

# Process Innovation for Cultural Heritage digitalization and valorisation

Angelo Corallo<sup>1</sup>, Marco Esposito<sup>1</sup>, Giovanna Mangialardi<sup>1</sup>, Laura Schina<sup>1</sup>

<sup>1</sup> *Department of Engineering for Innovation, University of Salento, Italy, via per Monteroni s.n.,  
angelo.corallo@unisalento.it, m.esposito@unisalento.it,  
giovanna.mangialardi@unisalento.it, laura.schina@unisalento.it*

**Abstract** – This paper aims to show a case of process innovation, based on the design and development of an ICT platform named “DiCeT Archeo”, based on the Rudiae Archaeological Site located in Lecce (Italy). The main purpose of the study is to bring process innovation within the Cultural Heritage Lifecycle, focusing on cultural resources with a significant economic value, as for example in terms of tourist spending. The methodological approach includes the modelling of the processes involved in the data collection, from the phase of survey to the valorisation, to provide a new method for the exploitation of the Cultural Heritage, considered as a complex, heterogeneous and still fragmented sector. The main innovation of the methodology consists in the application of techniques widely applied in the manufacturing and business domains, on the archaeological domain.

## I. INTRODUCTION

Nowadays, Process Innovation for Cultural Heritage digitalization and valorisation can be considered a requirement as well as a chance. The deep knowledge of this heritage, enabled by the usage of innovative technologies, could represent the key for systematizing the overall process of cultural asset management. In detail, this process renewal is particularly required in the archaeological field, where the times to make the community aware of the research results are always very long and the costs of the interventions are very high.

Starting from this assumption, this paper aims to present the development of an innovative multimedia platform based on a process modernization, named “Dicet Archeo” and realized by the Core Lab, a research laboratory of the Department of Innovation Engineering, University of Salento, in collaboration with A.R.Va - Archeologia Ricerca e Valorizzazione Ltd., in the scope of the DiCeT – INMOTO project.

The main objective of the Dicet Archeo platform is to bring process innovation within the lifecycle of an object of cultural value, as for example an object that may generate significant economic value in terms of tourist

spending. The methodological approach adopted in developing the platform has included the modelling of the processes involved in data collection, which means all the activities from the phase of survey until the valorisation phase, passing through the storage phase, proposing an innovative methodology for the exploitation of the Cultural Heritage, considered as a complex and heterogeneous sector that is still fragmented.

The first step was to define a set of standardized procedures to validate the operations of the Cultural Heritage digitalization, in the view of compiling technical models for an efficient resource management. The application of the Business Process Management (BPM) approach allowed the redefinition and the automation of the activities for the whole process optimization and enhancement, starting from the definition of the different phases.

The processes have been modelled based on a real archaeological excavation considered as a Test Bed, the Rudiae Archaeological Site. The processes are scalable on different type of cultural or architectural resources because of the similarity of the related operations, providing a standard methodology for Cultural Heritage digitalization and valorisation processes. Furthermore, the application of the Social Network Analysis (SNA) allowed identifying the players involved and their existing connections.

Basing on such processes definition, a detailed study about the emerging technological solutions for Cultural Heritage valorisation has started. The idea of developing the Dicet Archeo platform came out from these studies. The application has been tested using data coming from the archaeological activities carried out within the Rudiae Archaeological Park, in Lecce, also following the DiCeT project guidelines. Indeed, the valorisation of Rudiae is one of the priorities within the redevelopment projects in western suburban boundary of the city of Lecce.

In details, DiCeT Archeo is a platform composed by an iOS app (the front-end), which is dedicated to the fruition of cultural contents, and by a web application (the back-end) for the data entry and cataloguing. DiCeT Archeo offers an innovative way to enjoy and, at the same time, to exploit cultural resources by integrating data and information coming directly and real-time from the

archaeological excavation site. At the same time, the platform enables an innovative way to document the Cultural Heritage, designed to automate the storage and aggregation of contents into Points of Interest that can be explored by users through the iOS app. The POIs appear on the archaeological excavation site map shown by the application, by scrolling a sidebar that represents the time dimension of the archaeological excavation operations (with updated contents). Each POI appears exactly when the sidebar is positioned in a point that represents the time of the POI discovery, making available to the user all the information about such POI with a user-friendly interface.

The Web Application is in line with the need to simplify and systematize the data collection and storage in the archaeological context; furthermore, it has been realised basing on the logics belonging to the classic stratigraphic archaeological documentation methodology. The back-end allows, through a user-friendly interface, to create and manage the whole documentation related to the archaeological operations (images, maps, geo-referenced orthophotos, etc.). The data entry can be performed directly on the site, simultaneously with the operations, enabling the real-time selection of the information to make it available to the end user.

This research, started from the "As Is" definition, of the archaeological process, aims to integrate BPM and SNA approaches to optimize processes, by proposing a new platform that benefits from the data systematization for implementing a new strategy of community engagement during the whole cultural heritage process management. The paper is organised in five sections, including the introduction (section 1). The section 2 presents a brief review of the background focalized on the cultural heritage digitalization and valorisation. The section 3 introduces the research settings and method. The section 4 presents the Dicet Archeo Platform, describing the design and development phases, and finally, the section 5 presents the main findings and conclusions, including a discussion on the challenges identified and on future developments.

## II. BACKGROUND. CULTURAL HERITAGE DIGITALIZATION AND VALORIZATION

Over the last years, the issue of Cultural Heritage management and valorisation has grown in importance in the context of the regional development policies. In Italy, the Cultural and Creative Production System (cultural industries, creative industries, historic and artistic heritage, performing and visual arts, and creative-driven production) produce 6.1% of wealth (i.e. 89.7 billion euro). In addition, for each euro raised in the cultural sector, 1.8 euro are raised somewhere else. Those 89.7 billion euro thus stimulate the creation of other 160.1 billion euro, which gives us 249.8 billion produced by the whole sector, i.e. 17% of the national added value. The main beneficiary of such productive process is the tourism sector. The cultural production system creates

(i.e. regardless of the jobs created in other sectors of economy) 1.5 million jobs to people, 6.1% of total employment in Italy [1].

Cultural heritage data and resource management presents dynamics not so far from other industrial sectors; the main difference can be found in the poor development of such dynamics within the Cultural Heritage context, which remain prerogative of the academic knowledge of experts [2].

In particular, the issue of knowledge management in archaeological processes is relevant, because the cultural heritage valorisation process is strictly related to the correct management of informational flows. The adoption of a new managerial approach to the cultural heritage lifecycle, with the technological support, could allow the identification of innovative methods for related management and fruition.

During the archaeological process, the cultural resource is discovered, catalogued and, then, stored, therefore these processes represent the cultural heritage lifecycle phase when all the related information are properly gathered and stored. The knowledge management in the archaeological process can be optimized through the digitalization of data, whose properly utilization strongly depends from their analysis and interpretation [3].

The Product Lifecycle Management (PLM) approach is based on the application of technological solution to create, manage and keep all the information circulating throughout the lifecycle processes of a given product [4]. In the manufacturing sector, the adoption of the PLM is mainly focused on the improvement of *time-to-market*, productivity and control [5]. In the cultural heritage sector, characterized by the collaboration among different actors communicating each other, and where there is a direct connection between the information producer and the potential users, the PLM approach properly works on the information management [6].

The benefits deriving from a proper and integrated management of Cultural Heritage digital information are also stated from the European Parliament: "The digital shift is having a massive impact on how cultural and creative goods and services are made, disseminated, accessed, consumed and monetised. These changes offer great opportunities for the European cultural and creative sectors. Lower distribution costs, new distribution channels and new opportunities for niche products can facilitate access and increase circulation worldwide." [7].

Starting from these considerations, it is possible to assert that the proper understanding and management of the processes along the Cultural Heritage lifecycle is particularly important because it fosters the standardization of procedures and activities that produce data output. Furthermore, it allows the identification of both the involved actors and the criticalities in the procedures, which would be otherwise hard to identify. Moreover, the proper management of the informative flows allows to immediately turning them into assets to be enhanced.

The application of the Business Process Management

(BPM) approach ensures the enhancement of operational standards and improves data management [8]. Hervy et al [2] recently proposed the application of PLM in the management of historical and artistic knowledge in museums. The increase of available cultural knowledge is the main motivation that makes necessary the adoption of a PLM system inside museums. In the manufacturing sector, the adoption of the PLM logic is mainly focused on the capability to increase time-to-market or the efficiency of the intervention, and to rise the control, security and safety of processes and activities [5]. In the cultural heritage sector, where many different actors communicate, this approach properly works in terms of information management [6].

Starting from this literature review, this paper aims to present the development of an ICT platform (Dicet Archeo), based on a process innovation integrating different interdisciplinary approaches. The collaboration between archaeologists and engineering researchers produced one of the first examples of archaeological processes mapping, through which identify where to insert new technology solutions for data collection and interpretation. Such a solution was the starting point for the development of an innovative and interactive system to valorise the Cultural Heritage, contextually with the operations of archaeological excavation.

### III. METHODOLOGY

This work is part of the DiCeT-Inmoto project and arises from different assumptions in the field of the archaeological research that consists of activities involving a variety of methodological approaches.

Briefly, the main problems lie in the existing gap between the technical archaeological investigations, and in managing the shift from data and information to outcomes and findings, useful to increase the knowledge base of other stakeholders including the public at large.

In this sense, the most suitable solutions consist of technological tools for the data management, acquisition and elaboration, in order to support the real-time data encoding with the consequent distribution of information in a short time.

These tools and methods are the basis of the methodology and support the implementation of the case study.

The method comprises three different phases, aimed to collect the main users' requirements, and addressed to design and implement the solutions in line with the expressed expectations (Fig. 1).

The first phase aims to collect data and information from a group of archaeologists of A.R.Va s.r.l, a spin-off of the University of Salento, in order to be able to recreate the logical pattern of operations of the archaeological site lifecycle. This phase was useful to identify the existing operations and to define the main activities carried out in order to define the main functionalities of the back end of the proposed technological tool.

The second phase refers to the application of the Business Process Management (BPM) approach to provide a

snapshot of the current situation (AS-IS) and to identify improvement and changes (TO-BE), in terms of activities carried out.

The third phase consists in applying the Social Network Analysis (SNA) to identify the players involved and the existing connections, taking into account that the main holders of the knowledge are the same actors of the communication exchange.

In general terms, it is widely recognized the importance of the Social Network Analysis (SNA) as powerful diagnostic method to analyse the nature and pattern of relationships among members of a particular domain. One means of understanding knowledge flows or bottlenecks that slow down business processes, is 'mapping' the relationships between employees, with whom they communicate and how often [9].

According to Burt, 1992 [10], social network is a group of collaborating entities (e.g., persons, organisations, etc.) related to one another. In this aim the use of SNA allows to analyse and revisit the information and communication flows between the actors involved in all lifecycle phases of archaeological excavation (deeply defined with the BPM approach), with consequent insights for future improvements.

Based on the analytical phases, previously mentioned, we were able to provide the insights for the optimization of processes, activities and routines, to identify strengths and weaknesses of the existing network, and to support the improvement of the flow of information through the

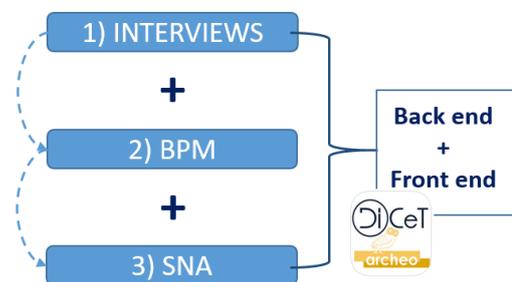


Fig. 1. Methodology

creation of a virtuous cycle of knowledge co-creation and sharing, based on the ICT solutions.

The integration of these three techniques allows improving the study with different levels of analysis in order to identify the general context (technique 1), the representation of the operational environment (technique 2), and the linkages among actors playing different roles along the overall lifecycle (technique 3). Each phase has been essential to enrich the analysis with complementary data and information. Indeed the first phase "Interviews" aimed to collect a set of rough data from the experts, in order to understand the operational context and starting to identify the existing relations among the actors. The consequent application of the BPM approach (phase 2) allows providing a more technical perspective both in terms of operations and actors involved. This second

phase is able to deepen and complete the study, and to define the potential relations with the external environment.

Finally, the SNA technique was useful to increase the previous understanding and to structure the network of actors in order to better understand the different roles and provide insights to optimise the informational and communicational flows to improve the overall archaeological lifecycle.

The integration of the phases described above, led to the definition of the DiCeT Archeo platform, both in terms of technological requirements and functionalities, and of appealing interfaces. The platform includes an iOS mobile application (front end), dedicated to the fruition of cultural contents for the public at large, and a web application (back end) for the data entry and cataloguing from technical personnel, as will be described in the next section.

#### IV. SOLUTION. DESIGN AND DEVELOPMENT

Once the methodology was defined, the new issue was the implementation of the suggested solutions mainly focused on how to transfer the amount of information to a wide audience in a functional and immediate way.

Thanks to the Business Process Management approach, it was possible to identify all the activities generating data and information, and putting them in valuable processes, in order to find the best way to improve such processes by integrating the extended network and the digital technologies, in order to make available in real-time all collected data. Starting from the opportunity to make immediately available the digitalised cultural heritage, the choice was oriented to develop a technological solution able to immerse the final user within the archaeological processes, giving him an active and interesting experience based on the everyday life aspects of an archaeologist, as the wonder for a new discovery. At the same time, the application would facilitate the daily data collection, overcoming the limits of the classical analogue approach (pen and paper).

Once identified the sequential steps, it was time to face a new dilemma: “how to insert new technologies in process without interfere with the flow of operations? In this sense, through the process modelling, it was possible to identify the most appropriate modification, in order to manage the collected data by means of the new technological solutions.

The next step was to select what kind of new digital data to collect (footage of the operations, daily aerial photos of the excavation area, chronicles of the activities with movies and photos, interviews with the archaeologists, etc.) and to further modify the processes with the new data collection activities. The result was an enhanced process model with a strong orientation to cultural dissemination.

Finally, the design of the technology solution started. It consists of a data collection smart system (Web Application) that allows archaeologists to collect data

directly on the field and contextually with the archaeological operations. Such data can be used for dissemination purposes through a Mobile App for iOS systems.

The solution has been implemented on a Linux system on which a Database MySQL had been previously installed. The database is managed by two systems, Apache Web (PHP) and Apache Tomcat (Java). The Apache Web system communicates with the Web Application (backend), the Apache Tomcat (Java) communicates with the Mobile App (Fig. 2)

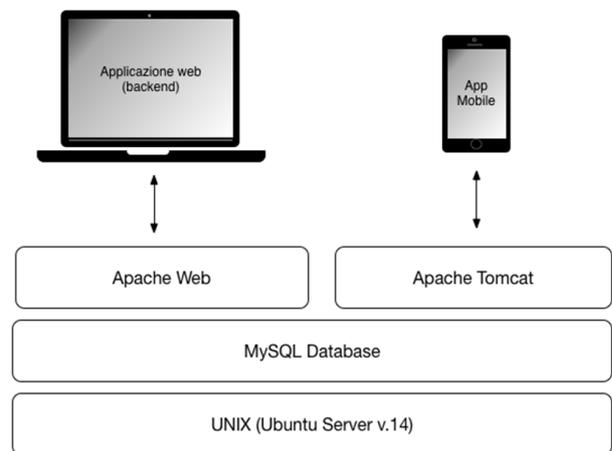


Fig. 2 Technology Solution Architecture.

A data model has been designed according to the logic suggested by the archaeologists during the phase of interviews.

The Graphic User Interface of the back end has been designed in order to be as similar as possible with the paper documentation currently used by the archaeologists (Fig. 3)

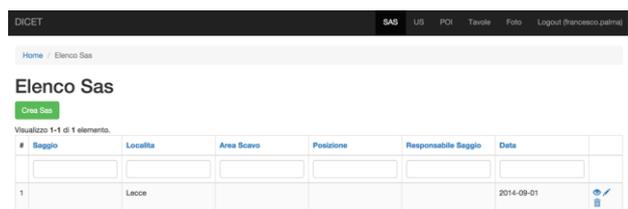


Fig. 3 Screenshot from the web application.

Such a technological solution, called “DiCeT Archeo” (Fig. 4), has been developed for dissemination purposes (Panarelli et al, 2016) [11]. It is available for iOS systems, but it can be easily translated for Android ones. The application aims to reproduce the everyday life of the archaeologists in the context of an archaeological excavation, focusing both on social and professional aspects.



Fig. 4 App logo



Fig.5 Screenshot from the app representing the aerial view of the excavation area with the timeline scrolling bar and a visible Point of Interest.

When the application starts, the first screen is the aerial view of the excavation area (the Rudiae Amphitheater archaeological excavation) (Fig. 5). On the bottom of the screen, there is a sliding bar representing the timeline, which can be scrolled by the user in order to see how that specific area has changed during the archaeological operations. In addition, some Points of Interest (POIs) appear on the map by scrolling the bar, in relation to the time of finding. The archaeologist can create a POI using the web application in order to add a piece of history with added value for increasing the user experience. Some examples of interesting events can be the finding of a statue, the discovery of an archaeological evidence, the finalization of a restoration, the evidence of a funny occurrence, etc. The scope of these animated Points of Interest is to let the user “living” the archaeological excavation through the eyes of a real archaeologist,

enjoying both historic and human related aspects.

## V. FINDINGS AND CONCLUSION

The use of innovative models for in-situ digital organization of the archaeological excavations data represents an opportunity to valorise unexpressed value, with important enhancement potential of the studied asset. The study reported the main research methodological phases, and the technologies and services developed for the management and sharing of multimedia data for the community.

An important result is the definition of an integrated and unified methodology leading to the identification of repeatable digitalized procedures built on the basis of a direct comparison with the actors of the process, tested in a real case.

In this way each process can evolved from the current model (single-digitization, no structured documentation of digitization modes, little potential for the re-use of intermediate digital products) to a new one. The new model is based on an innovative technological and methodological platform (full documentation of the digitalization process, wide reusability of digital resources, etc.), allowing also the introduction of new opportunities of economic valorisation of the result of digitization procedures linked to the archaeological heritage.

These results are also scalable in other cultural contexts.

Another important result is the direct use of the cultural data, produced by the content storage automatization that will populate the application. This implicates in a shortening of time and greater dissemination of results, which can also be consulted remotely.

The next steps will focus on enriching the data entry functions and on implementing the support to vector graphics and the interoperability with several types of digital sources, with the main aim to provide the end user with an environment of “augmented reality dynamically updated”.

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