

A Service-oriented Meta-design for the Strategic Digital Transformation Process in Natural History Museums

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Abstract. The mission and services of natural history museums (NHMs) show, preserve and study life and ecosystems on Earth to understand nature's patterns and support their conservation. The evolution of IS/IT has driven a fundamental transformation of services and processes within different types of organizations such as NHMs, giving rise to the phenomenon known in the literature as digital transformation. Digital Transformation (DT) is a strategic, organization-wide approach that brings and improves together processes, people and technology. DT is a complex process that requires organizational commitment, including the redesign of service/business processes, developing new skills, and sometimes overcoming people resistance and inertia. Museums have been no strangers to DT for the past few decades, but their pace of change has been slower than in other sectors, leaving most museums far from digital maturity. However, in order to open up their biodiversity data and increase the effectiveness of their service processes, NHMs are faced with the need to integrate IS/IT and transform digitally. Therefore, for NHMs strategic planning of DT has become crucial to set both a clear strategic direction for NHMs to fulfill their mission and maintain their relevance in 21st century. Using a design science research approach, the Museu de Ciències Naturals de Barcelona (MCNB) and the Universitat Politècnica de Catalunya (UPC) are collaborating in an applied research project, approved and funded by the Industrial Doctorate Programme of the Generalitat de Catalunya. The result will be a new methodology for strategic planning of DT in NHMs, as well as a first DT plan for the Collections area of the MCNB. This paper explains the meta-design carried out to build such a methodology.

Keywords: Digital Transformation, IS/IT Strategic Planning, Method Design, Design Science Research, Natural History Museums, Digital Museum.

1 Introduction

Digital transformation (DT) can be defined as an evolutionary process that uses digital capabilities and technologies to enable business models, operational processes and customer experiences to create value [1]. In Natural History Museums (NHMs), DT is influencing how exhibitions and educational activities are presented to the public;



how their collections and related information are accessed, used and required; and how their research is conducted [2]. The place of NHMs in society is changing, both through their own internal improvement and in response to changing contexts [2, 3].

Today, with global biodiversity in rapid decline, there is even more reason to study and appreciate the natural world, maintain biodiversity and geological collections, publish biodiversity data online, support scientific research and educate people about nature through exhibitions and educational activities. In this context of change, one of the key challenges for NHMs is to open their collections information and knowledge to new audiences in order to become more relevant [2]. NHMs must learn to integrate new technologies into their service/business processes to remain relevant and to serve audiences that are more diverse, more numerous and more tech-savvy [3].

However, DT is often a complex process that involves not only the integration of IS/IT but also a potential rethinking of services, processes, legacy systems and even organizational culture [4–6]. As a result, DT becomes a major challenge for NHMs today [7]. While museums continue to embrace digital innovation, they do so more slowly than other sectors of society [8, 9]. Some implementation problems have prevented the rapid adoption of technology in museums, such as the loss of information in the migration of data from manual to digital processes, staff resistance to the intrusion of IS/IT into their traditional roles and the high cost of using computers in relation to the modest budgets typically available to museologists [10]. In consequence, many museums are still far from achieving a high level of digital maturity [9, 11].

Currently, the process of digitization is considered a mandatory activity for cultural organizations [10]. DT may transform the entire museum experience and operation, providing a variety of ways to deliver information and share knowledge with public and researchers. This alliance between IS/IT and cultural organizations has given rise to the term 'digital museum', which refers to a museum that fully integrates digital tools into its working practices to enhance its core functions of collecting, conserving, researching, exhibiting and communicating [10, 12]. This is why NHMs need to build this digital dimension, and they need to do it well, with effectiveness criteria.

In such circumstances, the strategic planning of DT for NHMs and the right leadership in the implementation of digital projects is crucial to help NHMs establish new guidelines, goals and strategic projects, which support the achievement of their mission and increase their relevance in today's society. This involves not only promoting new ways of thinking, transforming processes with new knowledge and skills, but also assessing the effort and resources required in the future, such as: digital infrastructure, digitally skilled people, money and time [9].

In order to meet these challenges, the Museu de Ciències Naturals de Barcelona (MCNB), in collaboration with the Universitat Politècnica de Catalunya (UPC), has been carrying out an applied research project since July 2021. The project takes the form of a doctoral thesis, co-funded by the Doctoral Industrial Programme of the Generalitat de Catalunya [13]. The research was born from the real needs of the MCNB to improve the management of its IS/IT and all the data generated by its collections, while being considered a reference NHM in the south of Europe, as opposed to its limited resources (human and monetary) as a public institution. Consequently, the

main agreed goal for this research is to design, apply and share a comprehensive and strategic planning methodology for the DT initiatives and their deployment, designed to support the specific culture, services, processes and needs of NHMs.

Furthermore, through a pragmatic Design Science Research (DSR) approach, we design the artefact (the method) because we have a real problem to solve within NHMs and it is a relevant one (the strategic planning of their DT), with a theoretical contribution potential (the need for methods and guidelines to do so), as the literature gap shows. Therefore, in order to achieve our main objective, a service-oriented meta-design was required to enable the construction of the method. This paper describes the meta-design for the artefact construction.

In our proposal, we intend both the research process (the meta-design) and its outcome (the method) to be service-oriented. This is further justified by the format of this research as an industrial doctorate (an applied research) within a specific natural history museum, the MCNB. Therefore, the method developed in all its stages must be designed for the specific reality of NHMs, using and/or transferring techniques/methods from other sectors that can support NHMs in their digital innovation processes, and by designing new ones to fit the specific challenges of NHMs.

Lastly, the paper is structured as follows. Section 2 outlines the literature related to this work and its novelty. Section 3 describes the DSR approach and the meta-design proposed in this research. Section 4 summarises the conclusions, limitations and future work.

2 Related Work and Novelty

The museum and heritage sector is only recently but increasingly discussing the issue of DT as one of the main areas for its policy and research [14]. Related concepts such as digitization and digitalization have been considered to improve the reach and performance of museums, resulting in richer content and have been studied extensively recently. These concepts are linked to technologies such as 3D tools applied to cultural heritage and digital museums. Digitization refers to the collections that are digitized as resources, while digitalization refers to the use of these resources for education, exhibition or dissemination [14]. On the contrary, DT research has been associated with human-related concepts, such as digital literacy. However, the related literature on DT remains scarce and small, and discussions on DT seem to take a more organizational, human resource and human capacity approach. Furthermore, digital literacy has been conceived and implemented as a catalyst for museum transformation [14].

The digital museum has also been proposed recently and can be defined as a museum that uses IS/IT to digitally represent the functions of a traditional physical museum and to share the resources of the cultural objects it holds on the Internet [12]. At the same time, the main significance of digital museums is to bring into play the advantages of digital technology tools and propose solutions to the disadvantages of traditional museums, with physical collections as the core in the functional realization, to achieve functional complementarity [12].

Consequently, increasingly the museum's digital strategy plays an important role in how museums can use technology to promote the development of innovation networks, economic performance and comparative advantage. Also, a digital strategy may allow digital museums to be designed in a more organized way [15]. Ironically, a digital strategy for museums is not a priority for strategists [15–17]. However, digital museums can and should be strategically planned to achieve economic and social development outcomes, and therefore more research is needed in this regard [15]. In addition, digital museum policies need to be very concrete and critical in nature, as they require substantial investments and have significant implications for museum management. Therefore, it is important to study them in a methodical and coherent way, in terms of policy design and implementation within museum institutions [18].

To conclude, the types of studies that exist on DT topics in museums are diverse. There are themes that have attracted the attention of academics, researchers and experts, such as the dissemination or didactics of cultural heritage. And there are other topics, such as digital networks between museums or strategic planning of DT, which have not generated as many references [19]. Consequently, there is not much literature on DT within cultural and heritage institutions, and even less on their strategic planning of DT. This rather lack of prior research can be alleviated with research results from other classical disciplines, such as business management and information systems, which could be inspiring and adapted for NHMs. For this reason, we present in this paper a novel approach that provides a service-oriented meta-design for the construction of such a methodology.

3 The proposal

In this section we explain the design science research (DSR) approach used for the research process (section 3.1) and the service-oriented meta-design proposal (section 3.2).

3.1 A Design Science Research Approach for our Method

Design Science Research (DSR) is an investigative process that aims to produce innovative constructions (artifacts) that can be used to solve real-world problems or address opportunities that arise in the reality, and in doing so, make a theoretical contribution to the discipline in which it is applied. All human artifacts, such as models, diagrams, methods and information system designs are artificial constructs. Thus, DSR was chosen as the research approach for this project because there is a practical problem in the cultural heritage sector that also has research potential due to the knowledge gap found in the literature. Therefore, by developing an artifact to solve the problem (a methodology), a theoretical contribution is made at the same time [20].

The model we have chosen to contextualize DSR is the one presented by Hevner [21]. Hevner divides DSR into three parts: environment, design science research and knowledge base. The environment includes the practical domains: people, technical and organizational systems, with their problems and opportunities. In this research,

the environment is represented by the real museum (MCNB), where the research practice takes place and the designed solution will be tested. In this case, the initial knowledge base is constituted by the researchers’ studies and experiences, the relevant state of the art, as well as the support offered by the university (UPC) involved in the project. DSR is presented as an approach between theory and practice, a real situation in which the proposed artifact (the method) is to be designed and evaluated. See Figure 1.

Furthermore, as explained by Venable (2006), DSR must not leave theory and theorizing to the natural, physical and social sciences. Instead, DSR should engage in theorizing, before, during, and as a result of DSR work. Just as other scientific research paradigms, theory should be a primary output and that theory and theorizing need to play a central role in the advancement of DSR in IS [22].

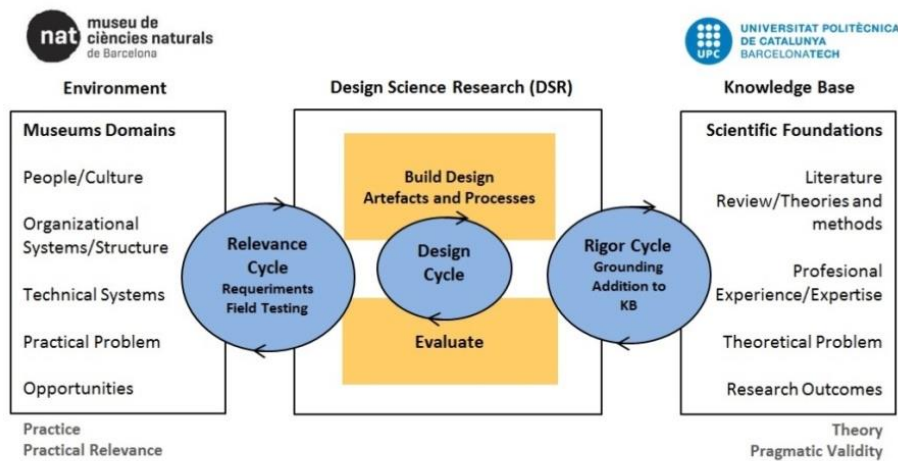


Fig. 1 DSR model. Source: adapted from Hevner (2007)

As a result, Venable proposes an activity framework in which design theory should take the form of utility theories, which relate improvements expected from applying a particular type or types of research “meta-designs” to a particular type of problem “meta-requirements” or “user requirements” [22–24]. Theory and theorizing are then seen as a central research activity, as in other research approaches [22].

3.2 A Service-oriented Meta-design for our Design Process

Service Science, Management, Engineering and Design (SSMED) are concerned with service interactions and their value creation, aims to understand services and innovate in service systems [25]. Thus, given the challenging circumstances faced by NHMs, our research approach needs to add value to the DT processes of NHMs, due to our service oriented approach. In order to achieve this value creation, it is necessary to know in depth the context of these museums, their pains, their problems, their particularities, so that both the research process (its meta-design) and the final result (the

method to be build) can generate a value proposition for NHMs that really helps them to manage their DT process with a strategic approach.

In the context of this research, the service-oriented meta-design is represented by the research design (Figure 2), which defines the roadmap for accomplishing the main goal (design a method for the strategic planning of DT initiatives in NHMs), by achieving the 5 steps (O1 to O5) and their specific objectives. The meta-requirements or user-requirements are represented by NHMs context, challenges and specific needs, for whom the method is designed and where the method (the final artifact) will be tested.

As the main goal of this study is to design a method for strategic planning of DT and deployment in NHMs, the main expected outcome is a complete method and any utility theory contribution made during its development, as well as its instantiation in a first strategic DT plan for the collections area of the MCNB [26]. In research design, the main goal was divided into five objectives (steps) related to the methodology to construct the artifact, as proposed by Manson [27] (see Figure 2): problem awareness (O1), suggestion (O2), development (O3), evaluation (O4) and conclusion (O5).

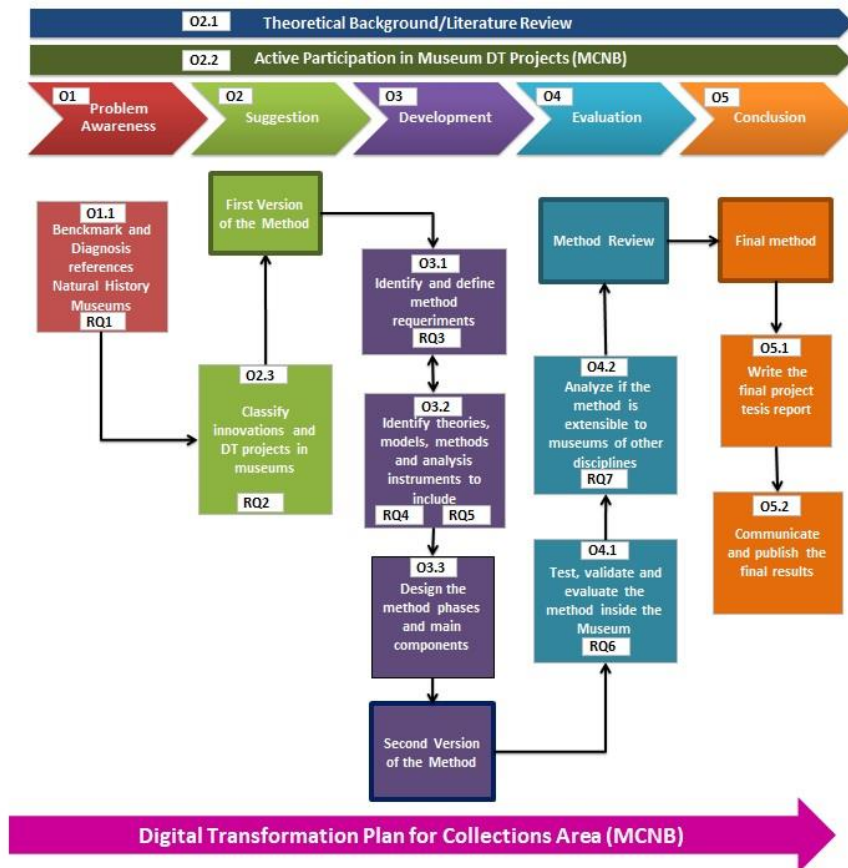


Fig. 2. Research design (Service-oriented Meta-design). Source: Own elaboration

In order to increase our awareness of the problem (O1) and to get more details about the context of NHMs (O1.1), we are conducting a benchmarking study of 16 reference NHMs, including the Smithsonian National Museum of Natural History, the Berlin Museum of Natural History, the London Natural History Museum, Naturalis, etc. This study is being undertaken to understand the reality of NHMs, their issues, challenges, organizational culture and characteristics. In addition, to assess whether the reference NHMs are planning their DT processes and, if so, how they are doing it. Also to understand the organizational structure of these museums, their strategic approach, the existence of IT departments, IT staff, etc. This will allow us to understand in depth the context of NHMs and the research problem.

In order to prepare a relevant solution (O2), a literature review was carried out to know the state of the problem and solutions regarding DT in NHMs (O2.1). In addition, we have participated in digital projects within the MCNB (O2.2) to gain more knowledge about the context and to achieve a service-oriented methodology [28]. To date, two projects have been carried out, one related to the migration of collections data from one system (Museum-plus) to another (Specify 7) [29], and an IS/IT diagnosis for the Network of Natural Science Museums of Catalunya [30], coordinated by the MCNB. In addition, a taxonomic study of digital innovation in museums is being carried out by reviewing 1416 papers published at 'Museums and the Web', the main international conference on digital innovation in cultural heritage, in order to draw up a taxonomy of digital innovation in museums. As a result, and based on previous more general methods, a first version of the specific method will be proposed to start the development phase.

In order to develop the method (O3), it is necessary to identify and define the method requirements (O3.1), the existing theories, models, methods and analysis tools to be included (O3.2), and to design the method phases and main components (O3.3). The development phase is crucial for the construction of the method, because here, thanks to the understanding of the problem obtained in O1 and the studies carried out in O2, we will be able to define the specific requirements adapted to the reality of NHMs, the theories that will help us to solve this problem and to propose the desired solution. This will allow us to develop a second version of the methodology for the evaluation phase and to maintain the service-oriented approach of the methodology.

To evaluate the method (O4), we will test and validate the design within the MCNB by doing its instantiation. By doing so, we will be able to test the method by applying it to a real museum, the MCNB. Only then will we analyze whether the method design could be adapted to museums of other disciplines (O4.2). We will assess the method by museums of other themes, such as art or archaeology, to evaluate whether the design can be extended to other museum subjects. An evaluation by expert groups will allow us to carry out the final review to initiate the final state.

Finally (O5) will present the final method, the final report (O5.1) and its publications (O5.2). Nevertheless, (O5.1) and (O5.2) are at the end, as long as results have come to light, they will be reported and published through the best channel. In fact, several articles have already been published, one at a specialized museum conference 'CIMED 2022' [31] and another at a specialized information systems conference

‘CAISE’23’ [32]. In addition, it is important to mention that O2.1, O2.2 and the DT plan for the MCNB are transversal to all design research.

4 Conclusions and Future Work

We are currently developing a novel approach to support NHMs in their DT processes. Strategic planning of DT is necessary for the cultural heritage sector to minimize risks, overcome obstacles and maximize opportunities for success, but the reality of some museums is challenging and there is no tradition of either strategic thinking or strategic planning. However, museums need to develop digital strategies to anchor their digitization activities and digital assets on a sustainable and long-term basis in order to better achieve their mission and strategic goals. We want to contribute to this effort by developing a methodology that helps to overcome these obstacles, also thanks to our service-oriented approach.

In this paper we have presented the service-oriented meta-design followed in our research process for such a new method for the strategic planning of DT in NHMs. Our work is still in progress; today we are finishing our O1 and O2 phases, while we are progressing in O3 and participating in IS/IT projects within the museum that will help us address O4.

Because our work is still ongoing, it has some limitations. First, the size of natural history collections (typically millions of diverse and complex specimens) has made the digitization process a work in progress without deadline, which is important for method construction in order to evaluate early progress. Second, for reference NHMs, massive digitization processes are a must, but small museums usually don't have the money to afford it, nor the human resources. Additionally, currently methods are only related to workflows for digitization process, without taking in count the whole process related DT neither its three main dimensions (people, process and technology).

Although there are similarities between NHMs and museums of other disciplines in areas such as exhibitions, education and public services, the internal area related to collections operates very differently. Natural history collections offer information about the specimen as the main value, rather than the specimen itself. This information is made available on web portals for free access by different audiences, including researchers around the world. This free access to its collection information is now the main value to offer in the collections area. In addition, for collections in other museum disciplines, it is the physical object itself that holds the greatest value (e.g. art museums). These structural differences have led us to develop the methodology for NHMs rather than museums in general. Future work we would like to undertake includes extending the methodology to museums of other disciplines where possible.

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