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Interactive Digital Signage – an Innovative Service and its Future Strategies

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Abstract— **Digital signage is an economically promising field in advertising. Yet, it is a hardly researched field; first empirical attempts focused on consumer reactions. Digital signage, though, brings together various market players, all of which with different objectives and expected benefits. For this reason, we introduce a conceptual framework for interactive digital signage that allows developing various business strategies and associated business values integrating the entire set of possible players in their relevant roles and configuration requirements. A rule set represents one of the core modules of the framework, which allows for a sustainable integration of functionalities. Acknowledging that technological and non-technological advancements of digital signage need reconcilement, our proposed integrated approach to digital signage allows for interdisciplinary contributions.**

Keywords- digital signage, interactive advertising service delivery and management, service design, service transformation, user interaction

I. INTRODUCTION

The return on advertising investments is the consumers' attention; but catching the consumers' notice is an increasingly challenging task. Digital signage, which consists of networked electronic displays installed in public spaces, is "poised to disrupt a major component of the advertising industry" [1]. Despite an overall economic downturn in recent years, the digital signage market is growing at an accelerating pace for years, and the end of this growth is not yet in sight [2]. Impressive growth rates can be observed in the United States [3], as well as on the European market [2].

The importance of digital signage is also highlighted by academic literature: "Digital signs are current gaining more popularity and becoming more prevalent. Casual observation reveals that they are now replacing conventional signage in many locations, and the trend is increasing" [1]. However, to date little attention has been paid to the phenomenon of digital signage in scientific research, as several authors claim [e.g., 1, 4-6]. Still, some interesting empirical attempts investigate digital signage focusing on atmospherics [5, 7], content [6], interaction features [8, 9], and consumer reactions [4] such as increasing attention [10, 11].

Basically, electronic (i.e., digital) displays used for digital signage offer new opportunities and advantages compared to traditional 'static' signage. For instance, it allows to display information such as news or advertisements, in the form of dynamic multimedia presentations containing audio, video, and animations [1]. Since sensors and technologies allow digital signs to adapt to context such as time and location, many options appear to catch the audience's attention. Such features are called contextual signage [10, 12, 13]: the shown messages are based on the ability of the system to display information on the basis of contextual factors such as time, location, demographics, consumer preferences, etc. This can also be combined with interactive features, where displays offer consumers possibilities to interact with the system [8, 9].

Taking a holistic perspective integrating all relevant market players, which are guided by different objectives and expected benefits, is however a missing link. For this reason, we develop a conceptual framework that identifies (1) the relevant market players, (2) the core modules and (3) characteristic functions of a digital signage system. In doing so, we provide a basis for a holistic, integrated approach that allows for interdisciplinary contributions. Simultaneously, we assist platform providers in answering the question what they need to consider when implementing a digital signage system. Basically, we aim to construct a digital signage system that reduces the negative externalities for the consumers, while maximizing consumer's attention to advertisements.

The remainder of this article is structured as follows: Section II provides an overview on digital signage by introducing the media format and discusses the market and the economic impacts of digital signage. It deepens the impacts of digital signage by focusing on relevant behavioral effects. Section III introduces the conceptual framework for interactive digital signage by identifying the roles, strategies, and configuration requirements. For illustration, we discuss an exemplary scenario applying the proposed framework. After discussing possible strategies in the context of the framework in Section IV, we finally conclude with a summary and most important, future research recommendations on digital signage.

II. DIGITAL SIGNAGE AND ITS ECONOMICS

A. The Media Format 'Digital Signage'

The term 'digital signage' is frequently used in literature. Still, though, it is often 'misplaced' by referring to any kind of simple digital poster signage (e.g., projectors), shop TV,

stand-alone plasma or LCD screens in stores rather than referring to a well-defined media system [14].

Digital signage is a networked, audiovisual information system that allows remote controlling contents – either program-driven or manually – but in any case from a centralized system [14]. It consists of several decentralized digital displays interconnected with a central system consisting of a content management system and user rights management system [14-16].

The German digital signage pioneer Smart TV-Networks highlights three significant characteristics of digital signage: (1) the possibility for local contents and local rights to use these in the 'content program', (2) actuality that allows to display new contents within a few minutes on the global network or at single locations, and (3) user rights management that allows distinct users to manage distinct 'program blocks' that are shown on a display [14].

B. Economic Benefits of Digital Signage

Economic benefits of digital signage are most obvious when comparing it to traditional, static signage. The CDI cycle (creation, distribution, installation) is reduced in terms of time and costs [1]. Digital signage is able to virtually eliminate the costs of the final two components (distribution and installation) of this cycle. Still, the implementation of a digital signage system requires rather high initial investment costs; thereafter contents can, though, be changed automatically and centrally from a remote system.

While static images are only able to display one message to the consumer, digital signs can change content within milliseconds. Furthermore, they may also adapt to any measurable context, such as to the audience up to the individual [10]. The increased effectiveness resulting from the ability to adjust to context variables offers the potential to contribute to content relevance for the consumer [17].

Additionally, the increased effectiveness of digital signage provides an opportunity for sellers of display time (so called 'time slots') to increase the price of slots for which there is more demand. Since human attention to advertising space is a scarce resource, auction mechanisms are often used to maximize the seller's utility [18, 19]. The possibility to engage in such price discrimination appears in conjunction with the increased effectiveness that is disposable for the advertiser. Hence, the achieved cost reductions due to lower expenses in the CDI cycle might partly be offset by this opposing opportunity for the seller.

C. Behavioural Effects of Digital Signage

Despite limited fundamental academic research on digital signage, a few academic [e.g., 4, 5, 20, 21] and commercial [e.g., 15, 22] experimental studies regarding digital signs and their impact on consumer behavior have been performed. Retailers report a positive effect of digital signage inducing sales uplifts [15, 20]. Yet, this field lacks substantial economically oriented academic research with reliable findings on driving forces, impacts, and also cost drivers.

Recent research emphasizes the value of consumers interacting with digital signage, as it increases consumer engagement [9]. Exemplary classification of the variety of interaction capabilities are (1) presence, where displays are able to detect, characterize and/or identify information about the public, (2) self-exposure, where displays are able to adapt their information on the basis of the public's interests, preferences or activities, or (3) actionables, where consumer reactions can be detected [9]. Advancement of information technologies (e.g., radio-frequency identification, Bluetooth) and the increased adoption of technological devices (e.g., smart phones) make interaction an increasingly attractive option for increasing consumer engagement.

D. The Significance of Content in Digital Signage Advertising

One could assume that so called bottom-up effects such as displays size, height of installation or the angle of a display to the walking direction may strongly affect consumers' perception. Although it cannot be denied that these factors influence whether consumers look at a digital signage, the top-down effects have shown to be more important: "Whether users expect interesting content seems to be more important than other effects that could be naively assumed, like the display size" [23]. This is where content as an important factor comes into play, since top-down effects are those effects that determine whether consumers consider the content shown to be relevant to them.

E. Negative Externalities

Giving attention to an advertisement can be regarded as a 'cost' for the consumer. Only if an advertisement conveys relevant information, it may also cause a benefit. An overload of signage is then the result of having more advertisements (causing too much costs) than would be 'optimal' [11]. Consumers' attention costs are currently not included in transactions calculus between buyers and sellers of advertising space for digital signage (i.e., transactions between platform/space providers and the advertiser). This situation is described as a negative externality in digital signage advertising [11].

Hence, receiving consumers' attention is not a matter of bottom-up effects (e.g., screen size, animated advertisements or sound), but rather of providing relevant content [11]. For instance, on the Web, prominent, interruptive pop-ups are less effective than contextual keyword advertising. Contextual keyword advertising consists of advertisements that are related to search keywords and appear next to search results (e.g., market leader Google AdWords [24]). Since such advertisements are better targeted to the consumers and their current situations and aims, they have a higher probability of being relevant and gain more attention [11].

Another alternative to cope with negative externalities is by market regulation. Theoretically, if negative externalities are eliminated, then the average consumer's benefit from giving attention to a particular digital sign is maximized. If the consumption of a consumer's attention could be monitored, one could sell the exact amount of advertisements until this benefit is reached. According to Müller and Krüger [11] several options exist to achieve this aim. They showed that working with *tradable certificates* might be the best solution: if one would sell certificates for a certain amount of

attention in a certain location, average consumer benefit can be maximized. An auction can serve as the solution by filtering out which advertiser is valuing the opportunity to advertise at that moment and location most. With this approach, transactions costs are high. However, automatic execution of the auction by software agents may help to decrease these transaction costs [11], and auctions are already applied successfully in this market [19].

III. Future Strategies for interactive Digital Signage

Along with an increasing number of different innovative capabilities, the need for self-regulating mechanisms for the adoption of digital signage in public increases, in order to prevent information overload due to 'overuse' of functionalities. Self-regulating mechanisms are based on 'rule sets' that are to be embedded into a holistic, conceptual framework for digital signage.

We provide such a conceptual framework, on the basis of which developers and researchers may systematically identify what digital signage in public space needs to provide, such that it allows tailoring advertising to the needs and requirements of the respective public. Essentially, the envisioned framework is beneficial for all market players. By presenting this framework, we address the need of digital signage providers (platform providers) to have an overview about the major roles, strategies and requirements that are important when setting up an efficient, and thus successful, system. By providing all the basic standard modules that are required for a holistic solution, the limitations of existing systems, which are built for specific uses and purposes only, are overcome.

A. Market Players

Understanding who is involved in the implementation and set-up of a digital signage system is crucial [25]. The system has to integrate at least three major market players, depending whether platform and space are provided by the same or distinct entities.

The *advertiser* is the player whose product or service is advertised for. *Consumer* can be everyone (individuals) the advertisement is directed to. The *platform provider* is the party who offers the digital signage network as such, including infrastructure (hardware, network), software (algorithms), user rights management, and content management. Finally, the *space provider* is the owner of the space where displays are installed. Typically, the space provider and the platform provider are two distinct players. In some cases, though, one player may take both roles.

B. Points of Use

Essentially we can distinguish three types of locations where digital signage can be successfully applied: point of sale (POS), point of wait (POW) and point of transit (POT).

The point of sale (POS) is currently the largest application area for digital signage. One can think of gas stations and convenience stores, shops with consumer goods, etc. Considering that 75% of purchase decisions are taken at

the POS [26], it becomes obvious that advertising within retailers' business premises is key for marketing success [27]. Having the right content at place can, thus, directly lead to higher levels of sales uplift as well as to an improved shopping experience [25].

At the point of wait (POW), consumers are waiting for a certain product or service, for example in a queue or in an elevator. Exemplary applications are healthcare, retail banking or office buildings. The three primary goals of digital signage at the POW are: (1) communicating key messages geared towards brands and products related to the service provider, (2) increasing customers' satisfaction, thereby influencing their perception regarding the actual waiting time, and (3) providing interesting, relevant content in various ways [25]. Longer waiting times at the POW enable advertisers to show longer messages and more repetitions. Typically, consumers are more deeply involved with the content shown, and the advertising benefits might be more long-term oriented, which differentiates advertising at this location clearly from that at the POS.

The third alternative is the point of transit (POT), where the audience (in transit) passes a signage. This kind of signage is typically found at airports, metro, train or bus stations, and store windows. Here, passer-by's attention has to be caught within a very short time period. Since advertisers are at maximum able to create a thought-provoking impression, the content has to be well evaluated [25]. Digital signage at the POT is not necessarily used to advertise a particular offer, but rather used to establish brand identity and increase brand value.

This threefold categorization provides a first attempt with respect to the systematic identification of points of use. The next step contains descriptions of these levels in even more detail, by considering a specific location category within a certain level, e.g., a supermarket at the POS, a doctor's practice at the POW, or a platform at a train station of the POT. On the most detailed level of abstraction concrete installations within one of the location categories are considered: e.g., Big John's corner shop in New York Fifth Avenue, the waiting room of Dr. Jane Doe's medical practice, or the metro station in London Oxford Circus.

C. Strategies

Having the information about the players and the points of use, a platform provider can start determining which customizing strategy will be followed. While existing literature argues that the central system of digital signage consists of a content management system [14, 15] and user rights management [14], we add as a third component a 'set of rules'. This *rules set* includes the strategies to be considered. It consists of two main decisions: the selection of the *pricing mechanism* and the *polling mechanism*.

Central question for determining a *pricing mechanism* is how time slots are 'sold'. Auctioning is an option for a pricing process. In an English auction, for instance, the highest bid receives the advertising slot. An appropriate algorithm for this method then requires careful consideration. In absence of such an auction mechanism, one can also attribute the time slots to content more easily, for example

per supplier or per location. A combination is also possible, for example where an auctioning mechanism is used for a predetermined location. Moreover, agreement has to be obtained regarding the player who decides what is shown. This can be either the platform provider or the advertiser, but also a combination of both. For the latter case, one can decide on different weights that both parties' decisions might have in reaching a final agreement.

A *polling mechanism* is required in order to select and retrieve a certain advertisement. A multiplicity of criteria is at disposal here: one might show the most demanded advertisement, but also the latest one added, or the most scurrile one.

Contextual advertising, which is similar to keyword advertising on the Web (prominently used by search engines), provides advertisers with the important possibility to show those advertisements that are most likely relevant to the consumer in that moment [28]. It is well possible to enhance the efficiency of search processes on the Web by means of context-aware query processing [29]. This is also promising for contextual digital signage. As there are usually fewer time slots than (potential) advertisers, slots become a scarce resource. Currently, auctions are the common market mechanism by which those slots are sold in digital signage advertising [11, 19]. Thereby the auction mechanism serves as both, the polling as well as the pricing strategy.

The main challenge is to auction these slots efficiently [19]. In the absence of queries such as in the case of keyword advertising with search engines, information must be gathered in an alternative way for digital signage advertising. One possibility is that consumers interact actively with the displays [8]. However, this option faces severe drawbacks in the form of privacy concerns. Another possibility is that consumers accept to be opted in via technologies such as Bluetooth/mobile phone or radio-frequency identification (RFID) [9, 12, 19]. Yet, the latter option has scarcely been investigated (e.g., [19]).

D. Configuration Requirements of a Holistic Digital Signage System

Against this background of various separate considerations, a holistic digital signage has a scale of requirements to fulfill. Meeting those prerequisites requires considering configuration options, which are structured alongside the market players. With respect to the *advertiser*, it is important to have information about the budget for advertising, either in a specific setting or for a specific product. The target group of the advertiser's product or service is another important consideration. Finally, it has to be taken into account what specific strategy and/or policy the advertiser pursues.

Since setting up a successful system requires information from *consumers*, at least to some degree, a specific consumer trigger has to be considered. Loyalty cards or keeping track of the profile via the consumers' mobile devices are possible approaches. With the latter approach, respecting consumers' privacy becomes an issue that deserves attention.

Also for the *provider*, a certain trigger is needed. Having the information about what stock is available in shelves, a retailer can develop an appropriate strategy. This strategy could then be tailored in order to, for example, maximize profit margins (price differentiation) or sell complementary goods. Minimizing the vendor's inventory may be a potential strategy if the supply chain performance is an important issue. For supermarkets or grocery stores, one could pursue a strategy to minimize stock of perishable food in order to avoid 'expired products'.

Finally, it has to be decided how to tailor digital signage to the situation at hand, i.e., what polling as well as pricing strategy will be used. Several basic options exist for the polling of advertising. First, fixed time slots for both time and location can be used. Second, allocating content can be done purely on the basis of an auction mechanism. Third, and this appears to be the most likely option for large digital signage networks, a hybrid solution can be chosen, where the majority of time slots is fixed with respect to time and duration, and the remaining slots may be sold via auctions. The pricing strategy is interrelated with the polling mechanism that is chosen. One can either decide to have fixed prices, or use an auction mechanism to pick the highest bid for certain advertising slots.

Figure 1. illustrates one possible alternative how such a
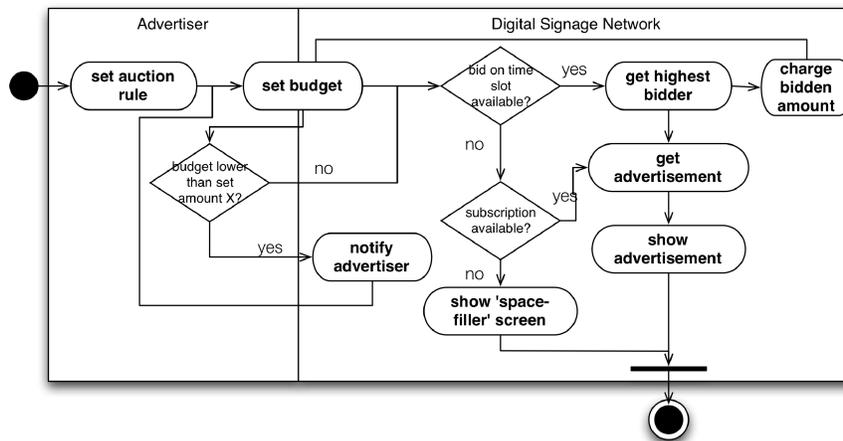
Figure 1.   An exemplary rule set integration for digital signage (UML activity diagram)

hybrid form with a combination of fixed time slots and auctions may be operationalized. In this example all time slots are available for 'fixed time slot booking' as well as for bidding on them in an auction. Alternatively, a platform provider may offer attractive time slots for auction, while less attractive ones are sold via fixed time slot booking. Market simulations may predict how such a market could evolve and may recommend alternative solutions to the provider.

E.   Exemplary Future Scenario

The interfaces of the market players with the envisioned digital signage network as well as their basic activities can be organized as follows: a platform provider typically rents various display locations from a space provider. In some cases, the platform provider may own display locations and thereby also overtake the role of the space provider. Content providers (i.e., advertisers) may subscribe to the digital signage network. In doing so, they provide their advertisements to the system. Provided that an auction mechanism is used, the content providers bid on desired time slots to show their advertising messages. The platform provider monitors the content providers' location preferences, based on their biddings.

Furthermore, the digital signage system could also include a democratic mechanism. With such a mechanism that takes consumers' needs into account, the image of both, the platform provider and the digital signage system, could be improved. A visionary example could be depicted as follows: A consumer dislikes a 'macabre' picture or discriminating text used in an advertisement. He or she uses the mobile device for addressing a voting component of the digital signage system. The voting system can be as simple as a like/dislike-vote or an unstructured consumer comment [9]. With a relevant amount of votes, the content provider (i.e., the advertiser) can use this feedback accordingly to adapt to consumer preferences. This requires the platform provider to monitor consumer preferences with respect to advertisements and locations.

Finally the system also offers the functionality for the platform provider to monitor the conformity of the operative business with its business model. In contrast to other advertising systems, the envisaged digital signage system even allows real-time computation of analyses.

IV.   DISCUSSION

The presented framework integrates various players' roles, points of use, strategies and configuration requirements, aiming to provide an overview that supports the set-up process for a digital signage system. This paper's goal was to pinpoint at the various viable options that have to be taken into account when designing a digital signage system, as well as outlining the variety of possibilities and combinations at disposal for each category. We want to emphasize that this framework is not yet exhaustive. Neither do we exhibit certain preferred strategies within this sequence of choices in the current state of research and development.

Currently, interactive digital signage is still in an experimental phase, facing several drawbacks. First, it is questionable whether this form of digital signage is without negative externalities. Consumers' attention is increasingly consumed in many environments. Possibly consumers are facing attention costs that are not sufficiently compensated by the relevance of the content that is shown. Second, deciding on which content to show in which context (scheduling rules) is a major challenge [10], which is still not sufficiently researched. Third, the public might well disapprove the use of contextual signage on the basis of privacy protection [30], which might also turn out to be a legal hurdle to take [10]. Opt-in solutions might be the best alternative to overcome privacy concerns [30].

Digital signage slots are often sold via auctions. If advertisers indicate the value they place for advertising at a certain place and time, advertising space can be efficiently sold. However, it is important that consumers consider the information to be relevant. In order to increase relevance, advertisements with interaction possibilities might be valuable. Those advertisements have the potential to facilitate a two-way interaction with the audience: the public opts in to be identified (e.g., via mobile phone, RFID card), passes the signage, which then calculates the content to be shown on the basis of the consumer's information as well as contextual factors [11]. Again, possible drawbacks are privacy issues. Interactive scenarios with consumer feedback, though, counteract this problem by using the opt-in solution, which seems to be a viable privacy-sensitive model.

V.   CONCLUSION

Digital signage plays an increasingly important role in today's advertising industry. However, this emerging mode of advertising via digital signage is to date characterized by a lack of substantial academic research. Along with its increased array of application options, there is a need for a cohesive framework that considers various strategies when setting up a digital signage system. This paper's main contribution is therefore the provision of various strategies within a framework, which encompasses the major players, levels, and requirements involved. Since this framework integrates both technological and management issues, it enables practitioners and researchers from various fields to suggest further extension and evaluation.

We have chosen a non-technological approach for our framework as most advancement in digital signage done has been from a technological perspective and it is the application layer that still needs most attention in future research threads. Still, we acknowledge that technological and non-technological issues need reconcilement in order to generate business value and provide consistency and applicability. Digital signage with user interaction represents an innovative business alternative that allows new players to enter the market while involving well-established traditional ones. Leveraging this new business segment eventually affects the entire market as close cooperation and vivid interaction deems necessary to make it work. Against this background, it is crucial to evaluate the effects of the market dynamics in advance. Leaving such a market-embracing

innovation up to the self-regulating dynamics of market forces might limit the potential benefits. From an economic perspective it deems crucial to motivate the appropriate entrepreneurs to engage in this novel and innovative business arena. For this reason, there is a need for secured scenarios, reliable planning, and sustainable strategies. As a consequence it is a key issue for future research to investigate market dynamics of interactive digital signage and requirements for any kind of market regulations in the field. Game theory and market simulation seem particularly interesting and meaningful approaches. Hence, some key questions for future research refer to market effects and dynamics of contextual digital signage with user interaction, and to efficient auction mechanisms considering issues of privacy and information overload for this innovative service.

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