards. The actual content that composed the boards had emerged from a continuously evolving social negotiation and the interplay of the interests of the board owners and users (Alt, Kubitza, et al., 2011). Also, a public space is not normally themed to the extent that it can be clearly focused on a topic. For example, in Facebook Pages or other online forums, clearly focused editorial line is essential to attract a specific, but very disperse, audience coming from the entire Internet. In a public space, the audience may change very often and can be very diverse. Therefore, a strong focus on a particular theme will be less common. To attract user-generated content, a display owner may have to accept some flexibility in regard to topics that may be of the interest to the display audience, even when they do not correspond to what the display owner had initially envisioned for the public display, as agreed by participant P18:

> *"What matters is the customer and we have to respect everyone, so the contents are for them".*

It is this inevitably ambiguous and progressive formulation of the editorial line that makes this risk so hard to manage.

5.3.6 Copyrighted material

Even if unintentionally, people are likely to post images, branded logos, text, videos, music or other materials that are protected by copyrights laws. This is probably the case where it can be easier to have objective guidelines about what is appropriate. However, most place owners would not have the competences to identify all forms of copyright infringement and they would not even be able to assess any type of borderline cases, e.g. those related with more subtle concepts, such as fair use. This is probably why they clearly acknowledge the problem, but also seem to have a somewhat lazy attitude about it. As stated by participant P15 in regard to the use of copyrighted materials:

> *"There are a lot of things that are protected and people use them without knowing it. Even the press uses it without knowing it. Usually that's not a problem...";*

and participant P8 about his own uses of copyrighted materials:

"We publish things innocently. I realise for myself, sometimes I pick up cartoon characters for my cakes and we do not even remember we can have problems".

This almost lazy attitude in regard to the occasional use of copyrighted material can be a particularly strong characteristic in the type of the small venues targeted in our study, and is essentially related with non-digital media. However, they do seem to be aware that the ultimate responsibility lies with them, as mentioned by participant P13 in regard to his responsibility concerns:

"It could have a lot of negative impact because it has protected rights and is on my screen".

In general, we found explicit references to copyright protection in the guidelines for most social media platforms, incentivising users not to include any content which is not original. Also, the specific liabilities associated with potential law infringement need to be considered and users are often warned about the consequences for them in case they fail to comply with copyright rules. Participant P27 makes a reference to the legal aspects of using copyrighted material and he is peremptory:

"Impact is maximum because this is illegal!".

On the other hand, participant P1 states her concern on the consequences to the place:

"The impact would be maximum, because if there is an inspection, we would have problems (me and the person who published), and maybe I even would have more problems because the person would not even identify herself on the publication".

Consequently, while not necessarily a priority, threats associated with copyright infringement induced by user-generated content, should be taken seriously. In particular, place owners should, at the very least, have proper mechanisms for dealing with reports of copyright infringement by quickly removing or blocking the respective content.

5.3.7 Personal exposure

The final threat emerging from our study is Personal Exposure. Content involving individuals can be regarded as inappropriate whenever it exposes those individuals without their consent. We have found many references to this risk in online fora, where usage policies often refer that personal attacks or defamatory statements are not acceptable and users should not post content that frames others in a negative light. The concern here is essentially to ask users to focus discussions on the issues and not on people. This is a case where public displays seem to have some interesting specificities. For example, photos of individuals are frequently posted on social networks, very often without explicit permission from the people in the photo, and very often with explicit identity markers that make them easy to track. Still, in general, this is increasingly seen as socially acceptable behaviour, as stated by participant P31 about student's publications on social networks:

> *"Students do this every day on Facebook and do not realize it. Very easily they take pictures and make videos of friends and publish them on social networks".*

With public displays, most people have a different perspective. Even completely public data from social networks, such as name and photo, may be perceived as excessive exposure when shown on public displays, as stated by participant P11:

> *"People already find it natural to expose others on social networks. If they realised they can also do it in this public screen, I am quite sure it would happen too.[...] It would be very serious because we would be exposing someone on our public screen".*

Previous research by Hosio et al. (Hosio, Kukka, & Riekki, 2010) has shown that many people see a possible conflict when posting to a public display photos with friends in them, even if these photos are already publicly available online. Participant P25 refers a similar situation at the respective venue:

> *"This has already happened. In fact, it happens with posters that are sent here with photographs, and people are not very careful about it. Here I receive many posters in which I recognize persons in the images, and I strongly believe there are images shown without consent of the people appearing in them".*

In the Moment machine (Memarovic, Fatah gen. Schieck, et al., 2015) people were in general excited about the idea of taking a photo to be presented at the public display, but the authors also report cases where privacy concerns were raised in regard to where and when were those photos being shown. Also, some people were simply not happy about their photos and wanted to have them removed. The authors report on a particular case where a woman contacted the researchers to remove her photo. She did not want to have photos where she was not looking good, especially not in a place where she passed-by on a regular basis. Throughout the many weeks of the Instant Places (José et al., 2008) deployment, the only occasion where a poster was rejected was when a bar's customers wanted to publish a poster poking fun at other customer. Even though the content was like a joke between friends and would not be seen as offensive by other people, the display owner refused on the grounds that the display content could be placing one of its customers in an uncomfortable situation. Participants have often referred their concern about this type of content:

> *"The negative impact would be high because they came to complain and I have to answer for what is going on inside my place"* P6;
>
> *"The negative impact would be high because it would always remain the question of who posted it"* P25.

This shows that even when the negative consequences can affect only a single person, place owners are aware of their if responsibility for the published content.

5.4 Risks analysis

Building on the characterisation of the main threats, we move to Risk Analysis. In this phase, we aim to assess the relevance of the various threats, based on their likelihood and their potential impact, and also prioritize them in the overall risk management strategy. To support this process, we gathered data from the interviews with place owners, where participants were asked to classify the various threats according to their likelihood and potential impact using a 5-point Likert scale. The results are listed in Table 7, where we also included the risk relevance as the product of its likelihood and its potential impact.

Table 7: Risk analysis data

Threat	*Likelihood*	*Impact*	*Risk*
Offensive content	2.45	4.20	10.29
Spam	2.88	3.33	9.56
Soft hacking	3.02	3.02	9.15
Etiquette breach	3.08	3.48	10.69
Editorial conflict	2.60	3.05	7.93
Copyrighted material	3.12	3.30	10.31
Personal exposure	3.02	4.38	13.23

Based on those results, we were able to build a global view of risk priorities and a risk matrix to help system designers in the definition of appropriate control strategies. The first approach to prioritization is to simply assume the magnitude of the threat, estimated by the product of the likelihood and the potential impact, as the priority criterium. The results of this approach are listed in Figure 35.

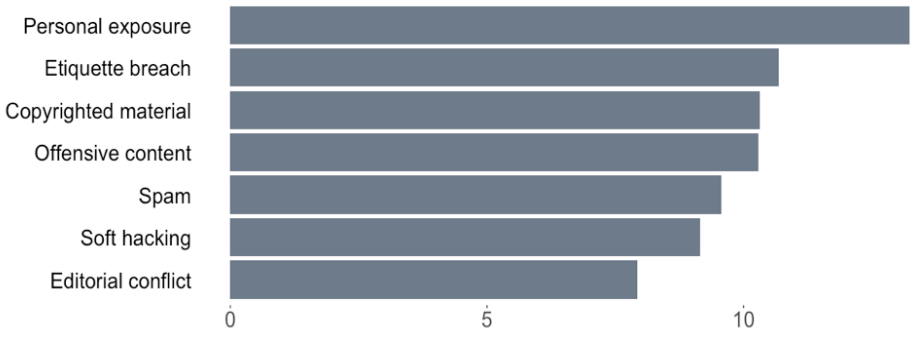

Figure 35: Risk prioritization based on likelihood and impact

These results may seem counterintuitive when we consider that offensive content is only ranked as priority number 4, despite being systematically mentioned as the key concern of place owners. However, there are two elements in our study that may help to interpret these results. The first is that some highly impactful risks are also perceived as not very likely or, at least, not very frequent, as summarised by participant P24:

> *"In all these years, I've never seen this type of content here. People can even place content without authorization, but not of this kind."*.

Perhaps more interestingly, this also shows how the focus on offensive content can be mainly caused by the lack of awareness about other, less obvious, types of risks. When confronted with a comprehensive lists of threats, place owners might be making a more rationale and thorough assessment of risks and a more balanced distribution of their concerns.

To go a deep deeper into this issue, and better understand the combined effect of likelihood and impact, we have also created a risk matrix, which combines the likelihood associated with a risk with the severity of the respective consequences. A risk matrix is a particularly useful way to analyse risks when the likelihood and potential impact cannot be estimated with accuracy and precision. It provides a simplified perspective of the risk levels and facilitates decision making. The risk matrix represented in Figure 36 is based on the same data presented in Table 7, but this time with the two dimensions separated.

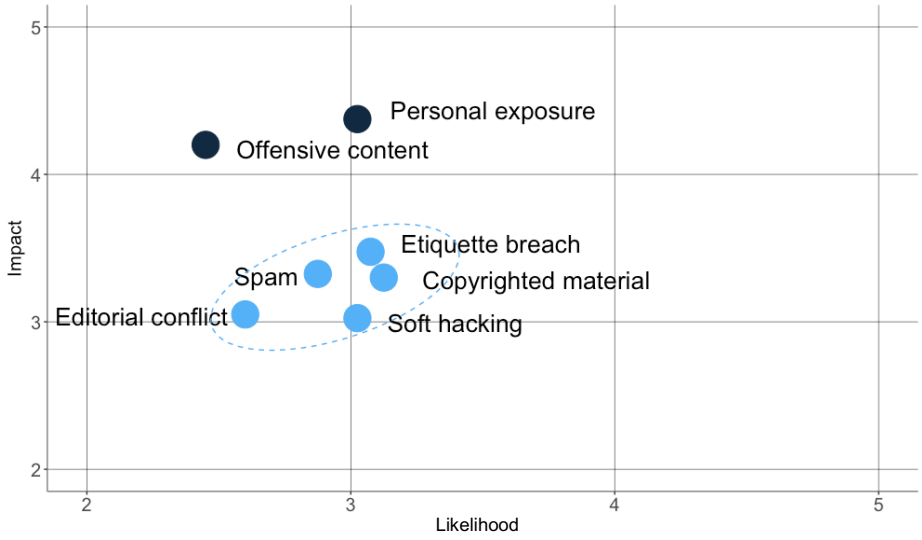

Figure 36: Risk matrix for control sharing in public displays

In this diagram, we can clearly observe the emergence of two main groups. The first is composed by the two types of risk that clearly cause a stronger perception of potential impact: personal exposure and offensive content. Here, we can highlight how offensive content was regarded as the least likely event from all types of threats. This is why it did not ranked very high in the previsous priority list. The second group is a major cluster where all the other threats congregate with similar perceptions of risk and potential impact. Place owners may have had some difficulty in answering with confidence about

how likely certains risks would be and that may have lead them to very similar answers closer to safe zone of the centre of the 5-point Likert scale that was used.

5.4.1 Risk assessment by place type

Another dimension of analysis is to assess the extent to which risk perception changes with the type of places. Figure 37 represents risk perception (Likelihood*Impact), as assessed by the place owners of the various types of places in our study.

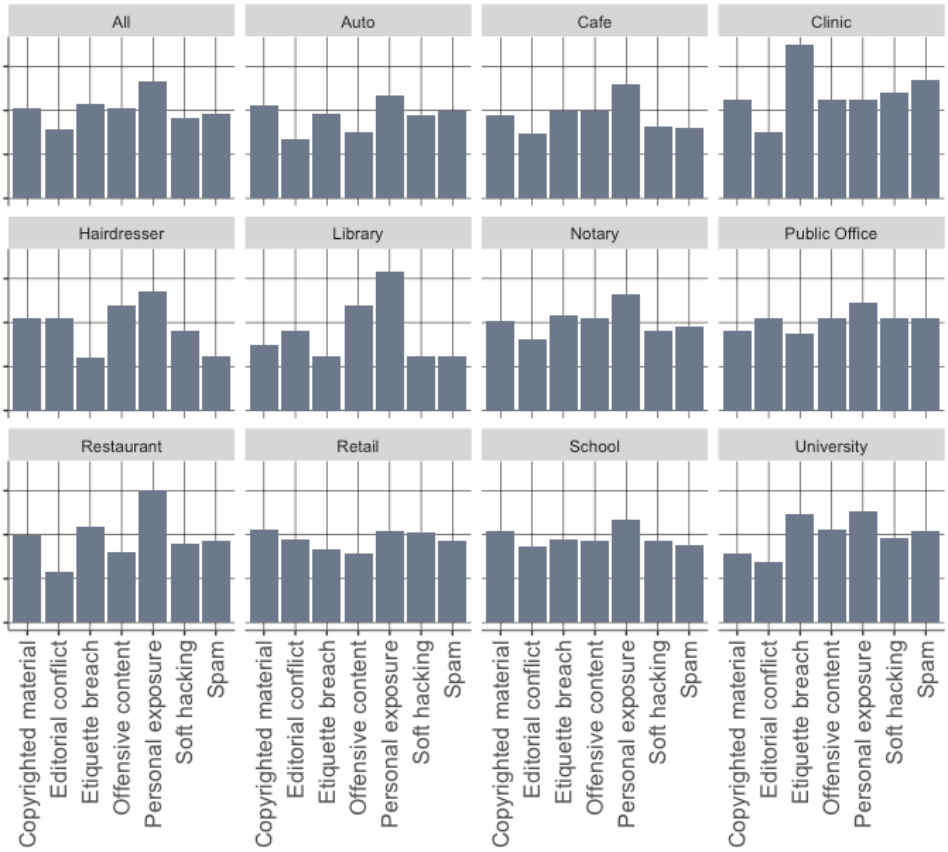

Figure 37: Risk perception by place type

The main result from this analysis is the key differences emerging from different types of places. Even though we do not have enough places to analyse with more depth the meaning of those differences, we can clearly highlight that risk perception is not uniform and that the social and cultural properties of each place will strongly affect the respective risk perception, as suggested by participant P16 about the impact of offensive content:

"Impact would not be high... only men enter here and they would even appreciate it".

These changes between different types of places are difficult to model, especially because they are likely to be extensive to different places within the same place type. The key implication is the need for flexible moderation approaches that can easily be adjusted to provide the best possible fit with the unique risk analysis of each place.

5.5 Moderation techniques as risk reduction measures

Once risks have been identified and assessed, the next step in a risk management strategy is the identification and selection of risk-reducing measures. From a risk management perspective, risk-reducing measures encompass four major approaches: risk avoidance, risk reduction, risk sharing and retention (Dorfman & Cather, 2012). In the context of this work, we are mainly concerned with moderation techniques as risk reduction measures. We present the identification of moderation techniques and their integration as part of a comprehensive risk management strategy, complemented with the insights from place owners. The elicitation of moderation techniques was based on the literature analysis, as described in section 5.2.1, where we coded any references to moderation approaches and their properties.

Moderation techniques can themselves be divided into two major groups according to the timing of the process: pre-moderation and post-moderation. A pre-moderation approach is a preventive action, where content is moderated before it gets published on the displays, thus reducing the risk of inappropriate publication. Post-moderation represents a set of procedures that can be executed to support moderation after content publication. This is a corrective action that does not prevent inappropriate content from being shown, but may reduce the impact caused by situations of inappropriate behaviour. The key advantage of a post-moderation approach is that moderation procedures are no longer an obstacle for a quick publication process, which can be much more rewarding for publishers.

Moderation techniques can also be organised in regard to the entity or entities responsible for the process. Moderation by the display owner can ensure the most effective control, but may be hard to scale. Alternatives approaches may involve the automation of the moderation process, the distribution of the process between multiple entities, increasing the accountability of publishers or selecting who gets access to the

right to post content (curation of access). Table 8 summarises the key moderation approaches emerging from the various combinations between moderation timing and moderating entities.

Table 8: Moderation Techniques

Actor	Pre-moderation	Post-moderation
Display owner	**Content pre-approval**	**Content reviewing and removal**
System	**Automated filters**	
Trusted curators	**Distributed content curation** **Trusted sources**	**Distributed content removal**
Accountable publishers	**Social accountability**	**Report abusive content**
Anyone		

5.5.1 Pre-moderation by display owner

The most basic form of pre-moderation involves the pre-approval of content by the display owner. A pre-approval queue allows display owners to review and approve, or reject, content before it gets published on the public displays. In their comprehensive study of pre-moderation techniques, Greis et al. (Greis et al., 2014) point out that the strong control provided by this form of moderation is a key element for encouraging display owners to publish content generated by others. The key benefit of pre-moderation seems to be the confidence it can give to display owners about retaining control, as stated by participant P27:

> *"I would open the display to other people as long as I had prior and absolute control over everything they wanted to publish!".*

However, according to Elhart et al. (Elhart, Memarovic, et al., 2013) pre-moderation faces three key challenges: the availability of individual content in advance; the scalability of the process; and the negative impact on the publication process due to the publication delays introduced by pre-moderation. In the interviews, place owners seemed to be aware of many of these challenges, as evidenced by the participant P31:

"If we have to control everything before publishing, then there will be no publications. We have this experience and we can't moderate everything. It is impossible to moderate everything...".

A large screen display that is open to user-generated content receives a continuous feed of new content posted by users or dynamically fetched from external sources, such as Facebook pages or media feeds. The dynamic nature of this content represents a major challenge for moderation approaches. In closed systems, it is simple to set-up approval processes where all content is carefully screened before publication. In an open system, content is not known in advance and any approval procedures must be incorporated into regular and also very dynamic content management procedures that could keep up with the dynamics of content generation. When content is being generated by applications, the problem can be even more difficult. The exact content that will be shown by an application in a particular contextual situation can be hard to preview until it actually gets presented on the display (Elhart, Langheinrich, et al., 2013).

Pre-moderation techniques can also be a problem because of the delays they can introduce in posting/updating content. While, in general, most users expect content to be moderated, a long delay between posting and having that content on the screen can negatively influence how the users interact with the applications. A study by Greis et al. (Greis et al., 2014) has shown that delay times caused by content moderation significantly influence the number of user-generated posts on a display. The authors concluded that people accept content moderation on public displays, but expect limited publication delays when moderation is done, more specifically within 10 minutes.

5.5.2 Pre-moderation through automated filters

One approach to reduce moderation delays and deal with highly dynamic content is the use of automated filters that can scan content and place it into quarantine whenever it gets flagged as potentially risky. This is seen as being prone to errors and something that can easily challenge people to soft hacking, as recognised by multiple participants:

"There are always things that can't be filtered and that go through... and if it happens within our space, we are obviously associated with the publication" P17;

"I partially agree, as long as the filters are well created, because whoever publishes can always try to escape the filters" P24.

Despite potential limitations, automated pre-moderation can be useful without having to be perfect. More specifically, it can complement the pre-moderation by the display owner, by improving moderation productivity and the scalability of the whole process. In particular, automated moderation can initially be used just to organise moderation tasks. With time, and once the place owner realises that direct control is increasingly redundant, he or she may gain enough confidence to allow the system to automate certain decisions and potentially even move to a fully automated process complemented with post-moderation support.

5.5.3 Pre-moderation through delegated content curation

Another way to promote the scalability of moderation processes is to delegate content curation between multiple trusted curators, other than just the display owner. This approach has been extensively explored by Taylor et al. in their study of a Village Photo Display (Taylor et al., 2007). A group of users was responsible for moderating categories of content created by themselves, but approved by the display owner, ensuring that only trusted users could act as moderators. The categories creators were then responsible for the maintenance of the content posted in the category by other users, establishing a form of category ownership. This approach was described as fostering a sense of content ownership by the community and having a positive effect on the number and relevance of the photos to the local community. Also, over the years of this deployment, the authors claim that they were not made aware of any problems with posted content. Participants in our study, seemed to appreciate the concept, but were not so sure who the trusted curators could be, as stated by participant P5:

> *"That would be ideal, always be seen by someone before going to the screen. But for that, someone should always be available and that is difficult. For example, it could be easier if it were made by people who came here often, who make similar publications..."*.

Overall, this distributed content curation approach may also be seen as embracing the use of external sources that are relevant to the place. For example, a Facebook Page or an Instagram Feed from a trusted source can be seen as curated sources of user-generated content that already incorporate their own content control approaches. The use of social media on public displays provides easy content creation, moderation, and storing, characteristics that can be considered crucial for long-term maintenance of a

system (Storz, Friday, Davies, et al., 2006). In most cases, the use of content originating from these sources can be considered safe because they already incorporate moderation procedures and their owners have also their own reputation and editorial line to keep. For example, participant P7 would accept content coming from a trusted institution that preserves and even promotes his corporate image:

> *"If I trusted the person... for example, if my game provider told me "let's put it there like that"... if I trusted the external entity coming here, I would have no problem".*

5.5.4 Pre-moderation through social accountability

Making publishers accountable for what they publish is the other major alternative for pre-moderation. Even without user authentication, some level of accountability may exist when interaction occurs in overt mode. Previous research has shown that public interaction can generate strong social pressure to the extent that it can even become a huge barrier to the use of public displays for social interaction (Rogers & Brignull, 2002). This can change significantly with covert interaction, where users are not seen interacting because interaction is mediated by a mobile phone or other similar devices (Finke, Tang, Leung, & Blackstock, 2008). In these cases, user authentication can play a major role (Trotter, Davies, Khamis, Prange, & Alt, 2018). With authenticated users, it becomes possible to define access curation techniques, where only known users are able to post, or to make people accountable for their actions:

> *"As long as the person is associated with the publication, that person would always be accountable for her acts, ... and she would only do it once, because then she would be banished!"* P5.

Even if publication is open to any authenticated user, this may by itself provide an important barrier for users to post offensive or inappropriate content. It can also help to reduce the perception of endorsement by the place owner, as stated by participant P4:

> *"If their names are there, then I will be clear that this is content that I am not responsible for".*

For example, in their study with tweets, Greis et al. (Greis et al., 2014) found that forcing people to use a twitter account for posting on a display had a strong impact in the occurrences of inappropriate content. Still, the effectiveness of this approach and the level

of trust that is needed can be highly specific to particular communities. In the Plasma Poster Network, Churchill et al. (2003) reported on how the restricted physical setting and the relative informality of a workplace were central to the success of the technology and also how a minimal content moderation policy was possible by relying on social accountability to ensure appropriate content was posted.

5.5.5 Post-moderation by display owner

The most basic form of post-moderation is to give the display owners simple procedures for the quick removal of any inappropriate content from their displays. In its simplest form, this may correspond to a web page constantly monitored by the display owner that provides a removal option. Whenever new content is brought to the attention of the owner, he or she will have the means to quickly ban that content from the display if it is considered to be inappropriate. This sense of keeping full control over the display is crucial for the willingness to share control with users, as long as the frequency and cost of inappropriate content remains acceptable. This is, however, a corrective action, which does not prevent inappropriate content from being shown, only reducing its potential impact. The key advantage is that moderation is no longer an obstacle for a quick publication process, which can be much more rewarding for publishers.

5.5.6 Distributed post-moderation

When used in isolation, post-moderation can be as cumbersome for the display administrator as pre-moderation. There is still the need to frequently monitor new posts to identify and remove inappropriate content. Moderation time is no longer an issue in regard to willingness to publish, but it may affect mitigation of impact. If it takes too long, the negative consequences of presenting inappropriate content may also be too high.

This can be improved by extending post-moderation to trusted reviewers and particularly to people who may be in more direct presence of the displays. Elhart et al. (2013) report on a distributed moderation process based on the RFID tags used by people to get access to buildings, which would allow authorized people to interact directly with the display and remove inappropriate content. This process is largely circumstantial, but it avoids the embarrassing and frustrating scenarios of being in front of a display that is presenting inappropriate content and not being able to remove it. It also enables post-moderation to be distributed to a larger number of authorized people, which can make this process much easier to manage.

5.5.7 Crowdsourced post-moderation

Post-moderation can also be extended to users by providing a denounce functionality that allows users to report inappropriate content. Since content is already published and being shown to everyone, then everyone can be empowered to denounce content as inappropriate. This is a common approach in crowdsourced platforms, which leverage on the community itself to moderate and define the relevance of the content being shared. When a report occurs, the respective content can be immediately banned and sent to the administrator for verification. For example, in Digifieds (Alt, Kubitza, et al., 2011), users could report inappropriate content through the abuse button. The reported item would be immediately taken out of rotation until reviewed. During the initial six months of deployment, two items with unsuitable content were reported and consequently removed. This possibility to allow everyone to denounce content can make the whole process much more scalable, but it may also have another benefit, which is to allow multiple sensitivities to emerge, highlighting different views on what may constitute inappropriate content and allowing people to express their strong feelings about particular types of content that they find disturbing.

The key problem with this approach is the potential lack of critical mass to make it work. In a media platform, published content may reach a large community in a very short period of time. It will be quickly scrutinized by many who are just a click away from denouncing that content. In a public display, content can potentially be published at a single location, where it may be seen by a few people over a few days. These people may not have any obvious or convenient way to denounce content. Unless it is something very obviously wrong, it may easily stay on the displays until someone goes through the effort of actually complaining.

5.6 Acceptance of moderation techniques

The final step in our work related with moderation techniques for risk management is to analyse the potential acceptance by place owners of the various techniques. This may be seen as the prioritization phase of a risk management strategy. However, in this study, the whole process is highly subjective because it depends very heavily on what we see as vague perceptions that place owners might have about a reality that they are only trying to envision. Therefore, to reduce the level of abstraction, we focused the analysis specifically on their perspective about specific moderation techniques, as described in

section 5.2.2. In the final part of the interviews with place owners, we presented them the various moderation alternatives described in the section 5.5. The presentation was as specific as possible, with a clear description of the overall approach. We then asked participants to express their availability to operate a system where moderation was solely based on that particular technique. Participants would reply with their level of agreement in a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree". We have also registered any related comments made during the process.

The first question was focused only on the two major groups of moderation techniques: "Assuming that you could always remove any appropriate content, would you accept to have a display based only on post-moderation techniques?". The answers to this question were overwhelmingly negative:

"I had to see everything, whatever it was" P4;

"Inside my house I like to see what is going to be published" P21.

The respondents expressed 95% of the answers as "strongly disagree", with only 5% going as far as expressing their answers just as "disagree". These results have negatively affected our ability to make any relevant analysis regarding acceptance of post-moderation techniques. We have thus ignored that part of our data and focused only on pre-moderation techniques.

The concrete questions regarding pre-moderation techniques were as follows:

- Pre-approval by display owner: "I would accept user-generated content if I were able to review any content before it gets published on the displays";
- Automated Filters: "I would accept user-generated content if there were automated filters, configurable by myself, that would be able to retain most of the inappropriate content";
- Trusted Sources: "I would accept user-generated content from external sources that I selected as being trustworthy";
- Social Accountability: "I would accept user-generated content from users who had known identities and could thus be made accountable for their publications".

The results of these questions are represented in Figure 38.

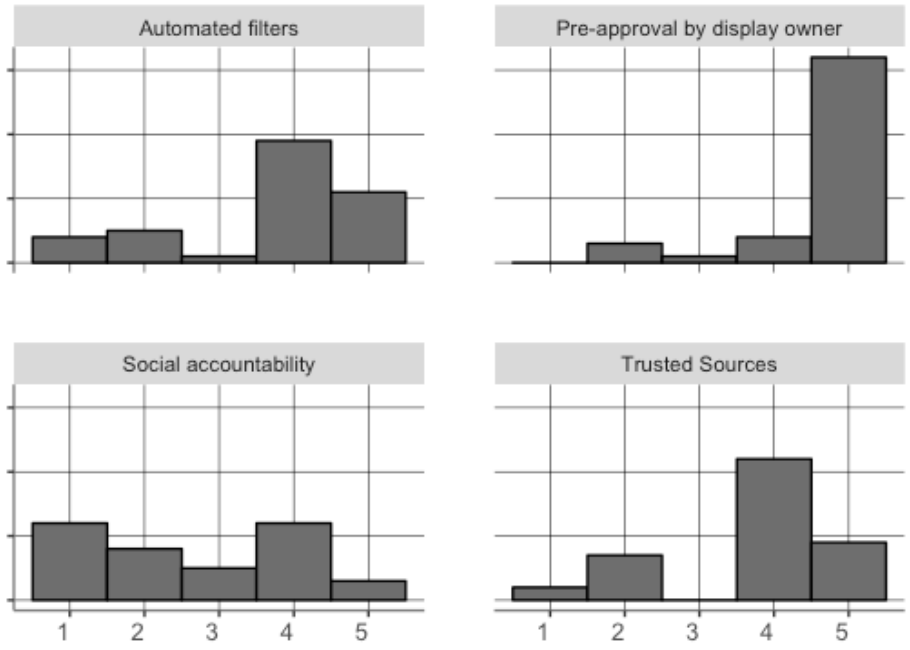

Figure 38: Acceptance of pre-moderation techniques

Participants have once more expressed a preference for the pre-approval of content by themselves. This is not surprising, considering the context of this study. Participants were not experienced with this type of moderation on public displays, and clearly, they would not be aware of the potential effort associated with a pre-approval model centralised on a single person. A few users seemed to be more aware of the implications and clearly mentioned them as a reason to consider other alternatives.

"If it was up to me, no one would see anything because I have no time!" P1;

"...we can't moderate everything. It is impossible to moderate everything..." P31.

The idea of approving/refusing any user-generated content going to their displays is clearly playing on the safe side. It is also a likely reflection of a focus on the risks of offensive content, as it could actually be a bad solution for other risks, such as copyright infringements.

It is still interesting that the other techniques do not rank so bad. Trusted sources and automated filters seem to raise opposite opinions. This might be related with the preconceptions that participants could have about the effectiveness of those approaches. Social accountability is more uniformly spread across the range of negative and positive

opinions. In this case, this might be genuinely related with the nature of the different communities associated with the various places in this study.

While this may not be good enough to create the expectation that displays would be operated without any type of explicit pre-approval, it does show a great potential to the combined use of multiple techniques. For example, automated filters and trusted sources are recognised as approaches to reduce the burden of pre-approval by limiting the analysis to borderline cases, as stressed by the participant P6:

> *"I agree partially because the problem is the work it would require. First, I would see and after that would give the OK to publish? The basis here would be trusting on who posted or have some automatic mechanism to filter".*

Social accountability is known to significantly reduce the likelihood of inappropriate content and participants recognise it may help to reduce risks. Still, participants have also mentioned some necessary cautions:

> *"I am afraid things will not be what a person initially thinks they will be"* P26;

> *"Even if the person identifies herself, she can put whatever she likes ... we may compromise our corporate image"* P24.

These results suggest the need to combine more than one technique, not just to get a better combination of features, but to have the flexibility of adjusting procedures according to evolving circumstances.

5.7 Summary

Enabling users to contribute with their own content can be a huge source of value for communication on public displays. However, user-generated content is clearly perceived as a risky practice, prone to produce abusive appropriations and uncomfortable situations for display owners and their guests. The obvious uncertainties about the different types of risks and the different techniques that can be used to mitigate them, often leads to closed systems or to procedures that demand too much effort from display owners or place too many barriers to user participation. In this study about risk management, we have taken a comprehensive approach to the risks of user-generated content on public displays, proposing a general risk management framework for dealing

with the various sensitivities of the problem. That are several contributions that can be stated from this part of present research work.

The first contribution is the identification of the diverse types of threat associated with user-generated content. Previous work has already identified these different risks in regard to specific situations. However, our goal was to systematize those different threats into a comprehensive and actionable list of risks.

The second contribution is an assessment of the different types of risks according to the perception of display owners. Based on the results of interviews with 36 display owners, we assessed the perceived likelihood and potential impact of those risks. We were then able to create a global perspective of risk priorities and a risk matrix to help system designers in the definition of appropriate control strategies.

The third contribution was a categorisation of different moderation techniques. Based on the qualitative analysis of the literature on user-generated content, we have identified a broad range of pre-moderation and post-moderation techniques, which we have aggregated around major categories. Together, they provide a toolbox for the selection of the specific combination of techniques that can be more suitable for a concrete scenario. When making this analysis, a display owner should seek the combination of techniques that is able to reduce risk to a level that is deemed acceptable, while minimising the moderation effort and the impact on the willingness of users to publish their content.

The final contribution is an analysis of the acceptance by display owners of the various moderation techniques. We have found that most place owners are only ready to rely on pre-moderation techniques and would not be available to delegate the process to post-moderation approaches. Not surprisingly, explicit control of content approval is the most widely accepted approach, but acceptance levels are also good for other pre-moderation techniques.

Overall, this framework should enable moderation to be approached from a broader risk management perspective. A broader perspective means avoiding focus on a single type of risk or in a particular type of moderation technique. It also means understanding that the goal should never be the full elimination of risk. There are other criteria that need to be considered and balanced against the level of risk, such as the moderation load on display owners or the publication barriers faced by publishers.

We believe this will help system designers in the definition of appropriate control strategies for mitigating the risks. It raises awareness about the full range of risks involved

and it is an important contribution towards a general approach to risk mitigation. It is clear, however, that risk perceptions can change substantially according to different types of place and even different place owners. This means there is no control sharing strategy that can be pointed out as the most adequate for all situations. Risks are very diverse and their relevance can change significantly for different places. Control strategies should thus be flexible and easy to evolve with the likely evolution of risk perception itself.

6 Media Practices with Place-based Displays

6.1 Overview

Digital public displays are evolving towards becoming more ubiquitous, but also towards alternative media publication paradigms that challenge prevailing assumptions. However, most of the existing display systems are used within isolated and unrelated display networks, each one presenting specific content in their displays. This entails issues in terms of content quality as those narrowcast models are very similar to the model of the broadcast television, leading people to expect the same level of media quality in both types of displays. This also leads to formal communication practices, where content creation is seen as a professional activity controlled by a restricted set of people, not leaving much space for creativity and situatedness.

The alternative way explores the concept of place-based displays, in which displays are locally and independently controlled by its owner. This allows displays to reflect the physical and social setting in which they are installed, consequently being closer to the communication objectives of the specific place.

This focus on places as central communication contexts might have two major implications regarding media practices. The first is that we can expect that a significant part of the display content will be locally created and will be intrinsically specific to that place. In particular, we expect this to trigger a much broader and more expressive set of use cases for communication through public displays. The second implication is that externally sourced content, although still needed, will no longer originate from a single central location. We expect that place-based displays will be part of open display networks, where multiple entities may generate and publish content to be consumed by multiple displays anywhere in a global network (Davies et al., 2012). Still, the ability to select, from many independent entities, the unique combination of external content that is, at any moment, relevant to a particular place, will also become a key driver for the situatedness of place-based displays.

Even though there is wide recognition for the huge potential embedded in the overall concept of place-based displays, there is still little evidence in the literature that place-based displays can actually sustain the emergence of new communication practices. In this part of the present research work, we aim to fill this gap by exploring how the particular properties of place-based displays affect the respective media publication

practices. We are particularly interested in understanding how media publication practices can be closer to the informal publication paradigms used in the social media, allowing content generation to be more spontaneous and creative.

6.2 Research Design

For the purpose of this particular study, we define a place-based display as a display that is locally managed to serve the specific communication goals of a particular place. We assume the existence of a local manager who is able to control the display by creating content locally or by selecting content created at multiple external sources. To study media practices associated with this type of display system, we defined a research approach anchored on the analysis of real usage data from place-based displays. More specifically, our methodology is based on the analysis of an anonymised dataset that includes the media management activities of 35 displays in the Displr[1] platform. Displr is designed around the idea of empowering display owners to easily create and manage their own place-based media. The 35 displays covered in this study, were mostly deployed in schools, but there were also one in a library and four at different locations of a University. The study covers a period of 10 months. However, since displays were being deployed throughout this period, the time range associated with each of them varies between those 10 months and just a few weeks.

The way these 35 displays are managed in the Displr platform clearly fits our definition of place-based displays. There are, however, some even more specific reasons why this dataset is a particularly valuable source for our research goals:

- These are operational displays, in daily use at the respective venues to serve specific communication goals. They were not deployed for research purposes and our research did not include any content creation or even any contact with the venues involved.
- Display owners had full control and freedom regarding the usage of their display. There was not any type of conceptual design driving display owners towards any particular usage of their display. The media creation tools were neutral in regard to the nature of the content. Display owners could publish their own content as well as integrate multiple types of external sources. No

[1] https://www.displr.com, accessed in 2018.

templates were provided that could drive display owners towards certain types of content.

- These displays were autonomously operated by many independent entities without any specific connection between them. The geographic dispersion is very high and most display owners are not even aware of the existence of other similar displays. Therefore, what each of them has decided to do was very much the result of an independent decision.

We thus believe this to be a representative sample of how people may appropriate the freedom and locativeness of place-based displays and the extent to which this might affect media publication practices.

6.2.1 Dataset composition

The dataset itself was composed of usage data related with the media management tools supported by the Displr platform. More specifically, it included media events associated the creation of content, either Displr messages or connections to external sources, and the subscription of external channels.

The first media publication tool is the explicit creation of place-based content in the form of Displr messages. Displr messages are the basic publication mechanism for allowing display owners to post their own content to the displays. Each display message can be composed by a text, an image or a combination of both. The authors can also specify background colours, transparency levels and a time scope for the message publication. The dataset includes meta-data from 705 display messages created at the 35 displays and the screenshots of 573 (81%) of those messages. The meta-data includes the publication parameters of the display messages, including textual content, and an anonymous id of the respective venue. The screenshots represent the actual media created by the display owners as it was shown on the displays. They had no uniquely identifiable information that allowed us to associate a screenshot to the respective display or associate multiple screenshots as originating from the same display.

The second media management tool is to repurpose existing content from relevant external sources, such as Facebook, Instagram or Dropbox folders. Display owners can create content that represents those sources and the respective media is dynamically fetched and visualised on the displays. This enables display owners to easily bring to the displays media they are already managing as part of their social media strategy. It also opens the door to leverage upon the wealth of social media as a major source for display

content. The dataset includes 178 content elements that place owners created to present on their displays the content from 142 unique external sources.

The third tool is the subscription of Displr channels managed by third-parties. Displr explicitly separates content providers and display owners. Content providers can produce content to be consumed at any display in the network. They organise and publish their content through channels that they fully control. The content itself can be Displr messages or connections to external sources. Display owners, on the other hand, can control the content on the respective displays through the subscription of the relevant channels. They can subscribe or unsubscribe to channels at any time. This is a loosely controlled system in which there is no central point of control. The dataset includes information about 270 channels subscriptions made by place owners. These subscriptions refer to 85 unique channels.

6.2.2 Data analysis

To address our research goals, we analysed this data from various perspectives, including quantitative and qualitative analysis. To support the analysis of the screenshots, we used a coding process based on a Grounded Theory approach. This approach involves the identification of codes, concepts (collections of codes of similar content that allow the data to be grouped) and categories (broad groups of similar concepts that are used to generate a theory). The coding process was based on a qualitative analysis tool and involved looking at each of the screenshots to identify any elements that should be coded. To provide some structure to the process, we started by defining a set of top-level concepts that corresponded to the key topics of our study, more specifically the themes represented in the messages; the quality of the created content; and also three specific dimensions of situatedness: time, location and authorship. In a first coding process we used open coding, seeking to explore the range of relevant properties that could match the concepts in our study. As a result of this analysis we have generated 1160 coded segments corresponding to 56 codes. We then conducted a consolidation process between the resulting codes and revised their association with the top-level concepts. From this exercise, we were able to create a code taxonomy for each of the five categories. We then re-coded the screenshots according to this structure, generating 33 sub-categories that characterise content according to the theme, the media creation approach, time, location and authorship. The codes within each of the categories were now mutually exclusive,

and we had exactly as many coded segments per category as screenshots (573), totalizing 2865 coded segments.

The metadata was analysed mainly from a quantitative perspective. Message metadata was analysed in regard to time parameters. The analysis of the metadata associated with external sources and channels was mainly focused on identifying how this usage of external content impacts the uniqueness and the locativeness of place media.

The results of our study are organised according to four major themes:

- **medium appropriation** seeks to identify what the displays were used for;
- **media creation** looks at the publication practices and particularly how formal and careful they were;
- **content lifecycle** considers the time scope associated with display media;
- **situatedness** considers how contextual information (time, location and authorship) was implicitly embedded in display media.

6.3 Medium appropriation

The first theme in our study was to understand the purpose being given to the displays. We believe this to be one of the studies where displays may have been more genuinely appropriated as a situated communication medium. They were operated as a general-purpose communication medium for their venues and it was up to each display owner to decide exactly what they should be used for. To understand how these owners of place-based displays decided to use this medium, we analysed their usage of the three different communication mechanisms available to them: messages, external sources and channels.

6.3.1 Message appropriation

Regarding messages, our key data was the set of 573 message screenshots. These messages were coded according to different criteria, with one of them being the topic represented in each message. After a consolidation process, we identified the main topic categories described in Table 9.

Table 9: Topic categories

Category	Description
Activities	Messages reporting recent activities at the place
Civic and behavioural change	Promote civic participation and behaviour change, including thoughts, motivational quotes and also messages to raise awareness of the community for global issues
Events	Promotion of internal and external events
General	General interest information (e.g. school timetables)
Announcements	Inform the community about impromptu situations
Self-promotion	Messages about institutional or community members achievements
Campaigns	Support internal or external campaigns by advertising them on the displays
News	News content, usually appropriated from external sources

Based on the quantitative analysis of the codes, we were also able to identify the most common categories. Figure 39 represents the number of messages in each category and their percentage in regard to all observed messages.

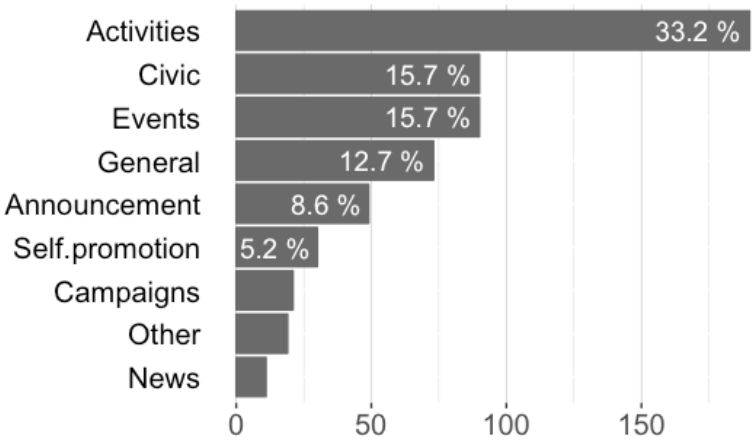

Figure 39: Communication topics in display messages

The most common topic is clearly to report activities that have recently taken place. For schools, this was mostly about events at the school or events involving the school

community outside the school environment, e.g. a field trip. The relevance of activity reporting in our study, might be biased by the number of schools in our study, where we can expect the sense of an active community to be particularly strong. Perhaps more interesting to our goals is the observation that topics that are more naturally situated, such as activities (33.2%), events (15.7%) and announcements (8.6%), account for 57,5% of all message content. This suggests that content that reflects place-based activities and practices is seen as a natural communication topic for public displays that support place-based communication.

6.3.2 External sources appropriation

External sources represent a fully open model for repurposing external media for display presentation. To create content elements referring to external sources, display owners had to explicitly insert the respective URL or source ID. There were no content recommendations being made about any particular set of sources, and, thus, any source usage was the result of a genuine initiative of the display owners.

The 35 display owners in our study integrated external content sources into their displays 178 times, using 142 unique sources. Figure 40 represents the number of content elements of each type that were created during our study and their percentage.

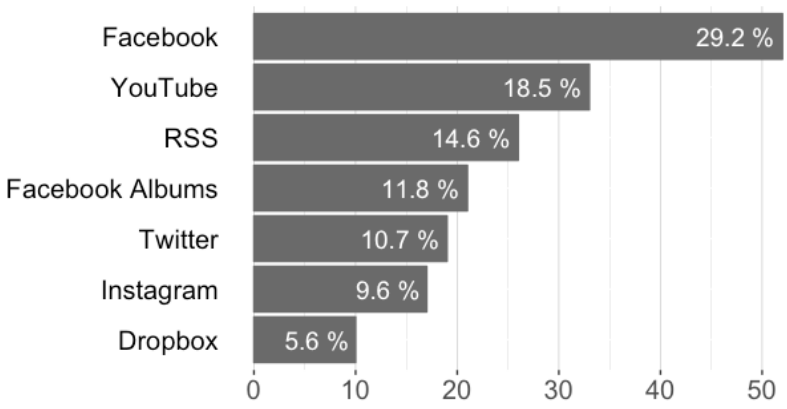

Figure 40: External content sources

Regarding the nature of the sources, Facebook (52) was the most popular one, with display owners explicitly adding 52 Facebook sources to their displays. The other external sources were YouTube (33), RSS (26), Facebook Albums (21), Twitter (19), Instagram (17) and Dropbox (10).

Even though there were no limitations to the number of sources, 90% of the displays integrated six external sources, or less. Table 10 represents the number of times that each of 142 unique sources were used in the 35 displays in our study.

Table 10: Distribution of the number of places where each unique source was used

Number of displays where it was used	Number of sources
1	123
2	12
3	3
4	1
5	1
6	1
7	1

These results show a considerable diversity in the usage of external sources by the 35 display owners. From a total of 142 unique sources identified in this dataset, 123 were used at only one of the displays. This uniqueness of the set of sources selected by each place can be seen as way to determine the unique nature of each place, even if based on external content.

6.3.3 Channel appropriation

The channel mechanism offered display owners a simple approach to compose their display media by subscribing to externally managed themed content. Unlike external sources, where display owners had to take the initiative to identify the source and create the content that represented the link to that source, channels could simply be subscribed from a list of pre-existing channels. The platform was seeded with 227 channels, which were offered to display owners as content recommendations that they could easily add to their displays through a simple subscribe button.

The topic associated with each of the channels is already implicit in the categories to which they are attached. More specifically, channels were organised in the following 8 categories: News; Academy; Culture; Sports; Entertainment; Famous; Football and

Institutions. The categories with more subscriptions were News (75), Culture (51) and Entertainment (46).

We observed 270 channel subscriptions, which means that on average there were 7,7 subscriptions per display. Those subscriptions referred to 85 unique channels. Given that there were 227 channels in total, 142 were never subscribed by any of the displays. Table 11 represents the number of number of subscriptions per channel.

Table 11: Distribution of the number of subscriptions per unique channel

Number of subscriptions	Number of channels
1-2	50
3-4	14
5-6	10
7-8	3
9-10	5
11-12	1
13-14	1
15-16	1

From a total of 85 unique channels, 38 were subscribed by a single display and there were eight with nine subscriptions or more. From the 35 displays, there were five with no unique channel whatsoever. These results show much less diversity than external sources. Even though there are still many channels used only once, it is clear that the initial recommendations have strongly affected subscriptions. More specifically, these results may have been biased towards a more common usage of certain channels, which were used as content seeds. When a new display is first created, a few channels are included to make sure there is already some out-of-the-box content to be shown. Display owners are entirely free and even expected to remove them, but many of them ended up staying, either for inertia or simply because they were actually appreciated.

6.4 Media creation practices

The second theme addresses the media publication practices, and particularly the original creation of content in the form of Displr messages. The display owners in this

study were faced with the opportunity, but also the responsibility, to create display media for their displays. Most of those venues were having a public display for the first time and, thus, most display owners were also assuming that role for the first time.

Regarding their media creation practices, we focused particularly in their perception of what would constitute appropriate quality for the content that was meant to be shown on the public display. To support this analysis, we analysed the 573 message screenshots and coded them with codes describing the approach used and also the perceived quality of the content. This was not about judging the good or bad taste of the content itself. It was about identifying the content creation approach and the amount of effort that seemed to have been made by display owners to get that content done.

The message creation tool in the Displr platform allowed display owners to post text only messages, image only messages or images with a text overlay. Despite the apparent simplicity of content in the form of text/image messages, there was a broad range of publication approaches, from simple plain text messages to professional level image compositions created with external tools. Based on the coding process, we have identified the following content creation approaches:

- **Text**: These were text-only messages with just a plain background and no image whatsoever.
- **Photo**: These were simple text/image messages, where the image was typically a spontaneous photo illustrating a local situation or activity, and the text, when present, was a just a photo caption.
- **Visual**: These were messages where the quality and impact of a professional image was central to the content, either used standalone or as background for a simple text.
- **ExternalTxt**: These were images created with some external tool, in which the content elements were all text. The use of an external tool allowed those text elements to be composed and formatted with greater flexibility, but it necessarily required the extra effort of using an additional tool. Therefore, this can be interpreted as an effort towards a more careful design of display content.
- **External**: These were images created with some external tool, but in this case involving a rich media composition with multiple text and image elements.

This was the most powerful way that display owners could use to create display content.

- **Repurposed**: This was image content created elsewhere, for some other medium, but repurposed for presentation on the display. This was a low-effort and convenient way to publish high-quality content. However, in some cases it was not fit for the displays, simply because it had been designed for a different purpose, e.g. a paper poster.

Figure 41 represents the results of the analysis and the relevance of each of the content creation approaches that were observed in the 573 messages.

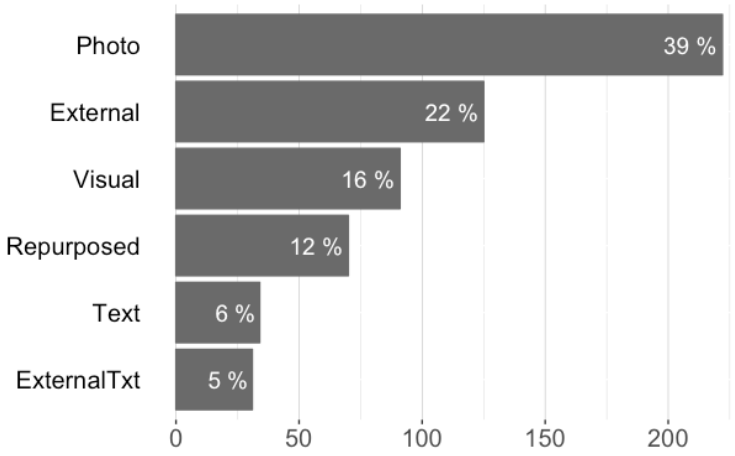

Figure 41: Media creation approaches

Even though the message creation tool was very basic, 61% of all messages (Photo 39%; Visual 16%; Text 6%) did not seem to involve the use of any external media composition tools. All this content was created with no more, and in many cases even less, than a small text and a generic image. This suggests that convenience can be an important part of the process of content publication to the public displays.

Image posting, most of the times with some text title, was the most popular. This may be related with the observation that displays were most commonly used to represent past activities. In those cases, a spontaneous photo of the activity, possibly with a simple text, was the most common way to report the past event. These were occasional images taken at events in which the main attraction was the potential identification of the community with the content itself, as in most cases it represented photos taken at the school or during school activities.

It is worth noticing that nearly 6% of content was text only. This seems to go against all common rules on how to create proper display content. Yet, there seemed to be an obvious value in this possibility to create an almost instant message composition that immediately gets to the display. Context, the value of immediate communication and the low publication barrier may have overridden other common concerns with branding and intrinsic content quality. To extend our findings in regard to the role of text only messages, we also specifically analysed their effective publication time. The results seem to confirm the transitory nature of this type of content. From a total of 34 text-only messages, 10 were published for a single day and 18 were published for only a few days.

Text only messages will certainly not match the quality expectations that are normally associated with display media. However, we may speculate that the crude nature of text only messages may have been appreciated as a signalling process that clearly conveys the idea that those messages had not been properly authored. We can find a parallel with the "*Sent from my iPhone*" text that can be automatically inserted in e-mail messages sent from iPhones. This also serves as a form of signalling to others that the message was composed under a constrained situation that may lead to all sorts of typos, abbreviations and the need for a more direct language. Even though we were not able to trace exactly how many, we observed that some of the text only messages in our study were first created this way and were later replaced by a more elaborate version with images. This seems to confirm their role as a quick way to get something on the display, even when there was no time for proper content authoring.

A recurrent theme in all these findings is the emergence of publication practices that are much more informal than current practices with displays networks. These display owners were not careless about their displays, but they seem to have perceived the need to balance between the values of immediate and spontaneous communication and the values of branding and media planning.

6.5 Content lifecycle

The third theme in our study, Content Lifecycle, refers to the time scope during which display media is perceived as relevant. Since external sources and Displr channels were both long term data sources that are expected to produce regular content, this dimension of our study was only based on Displr messages. We approached this theme from a quantitative and a qualitative perspective. The quantitative perspective was based

on the begin date and end date settings that display owners could define for their messages in the publication process. These allowed display owners to preschedule content for the future or to automatically remove it after a certain date. From the 705 messages included in the logs, 575 (82%) had this type of time information associated, showing that control of content lifecycle was a major concern for display owners. We used this start and end dates to determine the duration in days during which messages were published on the displays.

The qualitative perspective was based on the results of the coding process. From the observation of the screenshots, we coded messages according to the expected time relevance of their content. Whenever there was an explicit reference to time, we coded the message with the respective time scope. If, for example, a message referred to an event on a particular day, it would be coded as having a one day lifecycle.

To support the combined analysis of these two datasets we converted the quantitative data from the usage logs into the categories emerging from the coding process. The combined result is represented in Figure 42.

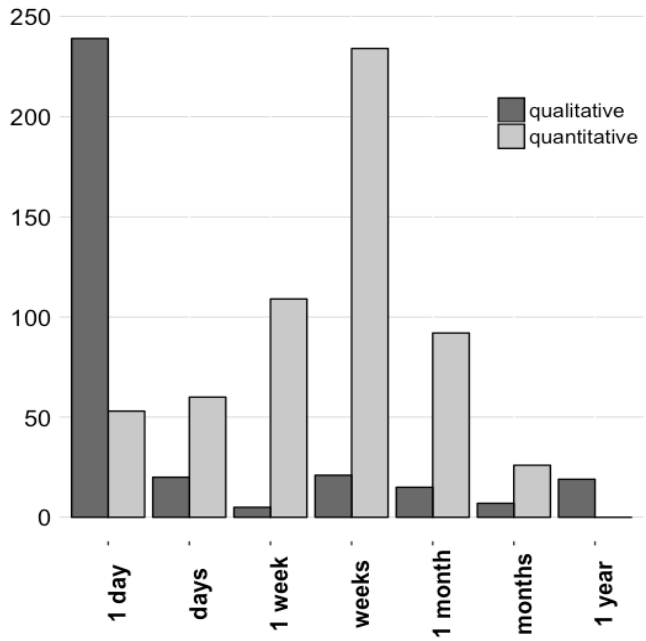

Figure 42: Content lifecycle

The first observation is that the qualitative data is shifted towards shorter lifecycles, particularly in regard to content with a single day lifecycle. These results can be justified by the considerable differences between the content lifecycle when understood as the time

during which it should be shown and the content lifecycle when understood as the time scope associated with the content itself. Very often, content is shown during a time scope that is larger than the time scope the content refers to. For example, there were many messages describing past activities, most of them one-day events, which were shown until a few weeks after the event. Similarly, content announcing a day event, will be shown at least for a few days, or even weeks, before the actual event takes place.

The second observation is the distribution pattern between the different lifecycle categories. If we excluded the exceptional results associated with single day content in the qualitative data, we can observe many similarities between both dimensions of the analysis. There is an initial peak of content with very short lifecycle (one day or a few days at most), and then a second peak for content with a few weeks of lifecycle. These results are also similar with another content lifecycle analysis described in the study by Friday and Davies on the long-term experiments at e-campus (Friday et al., 2012). The key difference is that in our study the second peek is at a few weeks, while in their study it was at approximately three months.

6.6 Situatedness

The fourth theme, Situatedness, refers to the extent to which content on the display is able to reflect the physical, social and organizational context of the place where the display is deployed. We have studied situatedness from the perspective of the locally created messages and the perspective of the external sources selected. Regarding messages, the key indicator of situatedness would be the content itself. As place-based content it should, implicitly or explicitly, reflect elements of the place in which it had been created. Regarding external sources, situatedness could not be in the content itself, as this was common to many places. Instead, we used as an indicator of situatedness the uniqueness of the specific combination of external sources selected by a place.

6.6.1 Situatedness of locally created messages

To analyse situatedness in the display messages, we coded the 573 screenshots to describe how this contextual information was represented. All the messages in our study were created to be shown at one particular location. This provided a natural context for creating content that was naturally embedded with assumptions about where it had been

created, when and by whom. Our goal was to understand to what extent these assumptions were actually embedded in the content itself.

Building on previous work on situatedness dimensions (José et al., 2014), we selected authorship, location and time as the most relevant situatedness dimensions for this study. For each of those three dimensions, we coded the messages to identify whether the information concerning that form of situatedness was explicitly included in the message, implicitly included in the message content, or simply absent. Not all messages contained elements from all of these three dimensions. For example, a message promoting healthy eating habits or a famous quote from some known personality would be timeless and would have no reference to location information. The overall results for the three dimensions of situatedness are shown in Figure 43.

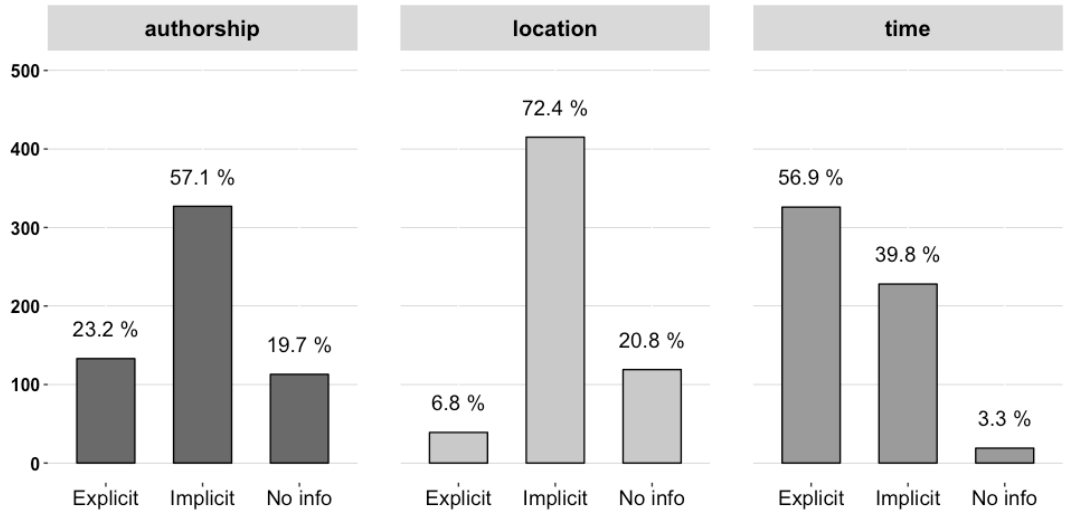

Figure 43: Situated content dimensions

Perceived authorship refers to the perception given by the content about who is the respective author. The interpretation of authorship is central for the correct interpretation of the meaning of the message and also for its credibility. In a scenario where displays can also integrate external content sources, this association can become blurred and significantly increase the need for more explicit forms of authorship. However, authorship is normally associated with display ownership. Any message without an explicit reference to the author would by default be assumed as having been created by the local display owner. We wanted to understand to what extent, the display owners in our study would deal with this potential ambiguity.

We classified as explicit authorship those messages in which there was an explicit reference to the author, such as a name or a logo. We classified as implicit authorship those messages in which the author was not explicitly acknowledged in the message. This is content that could not be taken somewhere else without affecting the perception of who the author was. The results suggest that display owners were aware that they would implicitly be perceived as authors and therefore only 133 (23%) of the messages had explicit information about the author. Many of these were actually among the 70 messages that were composed from repurposed content and already included a reference to external authors.

Regarding location, we coded as implicit those messages where location was expressed in a way that assumed the context of the display, e.g. "…at the reception". In these cases, content would lose its meaning if it were to be moved somewhere else. We coded as explicit, those messages containing explicit references to locations, such as an address or the identification of a venue. In these cases, location information was expressed independently of the display location and would not lose its meaning even if the content was shown somewhere else. Again, display owners seem to have assumed that including explicit location information would be redundant for their content, as this was created and shown at a single location. Most explicit locations were part of messages announcing events at other locations.

Regarding time, we classified as explicit, messages containing a reference to a particular day, month or year, e.g. the date for an event or campaigns taking place during a specific period of time. Implicit references were typically concerned with on-going events or timely announcements, such as informing that a teacher was not teaching on that day. We also included as implicit time, content referring to past activities that did not included any explicit reference to the activity date. People from the local community might have a sense of how old that activity was, either because they remembered the activity or because they remembered seeing it on the display for a long time. That same message shown somewhere else would have to be classified as having no time information.

Time was the only dimension where explicit information was more common than implicit information. A distinguishing property of time is that it does not require a change of location to lose context. As time goes by, any implicit form of time information will lose its meaning. Properly handling this continuous change would become a daunting task. It was also clear that there is a mismatch between the time represented in the content

(as observed from the screenshots) and the presentation time of that content (as specified by publication settings). Even if an event is taking place on a single day, it may be announced many weeks before. In these very common cases, explicit time references are mandatory.

6.6.2 Situatedness in the use of external sources and channel subscriptions

A very relevant part of display content was sourced from external services, either directly or as part of channel subscriptions. While, at first, this may seem to contradict the whole concept of place-based communication, it can instead be seen as suggesting that a key driver for place-based displays might be their ability to easily select and integrate the specific external content that is relevant for that place. Therefore, our key indicator for the situatedness of each display in regard to external sources was the uniqueness of their specific selection of sources. To analyse this dimension of situatedness, we studied the external sources and the Displr channels used across the 35 displays. Our goal was to understand to what extent the use of external sources and channels could contribute to decrease diversity between displays or, on the contrary, would generate many unique combinations of external sources, which could then be seen as an alternative form of situatedness.

Regarding the external sources, we can use the results previously presented in section 6.3.2. To get some indication about the uniqueness of sources used at each display, we estimated a uniqueness ratio based on the relation between the number of unique sources used and the total number of sources. We observed 178 uses of external sources, 142 of which were unique sources, resulting in a uniqueness ratio of 80%. This suggests that the selection of external sources was very unique to each place, and, possibly, that most of these links to external sources were indeed links to very specific services, possibly other media services from the same organization. For example, the Facebook page of the organization could be repurposed as a convenient and efficient way to have continuously updated content on the displays without the wasted effort of recreating the same content creation across multiple platforms.

Likewise, we also applied a similar analysis to channels subscriptions, this time using the results from section 6.3.3. Regarding channel subscriptions, we were mainly interested in understanding the extent to which some channels could become more popular and be used at many different displays. Unlike external sources, channels were subscribed from a list of existing channels, which would potentially have a major impact

in diversity when compared with the open integration of external sources. The ratio between unique channels and channel subscriptions is 30%, which suggests a considerable level of overlap between subscriptions made by the different displays. This represents a striking difference to the 80% ratio obtained with external sources, suggesting that content recommendations can have a huge impact in creating more uniformity between displays.

6.7 Summary

The study presented in this chapter reports on media practices emerging from a set of 35 autonomous displays. These were place-based systems where the display owners could easily post their own content to be shown within that particular context. Based on the analysis of the content created by these spots over a period of multiple months, and using three different publication paradigms, we have studied how the place-based nature of these displays affects the nature of the content that is placed on the screens.

Regarding the three different publication paradigms, the results seem to indicate that they can all play an important role in place-based communication and complement each other to offer a very flexible set of publication models. In particular, external sources and channels seem to play a key role in keeping the displays running with continuously updated content. The content that was explicitly created by the display owners was just a small portion of what those displays have shown.

The findings also suggest that, in these situations, publication practices tend to be less formal and much more situated than what is now common in most display networks. While in a more institutional display network most content would resort to specially created content in the form of images, here we observed that this was not even the most common case. These display owners seem to have a more relaxed view of the quality threshold for content posting. They seem to acknowledge that, in some occasions, the value of immediate communication might surpass the brand values of institutional communication, even if that means using crude text-only messages.

We also observed that situatedness is very common and often implicit in the media created under these conditions, particularly in regard to the author of the message and references to the location of the display. These are all properties that have also emerged with social media, and that we can expect to increasingly characterise, at least, part of the display systems.

7 Conclusions

Digital displays are increasingly ubiquitous and considered as a technology that may change communication paradigms in public spaces. They offer an opportunity to enhance places and promote social interaction, contributing to the sense of a shared place. Their integration as part of large-scale and open networks of pervasive public displays, should allow people to use the displays as a communication medium for different purposes. Place-based displays represent opportunities and value not only for the people that publish the content, but also for the owners of the displays, as the relevance of content for the potential audience is expected to increase.

However, the concept of place-based displays is not yet a reality. Public displays are still operated mostly in a closed and controlled situation. Content publication paradigms still have to evolve in order to create the necessary confidence within the stakeholders to post content, accept and select it to be displayed. Publishers should be provided with simple publication practices they can easily control and understand, promoting the spontaneity of content publication in public displays. Display owners should be provided with moderation mechanisms that allow them to open displays for user-generated content and still manage social expectations and content appropriateness in the place. Viewers may also be considered on the moderation process. Publishers and display owners should also have the possibility to define situatedness properties that could be used to outline the scope and the relevance of contents. This would promote the integration of content from many sources and ensure that public displays would be considered truly situated devices.

The general objective of this research work has been to explore new media publication paradigms for digital public displays that would allow displays to be used as an open communication medium. Digital displays may support a wide range of interaction modes but, they are still limited in relation to publication concepts and situated publication practices. Moreover, there is not a clear mapping between the interaction modes and the publication concepts. Therefore, it is fundamental to understand existing publication paradigms and explore new ones, to change public displays' role as communication media and central points for social coordination.

7.1 Contributions

To accomplish this general objective, firstly we proposed to understand and characterize existing self-expression and individual publication practices. This would provide a set of valuable metaphors and design sensitivities for individual publication in digital display systems, creating a design space of publication practices to inform the development of publication tools.

The second objective was to understand and characterize current non-digital place-based communication practices. This would provide a valuable source of insights to inform the design of new communication concepts of digital place-based display systems, in which places provide communication contexts and displays act as open communication media.

The third objective was to identify and to classify control and moderation approaches. This would provide a valuable set of techniques to inform the design of moderation control strategies for display systems that promote the presentation of user-generated content in digital public displays. This way, the design of display systems would be informed by a framework that could be used to map control and moderation needs to the most suitable set of available moderation techniques.

The fourth objective was to identify emerging digital publication practices. This would provide a valuable source of real strategies that people could use to publish and manage content in display systems, challenging the prevailing publication practices used for specific content types and situatedness.

This research has made contributions across the whole range of these objectives. We will now summarize those contributions and their relation to each objective, synthetized in Table 12.

Table 12: Research Objectives and Contributions

Contributions	Objectives
Usage dimensions signature for place-based public displays	2: Place-based communication
The value of combining external content sources in place-based communication	2: Place-based communication 4: Publication practices
A risk management framework	3: Moderation
Design sensitivities for the publication of user-generated content	1: Self-expression 2: Place-based communication 4: Publication practices

7.1.1 Usage dimensions signature for place-based public displays

The first contribution is the identification of the major usage dimensions that support common forms of place-based communication that are still served by non-digital displays. It is the main result of our study on place-based communication to uncover the different purposes of non-digital visual communication elements have in several types of places, presented in chapter 4. Overall, this diverse range of usage dimensions shows the diversity of purposes associated with visual place-based communication. These different usages of non-digital displays exist because they provide some sort of value to place owners. Their existence is the key indicator of their relevance. Even though similar research could lead to variations of these specific usage dimensions, and even though many of them are not likely to be exactly the same with digital displays, this list provides a concrete roadmap for the exploration of novel uses of digital public displays. It can guide and inspire place owners to venture beyond the obvious and more traditional usage scenarios and explore other ways in which their digital public displays can provide value to the local communication strategy.

We also provide a characterisation of the relevance of these dimensions for different types of place. The particular composition of the usage dimensions for each type of place allows us to present the unique usage signature that characterizes each of them. Moreover, we have shown that there is no dominant usage dimension for each place type. Each place type has, in fact, a significant number of predominant usage dimensions. Acknowledging

the relevance of these various usage dimensions and the different ways and circumstances in which they may be needed, may thus be a fundamental step to reason about the design of multi-purpose place-based display systems. It goes against the idea of specific displays created for one killer application or very narrow expectations of use. Instead, it suggests that the value of place-based displays may actually reside in their ability to offer place owners the flexibility to easily appropriate the displays according to many smaller, diverse and evolving communication needs.

7.1.2 The value of combining external created sources in place-based communication

The second contribution is the value we have found concerning the combination of several sources of content, including internal and external, to build place-based displays. This contribution is a result of our studies on places-based communication, presented in chapter 4, and media practices with place-based display, presented in chapter 6. We have shown that place-based communication is not just about locally created content, and we have identified the primary role of content originating from external sources.

In fact, our findings from the study on media practices suggest a complementary role of content created by different publication paradigms. This can be considered as a valuable insight for creating place-based displays, but also as a key aspect on the maintenance and relevance of content. We have found this to be of paramount importance for the continuous display of updated content, as content that was explicitly generated by display owners was just a small part of the all content presented in the displays. Without this content from third-parties, display owners would have to either incur in a significant content creation effort or assume the risk of having a display that would quickly be perceived by users as non-relevant.

We also observed how the particular selection of external sources made by each spot is also a form of defining uniqueness of each place. When this selection is open and controlled by the place owner, it does lead to very unique combinations of external sources. We have also shown that this can be associated with non-digital practices anchored on well-established processes involving place owners and external entities, which can be very sophisticated and even involve direct management or control of place-based content by external entities. These collaborative content management processes are very common with brand communication, but we have also found them for legal content,

mainly of convenience, and for community content, where ad-hoc collaborations emerge from familiarity with regular content providers and their content.

Our findings seem to suggest that the key for effective place-based communication may lie in the ability to easily integrate relevant content from many external sources. While this role of external entities might, at first, be seen as a contradiction to the whole concept of place-based content, it may also be seen as suggesting that a key driver for place-based communication might be the ability to easily select and integrate the unique combination of external content that is relevant for that place. This unique media space should reflect the natural business, community and social connections of that place, representing much of what that place is. From that perspective, it would be as place-specific as any locally created content. It might also partially explain why it is often so hard to find strong value propositions for place-based displays, when they are approached as serving only locally created content.

Unlike global communication platforms, the key value of openness for place-based displays may not be in the availability of global niche of content or applications, as is normally the case with mobile apps. Instead, the real strength of open display networks for places, may actually lie in their ability to support low barrier access to the many external media sources. Openness, in the sense of displays systems that are open to content from many sources (Davies et al., 2012), can thus be a fundamental enabler for place-based displays, allowing place-based communication to emerge, not just from locally authored content, but also from multiple external sources that can be selected to form the unique and dynamic combination that best serves the specific needs of each place.

7.1.3 A risk management framework

The third contribution is a risk management framework proposed for dealing with the diverse sensitivities associated with moderation and risk management. It's the main result of our study on moderation and risk management, presented in chapter 5. This contribution encompasses an identification of the threats of user-generated content, and moderation techniques as risk reduction measures.

Although user-generated content is recognized as a valuable source of content for communication on public displays, it is also perceived as a risky practice. There is always a high probability of abusive appropriations, which may lead to unpleasant situations for display owners and people there. Place owners tend to focus only on the high-profile

threat of having offensive content on their display, discarding a set of other possible threats. This contribution goes beyond this obvious type of threat and identifies a diverse set with the most common of types of threats associated with user-generated content. This opens new opportunities to mitigate them, which we strongly believe is an important step to lower common barriers on closed systems. In fact, these barriers not only require a paramount control effort from display owners, but also create obstacles to user participation.

The assessment of the different types of risks based on the perception of display owners allowed us to create a global perspective of risk priorities, based on their perceived likelihood and potential impact. Those two dimensions were also used to build the risk matrix, a contribution that allows us to clearly rank the identified risks in both dimensions. The risk matrix also allows us to reason about the relative position of the mapped risks and identify clusters of risks that might be considered in the definition of the respective mitigation approaches.

Moreover, the general risk management framework also concerns the identification and categorisation of different moderation techniques, based on their acceptance as risk mitigation strategies. In fact, the framework presents a broad range of moderation techniques aggregated by moderation timing (pre-moderation and post-moderation techniques) and the stakeholders involved in the moderation process. Thus, we expect to support display owners to reason about their moderation needs and the best mapping between those needs and the various alternative moderation techniques.

Lastly, we also provide an analysis based on the acceptance level display owners express in regard to the identified moderation techniques. This analysis informs that, although explicit pre-moderation control of content by the place owner is the first and most accepted technique, there is an interesting acceptance level for other pre-moderation techniques. This clearly opens the door for hybrid approaches, where different techniques can be combined to get the best results in regard to reducing moderation effort, publication barriers and the risk of inappropriate content.

The contribution of this framework should entitle new approaches to moderation and risk management, that move away from a focused approach on a single or reduced type of risks, only considering a few moderation techniques. It also provides space for reasoning about the moderation effort required from display owners and the publication barriers publishers might find. As we have shown, risk perceptions can vary substantially between places and therefore the right balance between all these criteria will always be a

local decision and a decision that is likely to evolve over time. A risk management strategy should offer simple and actionable strategies, but it should also offer multiple adjustment approaches that promote alignment between the techniques used and the evolving reality of user-generated content at each place.

7.1.4 Design sensitivities for the publication of user-generated content

The final contribution is a collection of design sensitivities that we have uncovered across the several studies we made. Some of them should be considered in the context of the previous identified contributions. However, they can also be considered as cross-cutting contributions to the various areas under study in this research work, and they can be contemplated in the design of new publication paradigms for digital displays, whenever similar issues are being addressed.

Our study on existing public self-expression practices, presented in chapter 3, uncovered design sensitivities related with perceived authorship, appropriateness and collaboration. Perceived authorship is concerned with the perception of who is responsible for a particular published content. It is particularly important in the context of open digital display networks, where contents from various sources are displayed. In this situation, we have found that a clear highlight of the source or the author is important to understand the correspondent message. We have also found its importance for display owners, as it provides a clear way for reducing the degree of endorsement and thus, increase the range of content that may be accepted for publication.

Appropriateness is related with acceptance of content, considering the social context of the place where it is published. In fact, we have found that the notion of appropriateness is very ambiguous and clearly related with the social environment where the publication occurs. Considering the context of open digital display networks, where a publication can be spread across all the displays, the sense of locality and social relevance should be renovated and other forms of social currency should be introduced. These include social negotiation around content, considering display owner and other participants as stakeholders of this process.

Collaboration concerns the collaborative effort for expanding the reach of a particular published content. We have identified different forms of collaboration that are very similar to the spread strategies used in social media. They separate the roles of message creator and distributors, minimizing the effort needed to collaborate and bringing more people to the process.

Our study on place-based communication, presented in chapter 4, uncovered interesting design sensitivities related with the role of deprecated content and nature of displayed content. Our findings suggest that deprecated content may still be presented in public displays as a second line of content, usually associated to some type of emotional aspect that is responsible for archive and repurpose old content.

Our findings also suggest that publication in place-based displays are less formal and much more situated than in most of the actual display networks. During our studies on place-based communication, presented in chapter 4, and media practices with place-based display, presented in chapter 6, we have observed a relaxed view concerning the quality of the content, some of the times supported by the value immediate communications seems to have. This does not mean that media planning is going to disappear. Very much like a brand in Facebook can be carefully planned, a brand display is also likely to be, even if they strive to seem spontaneous. We have seen, however, that the place-based nature of these displays may prompt for more situated and spontaneous forms of communication.

7.2 Future Work

In the course of this research work we have identified several challenges related to publication paradigms and practices on public displays. Part of them have been considered under this work, but others fell outside the core of this thesis. These challenges should be considered in future work, as they may provide opportunities for further research around the topic of publication paradigms for digital public displays.

7.2.1 Generic characterization of place-based communication needs

The whole range of usage dimensions identified in our research project can be regarded as a common usage map. Places should be able to dynamically appropriate usage dimensions that are relevant, and create a unique combination that serves their communication needs. This might provide a new and scalable path for multi-purpose place-based design. We plan to explore to what extent the process that was used as the methodology for this research, could be adapted to serve the generic characterisation of the place-based communication needs of specific types of place. This would be a way to regain the advantages of design processes, while being able to replicate findings across similar types of place. The approach could include a characterisation of the different

dimensions of place-based communication; a set of specific and generic communication elements that could easily be repurposed in each of those categories; and the ability for each display owner to easily move from the initially proposed concept to one that was adjusted to the specific needs of that place.

7.2.2 The diversity of place types

Another limitation that can be identified is that the diversity of place settings is something that necessarily exceeds the scope of any research. The diversity is inherently large and there can also be substantial cultural differences between different societies. We thus cannot expect to have captured much more than a small snapshot of that potential diversity of place types. In particular, not all places have this focus on place-based media, even those where display technology is already very common. For example, retail stores are evolving towards strongly designed spaces where every visual communication is carefully designed as part of a holistic shopping experience. In these spaces, almost non-places, media is much more uniform and there might not be much scope for the diversity of place-based communication opportunities that we uncovered in this research. Still, our studies were comprehensive enough to uncover patterns that are common across the diverse range of considered places. We can thus expect that most of them may also apply to other types of place not addressed in our research.

However, extending the study to other place types would allow us to compare and confirm some of the results of our studies. It would also allow us to understand new realities of communication and collaboration between related places. Moreover, it would allow us to add the cultural dimension to the study, comparing the current results, obtained from the study of a restricted set of types of places, all with similar cultural aspects, with the situation of other places, with diverse cultural realities.

7.2.3 Limitations

The main strength of our first three studies is also, in a way, their main limitation. We cannot expect that all existing practices with analogue communication will migrate directly to digital displays. Some analogue elements will have no correspondence in the digital, e.g. physical placement and regulatory signs are not likely to migrate to digital presentation either because of physical constraints or lack of interest. Likewise, other dimensions that are not common with non-digital media may gain a whole new dimension with digital screens. For example, digital entertainment is likely to be a strong usage

model for this type of place-based communication, but is not a very common goal for non-digital displays. By focusing on existing practices with non-digital media, we may be failing to capture new and emerging uses that will be enabled by digital displays.

Moreover, the results from our studies should be a valuable resource for approaching the design of public display systems. Many of the practices reported in our studies are anchored on clear communication needs that are, in their essence, independent from the specific medium being used. Despite all the implications of moving to a new medium, digital displays will not invent self-expression and place-based communication, and should thus not be designed from a blank sheet. Taking existing practices as a starting point may certainly help to achieve a more realistic path for sustainable value propositions for digital public displays.

Even the study on moderation could benefit from the inclusion of locations where digital displays were present. This would be a scenario where the place owner would have a more contextualized and experienced perspective on the various situations described in the interviews we did in the study. New contributions or at least a more complete understanding on the subject of moderation would probably emerge, which would allow us to complement the risk management framework.

Therefore, we suggest that studies could be adapted and extended to places where digital media are used in the whole communication process, in coexistence with the non-digital communication media. This would make it possible to understand the motivation for an eventual separation or combination of the types of content by both available media. It would also make possible to compare the practices to support the publication of content in both display media.

7.3 Final remarks

Public displays can be very promptly communication media, but they are still far from being able to accept contributions from others and be considered as an open medium that presents contextual information either relevant to the place and people within it.

We expect that the results of this research may contribute to a better understanding of publication practices in digital public displays and open new opportunities for the design and development of novel networks of public displays. Those networks would be supported by a suite of publication tools that people could use to publish their own content. In such scenario, public display systems would be able to offer a rich set of

publication opportunities, with diverse properties, and thus potentially fit for different communication purposes. This would definitely confirm the expectation that future display networks may become a more open medium for self-expression and appropriation.

Annexes

Annex A – Self-expression Study: Interview

Questions used in self-expression study interviews:

Part A – Commitment with the technique

1. Can you imagine yourself as the person(s) or doing what is in the picture?
2. Have you ever been in this situation? Can you describe it?

Part B – Motivations to the use of the technique

1. What is going on?
    a. What is this person doing?
    b. Where is this taking place?
2. Why is this happening?
    a. Do you think the objective will be accomplished?

Part C – Different ways of using the technique

1. Create a story about what you see in the picture.
    a. In which occasions does this happens?
    b. Where is this occurring?
    c. Who might be involved/around? Is there any sort of collaboration?
    d. For how long do you think this would be going?
2. Do you think this could be done everywhere?
    a. Can you describe any situation where it shouldn't be used?
    b. What should happen (be removed, hidden, etc)?
    c. Will it be used again after that?

Part D – the impact of the technique on others

1. Who do you think is going to pay attention (to the materials produced)? Who is going to see it and who is going to be affected by it?
2. What may be other persons' reactions?
3. Imagine yourself in the situation. Who would you like to see it? Who would you like not to see it?

4. How to you think other persons are persuaded to do it?

Part E – restrictions and authorizations

1. Where do you think people want this to be seen/not seen?
    a. Have you ever explicitly done it? Please, tell me more about that experience.
2. How is the place owner affected by the situation? What might be place owners' reactions?
3. Do you think people should ask permission to do it in a particular place? What kind of places?

Annex B – Place-based Study: Interview with Place Owners

Questions used in place-based communication study semi-structured interviews:

1. Who has created this kind of content?

2. Where is this kind of content created?

3. Is this kind of content uniquely created or mass-produced?

4. Why is this kind of content exposed in this place and location?

5. Is this kind of content specific for this place or can it be shown in other places?

6. Who takes care of this kind of content (posts it, changes it, removes it, checks it, etc)?

7. For how long is this kind of content exposed in this place? Please, select a duration period value from the following scale:

1	2	3	4	5
very short	short	normal	long	very long

8. Who do you expect to watch or react to this kind of content? Are you thinking of any particular target audience?

9. Considering all these kinds of contents, please select three that you would like to show in a hypothetical digital display in this place. Can you please explain the reasons of your choices?

Annex C – Moderation Study: Interview with Place Owners

Questions used in moderation study interviews:

Part A – Perception of the risks

One of the features of digital displays is to allow the publication of user-generated content. Considering that there is a digital display in this place and you would like to post other people's content on it, take a look on these images. They represent possible contents that people may use or create to publish in a display.

1. What do you see in each image?

2. What kind of threat does each image represent?

3. What would it mean for you and this place, if published?

Part B – Probability and impact of the risks

Considering the risk of having this kind of content published in your place:

1. What is the probability that someone that comes to this place tries to publish something like this, presented in each image?

1	2	3	4	5
rare	unlikely	possible	likely	almost certain

2. And considering this happens, what would be the impact of the situation?

1	2	3	4	5
negligible	minor	moderate	major	extreme

Part C – Perception about moderation techniques

Considering that you would always have the possibility to control and manage all the content published in a digital display present in your place, please choose one of the options from the following scale for each of the following sentences:

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

1. Assuming that you could always remove any appropriate content, would you accept to have a display based only on post-moderation techniques?

2. I would accept user-generated content if I were able to review any content before it gets published on the displays.

3. I would accept user-generated content if there were automated filters, configurable by myself, that would be able to retain most of the inappropriate content

4. I would accept user-generated content from external sources that I selected as being trustworthy.

5. I would accept user-generated content from users who had known identities and could thus be made accountable for their publications.

Annex D – Moderation Study: list of scientific references used

The list of the 26 references used as input in the coding process to identify risks and moderation approaches, considering openness of public displays for publication of user generated content.

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