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# RESEARCH OF ISSUES RELATED TO THE DEVELOPMENT OF DIGITAL SIGNAGE SYSTEMS AND CURRENTLY EXISTING SOLUTIONS

Mirosław WITKOWSKI[1*], Adrian KAPCZYŃSKI[2]

[1] Silesian University of Technology, Faculty of Applied Mathematics, Department of Mathematics Applications and Methods for Artificial Intelligence; Miroslaw.Witkowski@polsl.pl, ORCID: 0009-0004-2104-4587
[2] Silesian University of Technology, Faculty of Applied Mathematics, Department of Mathematics Applications and Methods for Artificial Intelligence; Adrian.Kapczynski@polsl.pl, ORCID: 0000-0002-9299-1467
* Correspondence author

**Purpose:** This article aims to explore what problems digital signage systems solve and therefore what caused their development. In the paper it is also examined the currently existing solutions to the problems presented.
**Design/methodology/approach**: The objectives have been achieved through a review of the literature and available software on the market, as well as the observation method and individual case method based on specific problems. This will allow research to be carried out on either the theoretical or practical side.
**Findings:** In the course of the work, individual cases of communication in the public sphere were analyzed, and therefore, on the basis of the presented cases, the features and functions that the solution should have been extracted. An analysis of the software available on the market was also carried out.
**Research limitations/implications**: In future research, it is worth investigating the experience of users when managing a particular digital signage system, depending on the level of competence of the specific users.
**Practical implications:** This research is an excellent starting point for enterprises developing digital signage systems wishing to create well-tailored software for the client. This allows one to make correct decisions already on the design phase which translates into cheaper and shorter software development process. Examples of how to analyze customer requirements are shown.
**Social implications:** This research can have a positive impact on communication in the public sphere. The cases in this paper can help improve the user experience of newly developed digital signage systems by better analyzing the needs of these users.
**Originality/value:** This paper is valuable especially for the public-sphere communications industry and companies developing digital signage systems. It makes it possible to note guidelines that enable the development of well-tailored digital signage software by analyzing individual cases and the tools currently in use. This topic is very important to provide appropriate tools for communication in the public sphere. On the other hand, the rarity of addressing this topic makes it important to study and makes it more innovative.

**Keywords:** digital signage systems, public sphere communication tools, software user experience, case study of public communication, VJ software.

**Category of the paper:** Research paper, Case study.

## 1. Introduction

The way information is presented in public places varies quite a bit and depends on many factors. This is best seen when analyzing real-life problems. It allows one to find an appropriate and well-tailored solution. An efficient and flexible solution can be provided by appropriate software.

By appropriate software, we mean software that will allow us to adequately present information to the public in a way that is appropriate to the existing circumstances and provide functions that will be needed under those circumstances. An example of a type of software whose main functionality is to spread information in the public sphere is Digital Signage.

The definition of Digital Signage is best summarized in a document "Digital Out of Home - A Primer-Section 1 – Introduction" written in collaboration with companies dealing with these topics. "Digital signage is a network of digital displays that is centrally manageable and addressable for targeted information, entertainment, merchandising and advertising" (Abrons et al., 2019, p. 3). Another rather specialized software is VJ software, which is used, for example, during concerts by so-called VJs. VJs are "mixing live visuals in front of real people" (D-Fuse, 2006, p. 10).

However, in addition to such a rather specialized type of software, there are also more general solutions available, such as video players. Player was defined as "a client program or control that receives digital media content streamed from a server or played from local files" (Rigdon, 2016, p. 932). So, the video player is a program that allows users to play back video. And, video is defined as "an audiovisual recording" (Rigdon, 2016, p. 1365). Another quite commonly used type of program is presentation program. The presentation program "is a category of software used to create content where information is often represented in a graphical or visual way" (Awati, 2023). Such programs are often used for business purposes, but also for education and information.

We can observe that there are several categories of programs that would suit the purpose of providing information in the public sphere. To decide which program will be the best choice, one needs to define the requirements corresponding to the use case. And now we are going to present some case studies on communication in public spaces. From each case, the features that the solution should meet in order to work in a given situation will be extracted.

## 2. Case study of communication in public space

Issues for specific type of public communication will be presented below under various conditions, which will give a broad overview of the requirements for appropriate solution. That solution will be software with specific features.

### 2.1. First use case: Periodic usage, for example in educational institutions

Everyone remembers well the various assemblies, speeches and performances that occur in schools at different stages of education. The largest of these are the beginning and end of the school year. Sometimes on the stage or in the hall where the event takes place there is a projection screen with a projector and computer in the background. And then an idea or request is made to have something projected in the background during that event.

At this point, it would be necessary to analyze how to solve the problem. We know that someone will speak, there will be time for the handing out of diplomas, and, at the end, some performances by students. This indicates that the content displayed must change dynamically.

Schools usually do not have the extra budget to purchase additional hardware or software, so free or already purchased versions will have to be used.

We also learn that it is possible to use photos and videos from the school archives and that each class will have to be presented. At this point, we know that the content displayed will be photos, videos and text.

Every video ends at some point, and we don't know how long the speeches, diploma handing, or performances will last. We need, therefore, also the ability to loop the videos.

Since the placement of the computer connected to the projector is in a visible location, the person operating it cannot be on the computer during the event.

Specifying the software requirements in this case, we can highlight:

- the ability to display videos, images and text,
- the need to control the displayed content to adapt what is displayed to the current situation on stage,
- the need to use freeware software,
- the ability to loop the displayed content,
- the ability to remotely control the displayed content.

### 2.2. Second use case: Family events and more

During the organization of a large event, such as a family event, like a wedding, wedding anniversary, birthday, etc., a lot of different equipment and software is used.

The organizers have rented a beautiful hall, taken care of the invitations, flowers, food, and now it is time to provide music and the right mood in the room. At this point, it is necessary to make an analysis of how to deal with the situation.

We know that the hall has a projector with a screen and two TVs that can be used. All these devices support the same resolution, but each is connected to a different computer. All computers are on the same network. At this point, we know that the system will have to display content on several screens simultaneously over the network.

Music issues will be provided, but the displayed content must change dynamically, each song lasting a different length of time, so the ability to loop the displayed content and control what is displayed will also be needed.

Stage lighting will be rented to provide the right mood. To achieve a good effect and make an impression on guests, the content displayed on the screens and the way, the movement of the stage lighting should be synchronized with each other.

Since most of the budget has been spent on providing the venue, music and appropriate equipment, the software used must be very cheap or preferably free.

In summary, the following software requirements occurred in this case:

- the ability to add new screens connected to different computers,
- the ability to display content on different screens simultaneously,
- the ability to change the displayed content and control what is displayed,
- the ability to loop the displayed content,
- the ability to synchronize with specialized stage lighting control software,
- the software must be as cheap or free as possible,
- ability to display photos and videos.

### 2.3. Third use case: Continuous usage, for example in organizations

For example, the university has purchased new monitors to display content for students and employees, which will be mounted in the corridors. It is necessary to find a way to display content on them. To do this, we will analyze the requirements.

We have received information that there will be a need to display photos, videos and texts. We already know that the system needs to support video, graphic files and be able to display content.

Sometimes, there will also be a need to display more than one type of content at the same time, such as two photos on one screen. With this information, we know that the system must be able to display many different contents on one screen at the same time.

All monitors were connected to their corresponding computers and these connected to one local network. The software will need to be able to add screens over the network.

It is also important to be able to easily change the displayed content, even from a phone. The system must have a mobile-friendly interface and the ability to change content remotely.

Many employees have different responsibilities; some will manage the technical side, others will prepare and post content. Sometimes new employees also come in. At this point, we know that it will be necessary for access to the system's control panel to be secured with a log-in and that it will be necessary to be able to add users with different levels of privileges.

It turned out that the screens are spread across different departments, and although they are connected to one local network, they need to display different content at the same time. The system will need to be able to assign displayed content to specific screens.

Specifically selected content is to display in a specified order, and then start the display from the beginning. This indicates that the system must have the ability to make playlists, where it will be possible to set the order and length of display of given content, and to loop the entire playlist so that the content is displayed all the time.

In addition to displaying current content, there must be the ability to quickly turn on an emergency message on all screens about a sudden event, such as a fire. The system will need to be able to quickly display a single message on all screens in the system.

The screens are located over a wide area and there is no way to physically verify that they are on. The software must be able to verify if a one is online and which screen it is.

After analyzing the problem, the following requirements were listed:

- ability to display images and videos,
- the ability to display several contents of different types on one screen at the same time,
- the ability to add screens via a local network,
- the ability to remotely change content and control its display,
- interface optimized for mobile devices,
- adding and managing users with different privileges,
- access to the administration panel after logging in,
- creation of playlists from specific content,
- ability to set the duration of content display in a playlist,
- assigning playlists to specific screens,
- selected playlist should be looped to ensure continuous display of content,
- the ability to quickly display a single message on all screens in the system,
- the software must be able to verify the current status of the screen.

### 2.4. Summary of the use cases described

In summary, software to display content display in the above-described situations must have a range of functions to meet the various requirements. It can be said that the requirements vary depending on the character of the use, whether it will be a continuously operating system or only a temporary one. Different requirements can also be seen depending on the size of the place where the system will be used, as well as who will operate it and on what device. In some cases, the functions needed conflicted with each other, depending on the location. Once the same content is needed on different screens, and once it should be different content. There are also industry-specific functions, such as integration with specialized software or the ability to suddenly change a different displayed content to one that is the same on all screens.

In each of these cases, you need to use the appropriate software which in a specific case will include other necessary functions. In some cases, there are also functionalities that overlap no matter where they are applied, i.e., the ability to display images, videos, or the ability to change and control the displayed content. In many cases, digital signage software will be a good solution. In more specific cases, such as at a dance event, it will be VJ software. But in some cases, simple software, such as a video player or presentation program, may be sufficient.

## 3. Case study of existing software on the market

So now let us see what software in this category is currently available on the market. Software of various types can be used to present content. From the simplest to those with a powerful technical background.

### 3.1. Video player

The simplest programs that allow for the presentation of video content and sometimes even photos, are video players. They allow one to control the content being played, arrange playlists, and often loop the video or the entire playlist. It is also possible to display the video on the full screen. However, it does not allow for the distribution of content on multiple screens, and the control panel, in most players, is displayed above the file being played. It also does not have an access authorization function, and it does not allow to display text, or display multiple different types of content on the same screen at the same time. Some of the most popular video players are VLC, ALLPlayer, or players built into the operating system. VLC also has a basic web interface that allows you to control the content being displayed without displaying a control panel over the content being played. It is also free and allows you to loop as well a single video as a whole playlist. This is an interesting compromise solution for displaying basic content on a single screen, but in the long-term it may not be convenient and causes the need to prepare

the content in advance, e.g. with text in other programs. Video players are mostly used in home environments.

### 3.2. Presentation program

To present various data, charts and content, we can use presentation programs. They allow rich editing of the created slides, adding text, photos, videos. Most often, they also have a built-in function to display a slideshow. The user can control the running presentation with the mouse or keyboard. This tool is designed more for one-time presentation of content on a specific topic. There is no possibility of authorized access, or connecting several screens and displaying selected playlists. The role of playlists is usually played by a file that contains previously composed slides. The creation of the presentation itself is also quite a time-consuming process. Some looping options exist, but the setup is quite complicated. It is also impossible to change the content invisibly during playback. The most popular programs to create presentations are the paid Microsoft Office PowerPoint, the free Apache OpenOffice Impress, or the online solution Prezi (prezi.com).

### 3.3. VJ software

VJ is an acronym for Visual Jockey. Compared to the more popular acronym DJ, from Disc Jockey. Just as a DJ is a person who uses specialized hardware and software to mix and play live music, a VJ is a person who, with the help of specialized hardware and software, mixes and plays live visual content such as movies and animations. Software known as VJ Software allows one to play live video and animation and has a panel to control the content being played and mix it. Allow for detailed adjustment of the file being played, trimming, rotating, repositioning, looping, working on layers. They usually have the ability to sync with other programs, such as those that play music or control the lighting on stage. They also often have a ready-to-use library of visual effects. Such programs are very professional, adapted to work live, for example, during concerts. Due to their large capabilities, these types of programs are more difficult to work on a use and are more suited to work on live. Usually have no access authorization, it must already be provided by the operating system. In exchange for specialized software, their price is quite high. The most popular programs of this type are ArKaos GrandVJ and Resolume Avenue VJ.

### 3.4. Digital Signage software

Programs of this type usually have the ability to play content such as videos, photos and text. Often, they allow you to display content on multiple screens, create playlists, access via user login, and some even allow to create displayed content directly in the software. Sometimes there is also the ability to report on the status of the screens. Such programs are for commercial use. Unfortunately, most of them are paid and complicated to use for the user. The rarely available free version of this type of program does not provide all the available functions or has

limitations on the number of screens displaying content. Often these solutions are also cloud-based, but not every user wants to upload their data to the cloud. Examples of such programs are AD SCREEN, intuiface and Yodeck.

### 3.5. Summary of available solutions

In conclusion, the appropriate program to display content can be searched through the wide range of available solutions. However, none of them is universal enough to work under all conditions. Each type of program allows for something different. In some, the priority is to quickly play a single file, while in others, to prepare a polished presentation, at the cost of consuming more time. Some other programs are more complicated and designed for live professionals, while others allow one to schedule what to play when. Some will work well for single-screen playback, and others for multiple screens. Much also depends on the available budget. With free solutions, we can count on rather basic functionality. Looking for a program for professional use and with specific functions, a paid version is already necessary, which is usually complicated to use. Nevertheless, each of them has some interesting feature that stands out and allows one to be inspired while developing new software.

## 4. Usage of appropriate software in the analyzed use cases

Already knowing the possible cases of need for specialized software and the category of software that can meet these needs, the matching of sample programs available on the market to specific uses will be presented.

### 4.1. Appropriate software for first use case

We assume an example of a periodic use case, as a use in a school during an end-of-year academy. To summarize the analysis of this case, it can be determined that the software should be cost-free and allow the display of videos, images, text and control of the displayed content live, along with the ability to loop and remote control.

Software such as a video player or presentation program will work well here. Examples of commercially available software that performs these functions are the VLC video player, or the Apache OpenOffice Impress presentation program. Both solutions are cost-free. The target customers for these solutions are average users who use a computer to perform basic tasks such as browsing the Internet, handling e-mail. This results in a user-friendly interface for these solutions. Although the Apache OpenOffice Impress interface due to the multitude of editing functions is more complicated at first. Using tools with a customized, user-friendly interface can improve the user experience.

The strengths of the VLC software are:

- cost-free,
- user-friendly interface,
- the ability to display images and videos,
- the ability to loop videos, create playlists and control playback,
- possibility of remote control via web interface,
- low hardware requirements.

The weaknesses of VLC software are:

- the need for advance preparation of the displayed materials in the form of photos and videos including the need to prepare texts in advance for display in the form of images or videos,
- lack of ability to use eye-friendly transitions between playbacks, should be considered when creating content,
- the need to configure and understand the basics of computer network operation in order to take advantage of remote control through a web interface.

On the other hand, the strengths of Apache OpenOffice Impress are:

- cost-free,
- the ability to display images, videos and text,
- the ability to loop slide with content, create playlists and control playback,
- the ability to edit content slides,
- the ability to use eye-friendly transitions between slides,
- low hardware requirements.

The weaknesses of Apache OpenOffice Impress software are:

- more complicated interface compared to VLC,
- lack of remote control, the need for additional solutions such as a wireless USB presenter for changing slides.

The mentioned tools could be used for the first use case. A better selection of the right tool is possible by listing the strengths and weaknesses of these tools, allowing the selection to be tailored to the needs of the customer.

### 4.2. Appropriate software for second use case

In the second use case, we are dealing with the use at different types of events, for example, weddings, anniversaries, etc.. To summarize the analysis of this case, it can be determined that the software should be cheap and allow the display of videos, images and control of the displayed content live, along with the ability to loop and remote control. Software should also allow for display on several screens simultaneously, and synchronization with music and stage lighting.

In this case, software from the VJ Software category will provide the best coverage of the needs. Since this type of software is targeted at professionals, it has a much more advanced interface, and its price can be high. An example of a solution in this category is Resolume Avenue VJ software. The price of this software may be high for a customer who wants to use the software for personal use, but for companies organizing events, the price may be acceptable (At the end of 2023, the price is € 299 per 1 computer with 12 months of free updates). The software interface will be more intuitive for professional users. It is not as user-friendly as the interface for a video player, but taking into account the purpose and huge amount of functions, professional users should have a good user experience.

The strengths of the Resolume Avenue VJ software are:

- The ability to display video, images and animations.
- The ability to synchronize displayed content with music.
- The ability to synchronize displayed content with stage lighting.
- The ability to display content on multiple screens simultaneously.
- Advanced functions for effects, synchronization, projection.
- Possibility of integration with external software and use of plug-ins.
- Intuitive interface for professionals.
- Live video mixing and audio analysis.

The weaknesses of Resolume Avenue VJ software are:

- High price for personal users.
- The interface may not be very intuitive for non-professionals and beginners.
- The use of integration with external software results in the need to perform the appropriate configuration and the need for knowledge of communication protocols.
- The need for a high-performance computer to use the software.

The described software can be used for the second use case by the event company. Individual organizers can decide, on the basis of the weaknesses and strengths presented, whether it is better to use specialized software and accept the weaknesses of this solution or to outsource this task to a company that already has suitable software.

### 4.3. Appropriate software for third use case

The third use case concerns continuous use. For example, use to display information at the university in public areas. To summarize the use case described earlier, the software to solve this problem should allow the display of videos and images, as well as several elements of different types on one screen and create, loop, playback playlists. It should be possible to display on several screens at the same time using the network, verify the current status of the screens, be able to manage the system and change content from a mobile device, authenticate through a user account with appropriate permissions and display priority messages.

This is where digital signage software comes into play. Most often, it is only the paid version of the software that allows the use of all the functions of digital signage software. The multitude of functions of this type of software can result in a quite complex interface. A well-prepared manual and instructional videos can improve the user experience. Users of digital signage solutions will be diverse. An experienced user will be needed for initial system configuration. Ongoing insertion of content can be carried out by users less experienced in the context of system configuration, but closer to the subject matter of the company where the content is to be displayed. This creates the need for users with different levels of authorization to access the system. An example of software that can be used in this situation is Yodeck. It is a web-based digital signage system that requires Internet access to use. The fee is on a subscription model. At the end of 2023, the monthly cost should close at $13 per screen.

The strengths of the Yodeck software are:

- the ability to display images, videos and text**,**
- the ability to create slides that display multiple types of content at the same time on one screen,
- possibility to use several screens through the network,
- the ability to access the administration panel over the network, including from a mobile device,
- the ability to create users with appropriate permissions,
- the ability to create, loop and play playlists,
- templates for easy content creation,
- the ability to play content according to a schedule,
- the ability to add screens to the system, check their status and manage them,
- the ability to display emergency alerts.

The weaknesses of Yodeck software are:

- necessity of a monthly or annually fee,
- more detailed user rights are only possible in a more expensive package, in the cheaper one, standard roles can be assigned,
- the need to connect display devices to the Internet,
- data is not stored locally, but on remote servers,
- possibility to manage the system from a mobile device via a customized web interface, but not via a mobile application,
- more advanced network security is only available in a more expensive package.

The software presented has many functions that meet the requirements. The best choice is the most expensive package because of the greater amount of network security. The weakness is the need to operate over the Internet, which means that data is not stored locally. Making the strengths and weaknesses visible will enable one to make an informed decision about the use of digital signage software.

### 4.4. Summary of the examples and solutions analyzed

An analysis of the available solutions in the context of the mentioned use cases shows that each of the given software categories meets the needs of a different group of users. Providing specific software examples for each use case and analyzing their strengths and weaknesses will enable a more informed decision to be made when selecting software to present content to a larger audience. The features presented demonstrate the capabilities of software currently available on the market. Attention is also focused on the character of the application of a given solution. It is necessary to use tailored software in order to achieve the best results. No software has ever been so universal that it can be used in every use case to meet all requirements.

## 5. Discussion

Research shows that there are many cases where providing a well-tailored way of communication in the public sphere is worth using well-tailored software. Despite the same goal of communication in the public sphere, other functionalities are needed from the software depending on the circumstances and the character of their use. Also, the user's level of experience significantly affects the required functionality.

Interestingly, it was also observed that certain features were the same independently of use cases, e.g., the ability to display images, videos and the ability to change and control the displayed content. These are specific to programs for communication in the public sphere. The information transmitted in this case is images and videos. The user has the ability to communicate this information to the audience by displaying this content at the appropriate place and time.

Of course, there was no lack of case-specific features, e.g. the ability to synchronize with specialized stage lighting control software and the ability to quickly display a single message on all screens in the system. These are features designed for professional use. Their presence is determined by specific requirements and where the information is to be distributed.

On the other hand, there is software to meet user requirements. Four main types of software, whose main function is to transmit information in the form of, among others, images and videos, are video player, presentation program, VJ software and digital signage software. The selection of the appropriate software will depend on the advancement of the user, the type and character of the information transmitted, and the functions that the software provides.

These results need to be interpreted with care because every use case is very individual. Much depends on the requirements placed on the software to help with the provision of communications in the public sphere. This research is a great starting point that shows the analysis of the situation to specify the requirements and selection of software.

## 6. Conclusions

In summary, communication in public sphere can be supported by software. Development of software led to creation more specifically types of software. From simple programs like the video player, to advanced programs that maintain entire communication systems like digital signage software. Choosing the right program depends on the needs of the particular situation. The results of this study highlight that a good specification of requirements is crucial to select the appropriate software. What is interesting here is that there is no universal program that works perfectly in every case.

Highlighting several major types of software gives a clear overview of what kind of software is currently available and for what purpose it was created. This shows solutions to the problems identified during the case study. Insufficient functionality of programs such as video players and presentation programs has led to the development of more specialized software such as VJ software and digital signage software. This study indicated what functionality digital signage software provides that had not previously been addressed in other types of software.

### 6.1. Further developments

This study provides the backbone for further investigation into areas related to digital signage software, the support of communication in the public sphere through software, and its adaptation to the user. As a precursor to future directions, this article allows the reader to explore the topic of software designed for communication in the public sphere, such as digital signage type systems. It is possible to further deepen the subject. There is potential in exploring the use of the software in other use cases. It is possible to explore the degree of versatility of the software in use. It would also be interesting to investigate the effectiveness of digital signage systems. It would also be curious to explore the use of artificial intelligence in this type of system.

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