

Virtual Exhibitions in Cultural Institutions: Useful Applications of Informatics in a Knowledge-based Society

Cristian CIUREA^{1*}, Florin Gheorghe FILIP²

¹ Bucharest University of Economic Studies, 6 Piata Romana, Bucharest, Romania

cristian.ciurea@ie.ase.ro (*Corresponding author)

² Romanian Academy, 125 Calea Victoriei, Bucharest, Romania

ffilip@acad.ro

Abstract: This paper presents specific technical issues related to the development of virtual exhibitions for both web and mobile devices. Several real implementations of virtual exhibitions are described, based on the MOVIO platform (in the case of web applications) and on the Android operating system (in the case of mobile applications). A comparative analysis has been performed in order to reveal the advantages of each type of implementation, based on two virtual exhibitions implemented for the Romanian Academy Library.

Keywords: Web applications, Mobile applications, Virtual exhibitions, MOVIO, Android.

1. Introduction

In the beginning of the 21st century, when several pacing *Information and Communication Technologies (I&CT)*, such as *Automated biometric systems, Cloud Computing, Internet of Things, Big Data, Business Intelligence, Diffusion Network Embedding* and so on (Alexandru & Ianculescu, 2017; Buciu & Gancsadi, 2016; Filip, Zamfirescu & Ciurea, 2017; Peng et al., 2008; Radulescu & Radulescu, 2018; Shi et al, 2019) applied to various milieux got ever more traction, the cultural heritage has gained new worth for the institutions and countries that preserve valuable collections. The new I&CT have made cultural heritage become a strategic economic resource for European countries. According to (Borowiecki & Navarrete, 2017), it has been estimated that cultural and research content preserved in cultural institutions of Europe has a market value around €27 billion.

Taking into account the current economic situation at European level and the envisaged future strategies, cultural heritage institutions should not depend too much on the public funding. They should find alternative financing methods with a view to become autonomous from this point of view. In the context of European economic uncertainties, the development and deployment of new business models for the creative re-use of digital cultural content should enable a wider access to cultural heritage collections on the one hand and, on the other hand, it should also enable the creation of additional revenue in order to guarantee the long-term sustainability of cultural institutions. Some cybernetic representations of

such business models for cultural institutions are described in (Filip et al., 2015).

Taking into consideration the influence of modern I&CT in all human activity fields, the cultural sector can benefit from the evolution of new technologies in order to enhance the market value of cultural heritage collections.

The cultural sector needs to adapt to the requests and behavioral-cultural profile of the general public visiting cultural institutions.

The remaining part of this paper is organized as follows. A few specific aspects of digitization of collections and the main concepts related to virtual exhibitions are reviewed in the following two sections, respectively. The methodology to create virtual exhibitions, both on web and mobile computing settings, is presented in the fourth section. A thorough technical comparison of both solutions (web and mobile) is provided in the following section. It is followed by a brief review of financial aspects.

2. Digitization of Cultural Collections

The greatest difficulty that occurs in the dissemination of cultural content from libraries and museums in the digital era is the digitization of cultural heritage collections. The process of digitizing collections must be done by 2D or 3D scanning or photographing cultural objects and by associating metadata in order to build the most accurate and complete databases with digital copies of cultural objects. This process

enables the researchers to get an easy access to rare heritage collections, especially to those that involve difficult physical access due to the physical degradation, conservation conditions or security policies.

The priorities of digitizing the heritage collections of a cultural institution have to be set based on a number of factors, such as the degree of degradation of the collections and the perceived or forecast public interest in certain collections in order to translate them into the online environment, based on the human and material resources available.

The online dissemination of certain exhibits or collections owned by a cultural institution may stimulate other institutions or persons' interest in making partnerships or collaborations for various joint projects. In this way, the cultural institution opens its doors to the categories of visitors interested in either studying collections or exploiting them through research projects.

3. Virtual Exhibitions – Concept and Objectives

The cultural institutions meant to provide the infrastructure for the accumulation and preservation of a nation's values, such as *art galleries, libraries, archives, museums* (GLAM), must adapt themselves to the evolution of new I&CT.

Virtual exhibitions represent a modern way for cultural institutions to contribute to arousing the public interest in the cultural collections and art objects they own. Also, virtual exhibitions are the most appropriate vehicle for the dissemination of cultural content from libraries and museums in the digital era.

In order to analyze the impact of virtual exhibitions on the dissemination of the cultural content sheltered by libraries and museums, the virtual exhibition is promoted for the digital access to cultural collections from everywhere and at any time, but with an approach that allows the visitor to achieve a personalized and interactive user experience.

Except for the main purpose of a virtual exhibition, which consists in promoting and capitalizing the cultural heritage collections, a secondary goal is to allow visitors to discover alternative ways of exploring and browsing the cultural content.

In this way, visitors can experience navigation possibilities that cannot be found in a physical exhibition (Lepouras et al., 2004).

Many cultural institutions need a “helping hand” to accommodate the current technological revolution in order to take advantage of the facilities offered by modern I&CT. Not only I&CT tools and techniques are applied in the cultural sector, but also some marketing strategies. Virtual exhibitions involve the use of elements from multiple domains, including I&CT and marketing.

Virtual exhibitions will “generate” *virtual visitors* who are interested in learning more about the exhibits presented in the application, and, later on, some of them will become *real visitors* of cultural institutions. In this case, virtual exhibitions can be seen as a “business card” or catalog that can provide real cultural visitors with initial information about cultural institutions.

Real visitors who have been stimulated to discover more details about the exhibits presented in virtual exhibitions are determined to visit them and, therefore, they will be willing to pay entrance fees or the price to obtain copies or personalized objects with cultural objects. For example, the Rijksmuseum in Amsterdam offers personalized shirts or mugs with pictures of the well-known painters from their collections (Kreinberger, Thinnis & Timmermans, 2014). Such a business model means an increase in the income of cultural institutions, as well as an increase in the public image and in the number of real visitors. A mobile museum tour guide was implemented for Rijksmuseum in order to provide personalized visits based on the user position inside the museum and interests (van Hage et al., 2010).

If a *cultural heritage institution* (CHI) wants to make use of modern I&CT tools and techniques in order to implement one or more *virtual exhibitions* (VE), both as mobile and web applications, and decides to apply adequate marketing strategies to promote the cultural heritage collections, then the virtual exhibitions will generate virtual visitors / users which will become real visitors (RV) of the cultural institution. Finally, an increase in number of real visitors will generate an increase in terms of revenues for the cultural institution. A diagram of interaction between CHI, VE and RV is presented in Figure 1.

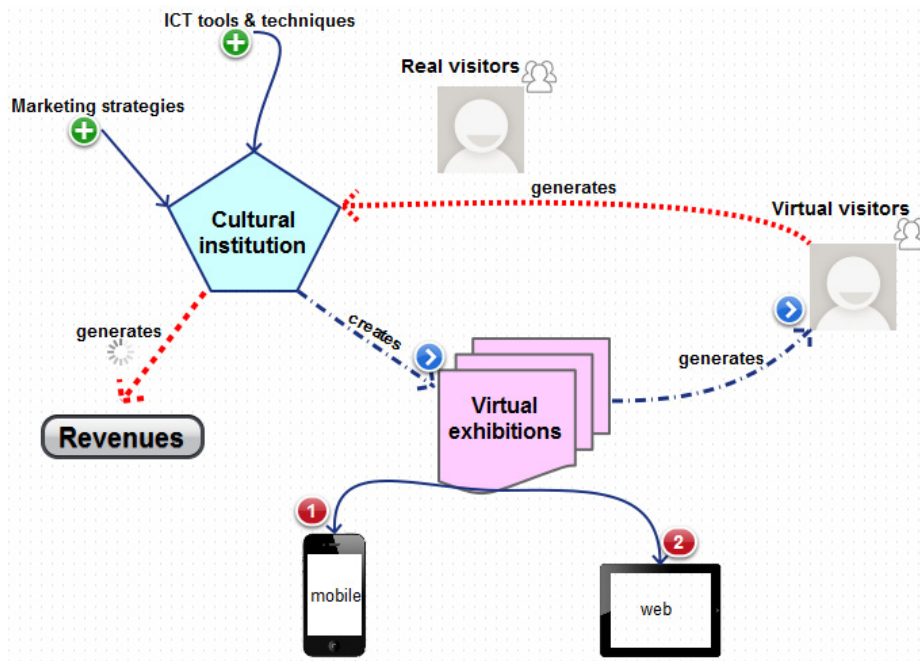


Figure 1. Diagram of interaction between CHI, VE and RV (Ciurea & Filip, 2018)

Nowadays, the increase in the number of web and mobile applications and expanding the use of information and communication technologies in all areas of activity have generated concerns about the analysis of users' behavior in online applications.

The analysis of visitors' behavior in a virtual exhibition is very important because it provides relevant information about the ease of navigation in the application, the public interest in certain exhibits or collections, the need to digitalize collections of the same category of interest.

4. Stages of Implementing a Virtual Exhibition

By applying I&CT tools and techniques to cultural institutions, attractive virtual exhibitions will be created in order to present the most interesting digital copies of the cultural objects. The virtual exhibitions can be designed and developed both as native mobile applications that are installed on mobile devices with Android, iOS or *Windows Phone* operating systems, or as web applications that can be accessed online from any computer connected to the Internet.

The steps required to develop a virtual exhibition differ depending on how the virtual exhibition is deployed, whether as a web application or

as a native mobile application. Both types of applications are described, based on the development cycle stages of an informatics application, taking into account specific objectives, input, activities, resources, techniques, methods, technologies and results.

4.1 Virtual Exhibition as a Web Application

In the situation of developing the virtual exhibition as a web application, available online and accessible from any computer or mobile device with an Internet connection, the following steps are required:

- **Step 1.** Choosing a theme of public interest, based either on a historical or cultural event, or on the presentation of special collections;
- **Step 2.** Selecting the most interesting cultural objects to be included in the exhibition and digitizing them, either by scanning or by shooting;
- **Step 3.** Processing the scanned images or photos using a specialized software tool (such as *Adobe Photoshop*) in order to reduce image size, increase brightness or contrast, for fast loading and for the proper use of the web pages;
- **Step 4.** Choosing the most appropriate descriptions of the cultural objects presented in the selected images to be included as

descriptive texts in the exhibition; if the virtual exhibition is carried out in more than one international language, it is necessary to translate those descriptions;

- **Step 5.** To increase the level of interactivity, it is recommended to include video clips or audio sequences in the virtual exhibition; these multimedia elements must be processed and saved in formats accessible from any device;
- **Step 6.** Selecting the most appropriate website template on which to build the virtual exhibition; the template must be self-adaptive (responsive), so that it adjusts the way the content is displayed according to the size and resolution of the screen; dedicated software tools, such as MOVIO, can be used or a website from scratch can be developed;
- **Step 7.** Changing colors and adjusting the presentation fonts of the website, which should be consistent with the theme of the exhibition, but also with the predominant colors of the images presented;
- **Step 8.** Including in the virtual exhibition the graphic and multimedia elements mentioned in the previous steps, as well as their corresponding text descriptions;
- **Step 9.** Choosing the most appropriate components (widgets) for presenting images, texts and multimedia elements in the exhibition, such as attractive image galleries, dedicated website templates, chronological presentation tools or geospatial representation tools of cultural objects;
- **Step 10.** Moving the exhibition to a dedicated web server to ensure visitor access at any time, from any location and any device connected to the Internet.

In the case of a virtual exhibition implementation as a web application based on the *MOVIO* platform (Natale et al., 2014), it is necessary to create and maintain a MySQL database and to have knowledge about the PHP (Hypertext Preprocessor) programming language, because *MOVIO* was developed using these technologies, similar as a *Joomla* content management system (CMS) (Ray & Ramesh, 2017).

4.2 Virtual Exhibition as a Native Mobile Application

In the case of implementing the virtual exhibition as a native mobile application running on mobile

devices with a dedicated operating system (such as *Android*, *iOS*, or *Windows Phone*), the following steps need to be completed:

- **Steps 1-5.** The same as in the situation of developing the virtual exhibition as a web application;
- **Step 6.** Choosing the operating system for which the mobile application is developed and setting the offered functionality, and also the limits of the application;
- **Step 7.** Designing the screens of the application, respectively the activities and controls included in each activity layout (buttons, menus, labels, text editing boxes, etc.); in the case of a mobile application, the design part is essential because of screen size limitations, as well as the modality in which the user interacts with mobile devices (touch screen navigation, swipe gestures, etc.);
- **Step 8.** Implementing the mobile application according to the design specifications from the previous step, using a development environment and a programming language specific to the type of the chosen operating system; in the case of a mobile application for the Android system, the Android Studio or Eclipse development environment and the Java or Kotlin programming languages can be used;
- **Step 9.** Including multimedia elements, images and descriptive texts within the mobile application in an attractive and user-friendly manner;
- **Step 10.** Publishing the mobile application to a dedicated application store (*Google Play*, *App Store*, or *Marketplace*) to make it available to users.

In both cases, user behavior measurement tools can be introduced in the virtual exhibition in order to extract statistics regarding the number of hits, the number of views of a particular cultural object, the degree of accessibility of all multimedia objects in the exhibition, etc. Very useful statistics about the visitors of a web application can be obtained by using Google Analytics.

5. A Comparative Analysis of Web and Mobile Implementations

Implementing a virtual exhibition means not only uploading and publishing images about cultural

objects in a gallery of images, but also creating an eye-catching software product for visitors.

As it has been described in the above sections, a virtual exhibition can be designed and developed as a web application or as a native mobile application, as these formats are the most popular based on the types of the devices used nowadays. Both formats have advantages and disadvantages, taking into consideration the development phases, the visitors experience and future maintenance.

Table 1 below presents the “plus” side (+) and “minus” side (-) of a virtual exhibition implementation as a web application using MOVIO and as a mobile application running on Android, based on five evaluation criteria.

As shown in Table 1, in the case of a web implementation using MOVIO, only the attainment of the platform, which is open source, is not enough, because a server configured to run the website and to keep a MySQL database

is needed. But, once the MOVIO platform is installed and configured, it is easier to add new features on the web application than in the case of a mobile application developed on Android. In the case of a mobile implementation based on Android, it is easy to install the development tools (Java platform, Android Studio, emulators), but there is not enough flexibility to add new features after publishing the application, because, in order to be reinstalled, an updated version needs to be delivered to the users.

The figures below represent two screenshots from the development phase of a virtual exhibition, implemented as a web application using the MOVIO platform. The virtual exhibition was implemented at the Romanian Academy Library together with eight other virtual exhibitions and all of them were published on the institution website.

Figure 2 shows the main administration page of the virtual exhibition developed under MOVIO. In this page, the administrator can easily add

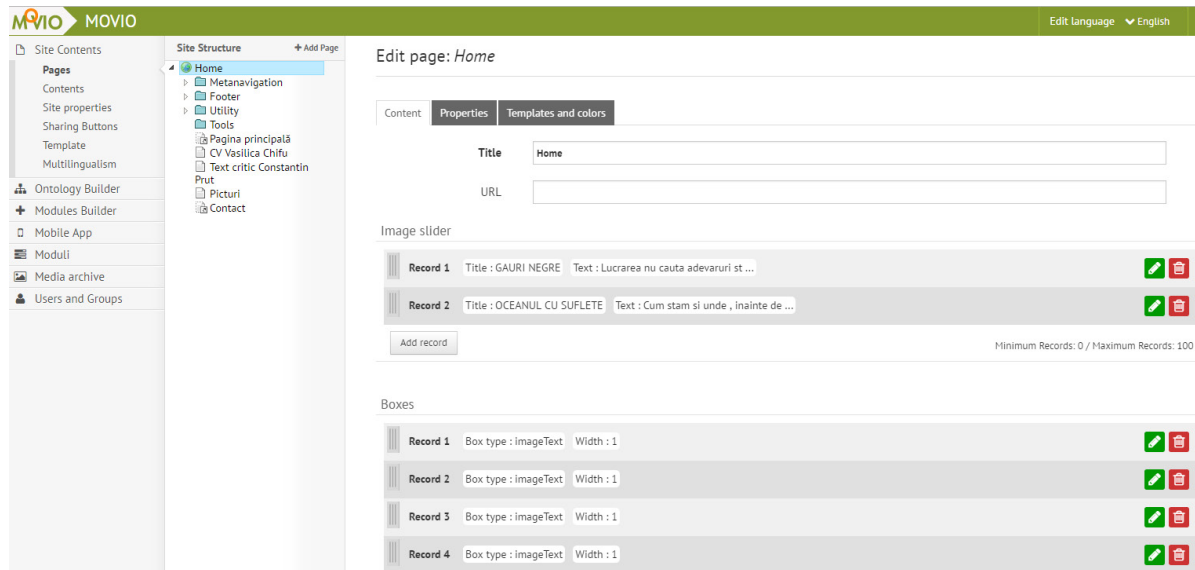


Figure 2. Home administration page in MOVIO

Table 1. Comparative analysis of MOVIO and Android implementations

No.	Evaluation criteria	web app (MOVIO)	mobile app (Android)
1	free available development tools	-	+
2	reliability and robustness	+	+
3	scalability and flexibility to add new features	+	-
4	security and data integrity	+	+
5	anytime and anywhere access	+	+

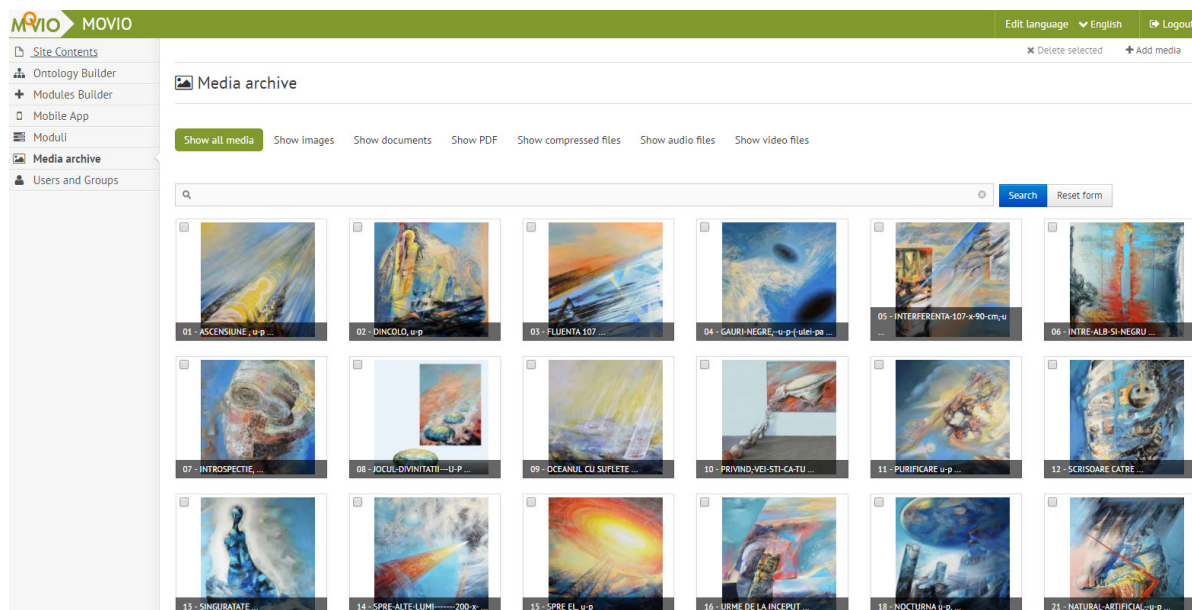


Figure 3. Gallery administration page in MOVIO

or remove new pages, resources, can configure the template of the application or can enable additional functionalities.

Figure 3 displays the gallery administration page of the virtual exhibition developed under MOVIO platform. The administrator can add or remove multimedia files, such as images or videos, and he can easily upload new resources by dragging and dropping them on this page.

When uploading new images in the media archive, the administrator should take into account the size of each image, the resolution, and the pages on which the image will be displayed, because each image must fit the dimensions of the pages and controls that display it. The images should not be of a high resolution, because they will necessitate more time to load the web pages of the application.

The most important advantage of implementing a virtual exhibition as a native mobile application is represented by the usage of all the features and hardware functionalities offered by a mobile device, such as the sensors for location, the accelerometer, the camera used to capture or scan QR (Quick Response) codes etc.

In the case of an Android mobile application, the implementation of a virtual exhibition involves the use of the internal file system to store specific data on the mobile device, and certainly the use of a SQLite database or Google Firebase

to store text, documents and images related to the exhibition.

Figure 4 illustrates the virtual exhibition entitled *Ferdinand I* and created in MOVIO, but seen on a mobile device, because it has a responsive interface that adapts depending on the screen size.



Figure 4. *Ferdinand I* virtual exhibition

Another interesting feature offered by a mobile application is the possibility to use *Google Maps* in order to display on the map images from collections belonging to one or more cultural institutions and to create a link between them, based on their geographical location on the map. For example, Figure 5 presents three cultural institutions (The Romanian Academy Library, The Romanian National Library and The National Heritage Institute), which preserve documents and images related to King Ferdinand I of Romania. A connection between these three institutions is made on Google Maps and a representative image is displayed on the map next to each institution.

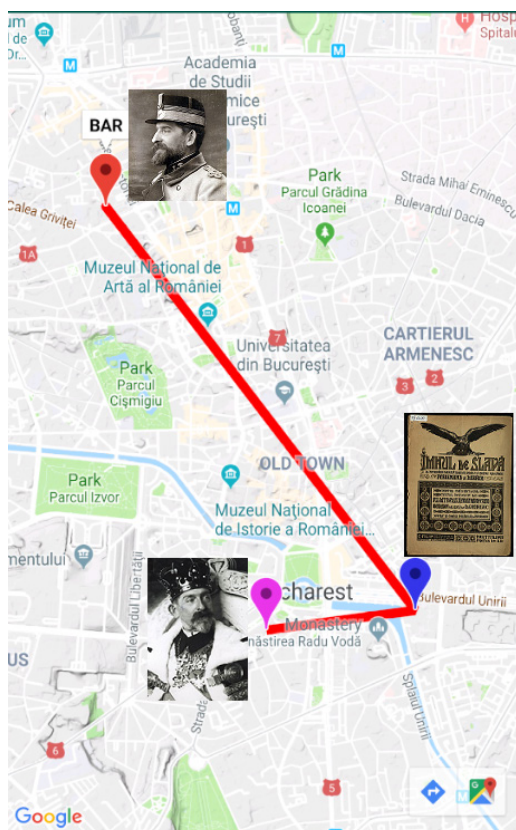


Figure 5. Cultural institutions connected on Google Maps

Establishing connections on the map between cultural institutions that preserve similar collections or cultural objects on the same topic is important, in order to see the geographical distribution of cultural collections. If a cultural institution intends to implement a virtual exhibition on a dedicated topic, it can borrow missing and complementary cultural objects (documents, pictures, paintings, textual fragments etc.) from nearby cultural institutions with which

it can collaborate. In this case, one can talk about a collaborative virtual exhibition created by two or more cultural institutions that collaborate and interchange complementary cultural collections.

A *collaborative virtual exhibition* is a particular case of a collaborative system. A detailed analysis of computer-supported collaborative systems based on the decision-making process is presented in (Filip, Zamfirescu & Ciurea, 2017), together with a dedicated platform that covers collaborative and group decision sessions, as well as individual decision sessions in a way that users on each decision stage are free to collaborate with other users.

6. Financial Aspects of Virtual Exhibitions Implementation

When a cultural heritage institution takes the decision to implement a new virtual exhibition, it must consider the implementation costs generated by hiring I&CT specialists or purchasing specific software tools and licenses. These costs should be covered by the cultural heritage institution or, if it can be applicable, by different sponsorships offered by private companies or NGOs (non-governmental organizations).

When the proposed business model is set and the virtual exhibition meets the need for trust at the market place (Mocanu, 2011), these costs will be covered from the entrance fees collected from new visitors and from other sources of payment, such as the reproduction rights.

Depending on the budget available for developing a virtual exhibition, the respective cultural institution can decide what type of implementation should be selected. In the case of virtual exhibitions that are implemented as native mobile applications, if a cultural institution needs to develop a mobile application for all the operating platforms (Android, iOS and Windows Phone), the costs will be higher than in the case of a single implementation.

If the exhibition is designed and developed only for a particular mobile operating system (for example, Android), then the target audience will be limited to users who have mobile devices with

that operating system. Users of other mobile operating systems may feel neglected because they cannot install and do not have access to the application. In conclusion, the solution is to create an application that can be accessed from any type of device.

Therefore, the virtual exhibition should be implemented as a multi-platform solution that can be accessed from any computer and from any mobile device. It consists of a web application with a self-adaptive interface. There are several interesting technologies that enable the design and development of such applications (for example SAP UI5) (Mukherjee & Mukherjee (Das), 2017).

Regardless of the type of implementation, costs may vary depending on many other influence factors, including the salaries of specialists, the degree of digitization of the cultural objects selected to be presented or other administrative costs.

7. Conclusion

The most important result of the present research is that the modern information and communication technologies can contribute to the development of the cultural sector as in many other human activities. It is expected that in the nearest future, the applications of I&C technologies in the cultural sector to be embedded into complex cognitive assistants meant to enhance the human performances

(Siddike et al., 2018) and, at same time, to improve the quality of life.

The central idea of the proposed model and the design methodology is that I&CT specialists will bring modern technologies to cultural institutions, which will contribute to the progress of cultural institutions, in terms of both cultural and economic development.

The current experienced technological revolution has radically changed several aspects of the existing domains of human activity, and therefore some of them have disappeared and others have been reinvented. In a future research, the manner in which the I&CT tools and techniques have influenced cultural institutions will be analyzed in detail.

The design and implementation of virtual exhibitions through the use of I&CT platforms and tools represents a various process that may include several decisions to be taken at different stages. There are several critical issues, both technical and non-technical, which should be considered. Among the main issues that could be problematic are the evolution of the technical constituents, together with the increased requirements of the customers for the quality of the solution. Criteria and multi-attribute decision models could be used effectively in solving the encountered decision-making situations (Filip, 2012; Ciurea & Filip, 2015).

REFERENCES

1. Alexandru, A. & Ianculescu, M. (2017). Enabling Assistive Technologies to Shape the Future of the Intensive Senior-Centred Care: A Case Study Approach, *Studies in Informatics and Control*, 26(3), 343-352, DOI: <https://doi.org/10.24846/v26i3y201710>
2. Borowiecki, K. J. & Navarrete, T. (2017). Digitization of heritage collections as indicator of innovation, *Economics of Innovation and New Technology*, 26(3), 227-246, DOI: <http://dx.doi.org/10.1080/10438599.2016.1164488>
3. Buciu, I. & Gacsadi, A. (2016). Biometrics Systems and Technologies: A survey, *International Journal of Computers Communications & Control*, 11(3), 315-330, DOI: <https://doi.org/10.15837/ijccc.2016.3.2556>
4. Ciurea, C. & Filip, F. G. (2015). Multi-Criteria Analysis in Choosing IT&C Platforms for Creative Digital Works, *Uncommon Culture*, 6(2/12), 21-27.
5. Ciurea, C. & Filip, F. G. (2018). Identifying Business Models for Re-use of Cultural

- Objects by Using Modern ICT Tools, *Informatica Economică*, 22(1), 68-75, DOI: <http://dx.doi.org/10.12948/issn14531305/22.1.2018.06>
6. Filip, F. G. (2012). A Decision-Making Perspective for Designing and Building Information Systems, *International Journal of Computers Communications & Control*, 7(2), 264-272, DOI: <https://doi.org/10.15837/ijccc.2012.2.1408>
 7. Filip, F. G., Ciurea, C., Dragomirescu, H. & Ivan, I. (2015). Cultural Heritage and Modern Information and Communication Technologies, *Technological and Economic Development of Economy*, 21(3), 441-459, DOI: <http://dx.doi.org/10.3846/20294913.2015.1025452>
 8. Filip, F. G., Zamfirescu, C. B. & Ciurea, C. (2017). Computer-Supported Collaborative Decision-Making, *Springer, Series Automation, Collaboration, & E-Services*, 216 pg, ISBN 978-3-319-47219-5, DOI: <http://dx.doi.org/10.1007/978-3-319-47221-8>
 9. van Hage, W.R., Stash, N., Wang, Y. & Aroyo, L. (2010). Finding Your Way through the Rijksmuseum with an Adaptive Mobile Museum Guide. In: Aroyo L. et al. (eds.), *The Semantic Web: Research and Applications. ESWC 2010. Lecture Notes in Computer Science*, 6088. Springer, Berlin, Heidelberg.
 10. Kreinberger, N., Thinnies, F. & Timmermans, N. (2014). White paper: Business models for tourism: Identifying business models for the re-use of cultural objects for tourism, *Austria: Europeana Creative*, Austrian National Library.
 11. Lepouras, G., Katifori, A., Vassilakis, C. & Charitos, D. (2004). Real Exhibitions in a Virtual Museum, *Virtual Reality*, 7(2), 120-128, DOI: <http://dx.doi.org/10.1007/s10055-004-0121-5>
 12. Mocanu, M. (2011). Sociological perspectives on financial auditing, *Actual Problems of Economics*, 126, 391-399.
 13. Mukherjee, S. & Mukherjee (Das), S. (2017). Integration with SAP MII, *SAP MII.*, 107-186, Apress, Berkeley, CA, DOI: https://doi.org/10.1007/978-1-4842-2814-2_6
 14. Natale, M. T., Minelli, S. H., Dierickx, B., Ongaro, P., Piccininno, M., Ugoletti, D. & Raggioli, A. (2014). Exhibiting Intangible Cultural Heritage using MOVIO: a multilingual toolkit for creating curated digital exhibitions. In *ICOM 2014 – Access and Understanding-Networking in the Digital Era: intangible Cultural Heritage* (pp. 1-16).
 15. Peng, Y., Kou, G., Shi, Y. & Chen, Z. (2008). A Descriptive Framework for the Field of Data Mining and Knowledge Discovery, *International Journal of Information Technology & Decision Making*, 7(4), 639-682, DOI: <https://doi.org/10.1142/S0219622008003204>
 16. Radulescu, C. Z. & Radulescu, M. (2018). Group Decision Support Approach for Cloud Quality of Service Criteria Weighting, *Studies in Informatics and Control*, 27(3), 275-284, DOI: <https://doi.org/10.24846/v27i3y201803>
 17. Ray, A. K. & Ramesh, D. B. (2017). Open Source Software (OSS) for Management of Library and Information Services: An Overview, *International Journal of Library and Information Studies*, 7(2), 20-31.
 18. Shi, Y., Lei, M., Yang, H. & Niu, L. (2019). Diffusion network embedding, *Pattern Recognition*, 88, 518-531, DOI: <https://doi.org/10.1016/j.patcog.2018.12.004>
 19. Siddike, MD A. K., Spohrer, J., Demirkan, H. & Kohda, Y. (2018). People's Interactions with Cognitive Assistants for Enhanced Performances. In *Proceedings of the 51st Hawaii International Conference on System Sciences* (pp. 1640-1648), DOI: <https://doi.org/10.24251/HICSS.2018.205>

