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THE DIGITAL TRANSFORMATION OF THE MUSEO EGIZIO

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Abstract:

The project of the digital transformation of Museo Egizio di Torino started in response to the rapid change of its structure and needs. The project is centred on the integration of heterogeneous information and data to implement collection management, conservation and research workflows. This paper presents the concept and design of a management system, called SiME (Sistema Museo Egizio) that the Museum conceived in collaboration with Politecnico di Milano. The project is intended not only as a mere acquisition of technological tools, but rather as the construction of an integrated system that facilitates dialogue and connections between all museum activities, from daily management to research, from the design of installations to the generation of multiple possible narratives. Considering the pace of technological innovation a solid methodological approach has been adopted to ensure the longevity of the designed solutions from a long-term perspective.

Keywords: digital innovation strategy, collection management, archaeological data, workflows management, museum

1. Introduction: the cultural and socio-economic framework

Museums aim at preserving cultural identity and collective memory as well as interpreting and communicating their meanings to wide and heterogeneous audiences. By their nature, they are open and dynamic places that encourage, promote and host the interaction between objects, researchers and audiences.

The Museo Egizio di Torino, a bicentennial institution profoundly renewed in 2015, is an archaeological museum and research centre focused on socio-cultural topics.

To support the development of the Museo Egizio, the elaboration of a digital innovation strategy has been identified as necessary. It is intended not only as a mere acquisition of technological tools, but rather as the construction of an integrated system that facilitates dialogue and connections between all museum activities, from daily management to research, from the design of museum installations to the generation of multiple possible narratives.

Therefore, the switch provided by the digital transformation would significantly act on two main aspects:

a) The possibility to overcome the de-contextualization of the collection's objects (typical problematic issue of archaeological museums) through innovative ways of managing and visualizing data and information.
b) The implementation of the interaction strategies with the public.

The proposed project, in line with the general mission of the Museum, aims to replace all outdated software and to fully exploit the capabilities of the tools already in use to address the heterogeneous needs of the Museum.

Furthermore, the current socio-economic context makes the project even more relevant. The global Coronavirus crisis has had an unprecedented impact on cultural institutions and, specifically, museums all over the world. Most museums around the globe are now closed (93%) and report a considerable loss of income of 75-80%, with larger museums and the museums in tourist areas losing between 10.000 and 600.000 Euros per week, depending on their dimension (NEMO, 2020).

Regardless, the current crisis may represent the chance to re-design the relationship between material and immaterial culture: museums will need a more flexible interplay of the onsite/online public engagement by harmonizing digital and material experience of cultural heritage as complementary phases of the same dissemination process. This means, in practice, connecting a large mass of data and information: in this respect, the proposed digital transformation of the Museum will play a crucial role (Fig. 1).

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Figure 1: The metaphoric depiction of the digital transformation of the Museo Egizio involving collection, workflows and building management. Image source: Authors.

2. Planning the Digital Transformation

2.1. The *as is* analysis and the Museum needs

The digital transformation of Museo Egizio di Torino is necessary to fill the gap between the available software equipment and the Museum's needs. On the one hand, the rapid increase in the number of employees requires new tools to coordinate their tasks as well as new tools to manage the growing material produced by the Museum research activities. On the other hand, technological development offers a growing number of tools to be potentially used to enhance both the collection and the work that is being carried out on it in a coordinated and organic manner.

The digital transformation process started by identifying three main needs of the Museum:

a) Improve the Collection Data Management;
b) Facilitate the coordination between departments;
c) Guarantee the security of the data over time.

Regarding the improvement of Collection Data Management, the following needs have been identified:

1) Simplify and make access to data more user-friendly;
2) Collect, connect and consult the new material produced (i.e. photogrammetric data, data relating to the logistics of the museum objects, digital material resulting from conservation work and physical-chemical analysis);
3) Prevent employees from wasting time on unnecessary paperwork;
4) Online access to the Collection data;
5) Encourage smart working activities (a latent necessity that exploded during the Covid19 pandemic);
6) Promote the sharing of the research results among researchers from other museums and academia;
7) Avoid loss of money and efforts in the development of non-interoperable applications;
8) Improve Museum attractiveness towards a younger audience;
9) Increase the digital skills of employees to seize the opportunities provided by new technologies and spread the culture of innovation.

About the coordination between employees of the Museo Egizio, the project aims at promoting dialogue and collaboration between Museum departments.

Finally, concerning data security, Museo Egizio di Torino needs to:

1) Limit as much as possible the risk of loss of digital material;
2) Comply with the most up-to-date security criteria regarding data sharing.

2.2. The goals of the digital transformation project

To implement the proposal, the needs listed above have been translated into a list of measurable goals, which include:

1) designate a technological partner capable of supporting the museum in digital choices and of helping it to foresee future trends and to focus all efforts in a consistent strategy;
2) collect and catalogue the huge amount of multimedia data into a new Collection Management System, strictly web based; in which almost every paperwork could find a place and be transformed into a digital online procedure;
3) implement an IT infrastructure capable of supporting smart working;
4) plan a "cold" backup for all the data owned by Museo Egizio on cloud infrastructure;
5) schedule training courses to push collection managers and curators to the use of digital systems.

2.3. Actions needed

The project of digital transformation requires the completion of various actions on the fronts of the archive, of the shared tools and of the IT infrastructure (Fig. 2). The actions will directly involve all sectors of Museo Egizio.

Concerning the development of the Collection Management System of SiME, the following actions are envisaged:

1) Review the cataloguing method of the museum collection, starting from a study on the ontology;
2) Map workflows and multimedia material that employees want to manage within the new Collection Management System;
3) Develop an ad hoc document system that is more in line with the needs of emerging professionals and that allows the archiving of the large (and growing) amount of data resulting from their research activities;
4) Develop simple Application Programming Interface (API) protocols to allow third-party applications to use the collection's data;
5) Create an open interoperable section in the Management System accessible to researchers and scholars.

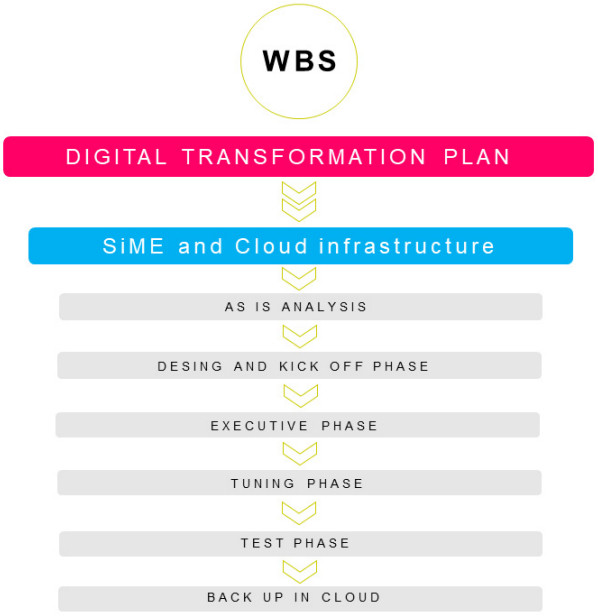

Figure 2: Diagram of the Work Breakdown Structure (WBS) for the SiME development. Image source: Authors.

Concerning the Cloud infrastructure, the following operation is envisaged:

1) Purchase and set a cloud backup service for all collected data. The service should complement the backup that already takes place on the servers in situ;
2) Build a solid IT infrastructure to host SiME.

3. Methods and approaches

Considering the pace of technological innovation a solid methodological approach has been adopted to ensure the longevity of the designed solutions in a long-term perspective. The identified methodological approach allows reducing the risk of developing incoherent solutions and tools without a holistic vision. Below is a detailed list of the methods and approaches that have been adopted.

3.1. Bottom-up approaches for knowledge and critical analysis of the *as-is* situation

The needs of the different departments of the Museo Egizio di Torino were identified thanks to a survey conducted through targeted interviews with 32 employees (out of 54).

3.2. Digital transformation approach

Museo Egizio charged Politecnico di Milano to support the Museum in the digital transformation process.

In the very first steps of the project, the team of Politecnico di Milano carried out focus group and individual interviews identifying and collecting all the needs and requirements to later translate them into concrete objectives.

Then, the team of Politecnico di Milano supported the Museum in the definition of the most appropriate and customized technological solutions to be developed by a technological partner.

3.3. Technological partner selection

The partner has been identified in the Piedmont area, thus reducing assistance times and costs. The selection criteria considered the following strengths: small and medium digital agencies with great skills in developing high-tech IT solutions, designing visual experiences, strong forecasting capabilities on digital trends and proactivity in solving current or upcoming problems.

3.4. Innovative approach for the implementation of the SiME Collection Management System

3.4.1. Analysis of the archiving system in use

The organization of the data in the old management system will not be completely replaced. At the time of writing this article, the old management software is being studied to understand how the fields were used and what were the problems encountered during the data entry. To carry out this study, the team of Politecnico di Milano is working closely with the curators and collection managers of the Museo Egizio.

3.4.2. Collaborative approach for the study of ontologies

In this project, it was necessary to select some categories and subcategories among all the others to cluster the objects and to simplify the search within the database. Therefore, a shared effort will be required from all editors to produce a table of relationships among the input fields. This will allow the software engineer to add alerts and controls at the same time as the data entry in the management system.

This operation will be carried out by the entire team of curators coordinated by a professional with extensive skills in archiving.

3.4.3. Testing approach

Professionals not directly involved in the digital transformation project will be selected for each department to complete some activities on the Collection Management System among those carried out daily. The testers will then be asked to comment on the aspects that they would like to change or that they do not find intuitive or immediate.

4. Workflow interested by the SiME development

The main challenge in the project development is the integration of most of the processes including their checkpoints as well as the integration of data.

Below are reported the processes that will be most affected by SiME:

- Conservation and restoration of the collection objects;
- Design and schedule temporary exhibition;
- Chemical-physical analysis on the Museum collection;
- Visual query builder;

- Organization of multimedia and photographic material;
- Interdepartmental digital communication.

4.1. Conservation and restoration of the collection object

Concerning the conservation issues, the project acts on two main aspects: the condition reporting and the archival of digital files produced by objects' analysis. Both aspects are relevant for both managing conservation actions and insurance issues.

SiME will implement the semi-automatic production of the condition report and legal documents needed to loan collection objects (i.e. in case of temporary exhibitions) or to move them outside the Museum (i.e. in case of conservation works).

4.2. Design and schedule temporary exhibition

The workflow needed to plan and design temporary exhibitions will benefit from the objects' calendar interconnection that will define in real-time position, planned loans, state of conservation and restorations planned. This will avoid the overlap of loans allowing at the same time to gain useful information for the exhibition design according to the conservation conditions of each object.

4.3. Chemical-physical analysis on Museum collection

Non-destructive analysis and sample analysis will benefit from a standardization of the data entry process.

It will be possible to keep track of all the material sampling interventions made on each object with an indication of the type of analysis carried out. This approach will avoid overlapping analysis.

4.4. Visual query builder

SiME will implement a complex query builder system for the consultation of the information in a simple visual way. A visual query system will allow users to interrogate the digitized objects interactively.

4.5. Organization of multimedia and photographic material

The development of SiME will radically change the data research and retrieval process. SiME will allow the storage and management of 3D data such as point cloud, geometric 3D models, 3D animation, video, VR, AR and XR products. This will affect the collection management department, the curators' department as well as the communication and marketing department actions (i.e. in the ADV online and offline activities, the social media communication, press and digital visual communication).

4.6. Interdepartmental digital communication

The creation of a single interconnected system (SiME) will allow both to speed up and facilitate individual processes and to connect the workflows of each department.

5. SiME's modularity and the Satellite applications strategy

The modularity of the SiME system will be guaranteed by its internal structure, which will allow the expansion of the platform through satellite applications, thus extending its functionality and display methods. Also, the flexibility of SiME will allow future changes according to the new needs of each department of the Museum (Fig. 3).

All satellite applications will refer, for data exchanging, to a centralized database, shared with SiME. All these applications could only be released once the development of SiME will be completed, the end of the works is expected by November 2021.

An example of a satellite application is CURA, which will integrate different tools to carry on conservation processes including the condition report tool (that will register the conditions of each museum's object) and the conservation tool (that will allow to record all the multimedia files acquired for documentation and conservation purposes).

6. Technical solutions adopted

The technological solutions provided concern both hardware and software equipment.

6.1. Cloud infrastructure

6.1.1. Hosting on external virtual machines

Concerning the hosting of the SiME, the aim is to move to an external cloud infrastructure to delegate the maintenance and performance control operations outside. The advantage of this solution is the scalability of the hosting of SiME.

At its fullest potential, SiME will involve three virtual machine services dedicated respectively to the following applications:

- Core software;
- Frontend software;
- Database.

6.1.2. Backup in cloud

The Museo Egizio selected a 'cold' hybrid cloud backup solution integrated with a 'hot' backup solution, already in use. This solution will be implemented through the Microsoft Azure Blob archive service.

6.2. SiME collection management software solution

Concerning the collection documents, recently there has been a change of direction in the software market for Saas (Software as a service). The strong competition between large software houses such as Microsoft and Google led to the development of software applications that can be easily integrated with custom software solutions. This condition has given new impetus to the creation of *ad hoc* software that meets the needs of customization, maintenance and reliability of the software over time.

With this in mind, we have chosen to develop an *ad hoc* system for the collection's documents which includes the software solutions described below.

6.2.1. Web-based

It allows consultation through any remote browser instead of inconvenient installations of limited software licenses.

6.2.2. Query builder

It allows users to query the database in a user-friendly mode and save the outputs of complex searches.

6.2.3. Image navigator and real-time collaboration

It allows the exploration of very high-resolution images with Google Maps like algorithm through the zoom function.

It also allows real-time collaboration through tags and comments that can be placed directly on the image of interest. Multiple researchers can remotely work on the same file by sharing their comments to speed up the study and research activities.

6.2.4. JSesh library

The integration of JSesh allows the editing of hieroglyphic texts as a sequence of symbols in .png format and transliteration into digital text according to the *Manuel de Codage* standard. The Turin Papyrus Open Platform (TPOP), the platform dedicated to Papyri, is already using the JSesh engine for transliteration and the creation of glyphs in image format.

6.3. Management of permissions and users

SiME administrators will be able to create users with different profiles for accessing the database, this will allow curators to manage external users' permissions.

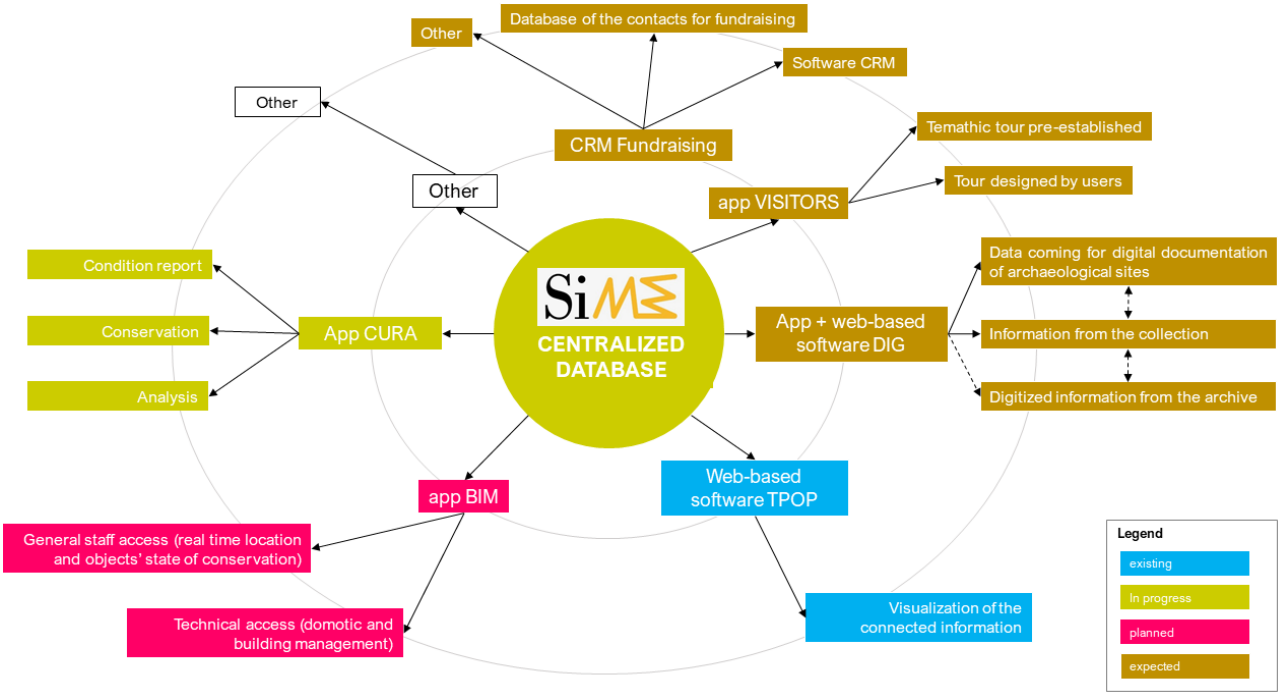

Figure 3: The figure illustrates the satellite applications connected to the SiME system. Image source: Authors.

7. Expected deliverables

The deliverables expected by the digital transformation, in a temporal framework of 15 months, are the following, classified into two macro-area of interest.

7.1. Cloud infrastructure: Hosting of SiME

a) Provision of hosting services for SiME: 3 virtual machines (software that emulates a physical machine but more flexible) dedicated respectively to frontend, backend and database instances;
b) Acquisition of the Microsoft Blob Azure service for "cold" backup of the whole data.

7.2. SiME outputs

The deliverables of the SiME project include software solutions as well as services, such as:

- Documentation regarding the study of ontology and objects classification;
- Export software - expected date: April 1, 2021;
- SiME platform - expected date: December 1, 2021;
- Automatic data import and semi-automatic data entry;
- The application CURA - expected date: April 1, 2022;
- Capacity-building activities.

8. Monitoring phase

To monitor the effectiveness of the proposed solution, Key Performance Indicator (KPI) have been identified to measure the project performances.

8.1. Specific goal

Organization of 60% of digital material in SiME and consequent sharing of data from the Museum's collection to facilitate collaborative maintenance, research, promotion and communication activities, by June 2023.

8.2. Key performance indicator (KPI)

The KPI measure the capability of the Museum to increase research on its collection and improve the management of its tangible and intangible heritage.

8.2.1. KPI measurement

The indicators to measure the achievement of the specific goal are:

1) The number of user interactions with the archive;
2) The number of satellite apps developed in dialogue with SIME.

8.3. Verification sources

To verify the results of the first measurable KPI, the log file (recording users' activity) of the new platform will be compared with the one currently in use.

To test the second KPI measurement, the number of applications in use will be compared with the number of satellite applications that will be developed.

9. Capacity-building activities

According to the project objectives, the training approach involves the collaboration of all the Museum staff. Based on the professional profile and competencies the training activities have been differentiated for two teams.

The team with technical and IT competencies will deal with data and information security, cloud infrastructure management and problem-solving in response to system alerts.

The second team composed of most of the Museum staff with a basic and medium knowledge of IT system will deal with data editing and consulting of the System SiME, task managing and multimedia data archiving and cataloging procedure.

More specifically, capacity-building activities for both teams will include two courses of three meetings each to be repeated for the first two years.

10. Conclusions and future perspectives

The working activities briefly described in this contribution are the first step of the digital transformation of the Museum.

The digital transformation is a cross-process to all the museum's departments involving all the staff's workflows.

More specifically, the planned actions concerning the data collection management affect the monitoring and conservation processes as well as exhibition design and research activities.

The project output consisting of a tailor-made database will enable more immediate access to collection data and collaborative workflows. The effectiveness of this approach has been already tested in the TPOP platform which was awarded by the prestigious Heritage Prize Europa Nostra 2020 Awards in the research category.

In a long-term perspective, the logic of a central database and satellite application can develop new processes such as virtual tour of the collections.

Further, the development of Application Programming Interface (API) software allows the interoperability with third-party applications with SiME thus not depending on a single service provider.

The implementation of an integrated system will amplify the awareness of the museum activities by the different departments in real-time as well as cross-department collaboration.

The proposed project generates a digital environment integrating the existing hardware resources (when possible), developing tailor-made solutions based on the consolidated experiences of the Museum staff that oriented the development of SiME in the design thinking phase as well as in the tuning phase.

Future perspectives also include the development of an HBIM (Lo Turco & Calvano, 2019) of the building to be configured as a satellite application connected with SiME. This structure enables the development of an integrated HBIM-CIM model for an overall documentation and stewardship of the Museum intended as building (container) and its archaeological collection (content) (Lo Turco & Spallone, 2019; Lo Turco, Giovannini, & Manfrici, 2020).

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