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Data-Driven Strategies in Museums: A Cross-Case study in the Low Countries

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1 Introduction

“The farther back you can look, the farther forward you are likely to see.”- said Winston Churchill, not thinking about what an inspiration this sentence could be for museums. Undeniably, a visit to a museum can be today the best way to look far back to the past. But what if museums themselves cannot not prepare for the future? How can they deliver their social mission if maintaining them is not going to be feasible anymore?

Museums and other cultural institutions are highly dependent not just on the actions of governments and politicians who can limit their budget, modify their power with policies; but also on other competitors, who can steal customers and copy processes. But there is one strategic asset, that none of them can have: the data and information (Redman, 2008) of the museum. When thinking of museums, “data-driven” is not the first thing that pops into mind. But in fact, "museums are in their very nature data centric institutions. They are creators and collectors of diverse range of data" (Murphy, 2022). These can be the cost of a ticket, the length of the visit, the route that visitors are taking, an artifact viewed on the website, and many more.

The Art Institute of Chicago stood in front of a challenge that many museums are facing, namely, how to increase revenue by ticket sales. By tracking the path that visitors took inside the museum and the duration trends in certain locations, they identified the most popular galleries. By putting the focus on these galleries they managed achieve a 35% increase in sales (Hope, 2018). Te Papa, the national museum of New Zealand partnered with a data analytics company in order to forecast their visitor numbers and discover the significant independent variables that influence the popularity of the museum at a certain time. Thanks to this, the museum can prepare better for the future and adjust their activity and strategy to the seasonality (Future Museum, 2021). Undeniably, these examples were big-scale museums, that due to their size and popularity can invest into Big Data and function as a data-driven company.

Although the use of data strategy is growing in general, this rise in use is highly connected to the size and resources of organizations. However, most museums are smaller, with less funding from governments. So, how can small and medium cultural institutions stay in competition if they do not have the scale and financial means to

the became data-driven? Naturally, in their case, using such complex technologies as Big Data is out of the question; data analysis on a smaller scale can already be a huge step towards informed decision making (Acelera pyme, 2023).

Thus, a possible path that museums can follow is to join the recent transitions in the market, where every company is becoming a data company. By restructuring the business models to a more tech-savvy a data-focused one, every company can generate unique value (Forbes, 2020). This way, building a data-driven organization is one of the main game changers that can contribute to the independence of museums. So, this paper aims to answer the following research questions:

(1) What steps have museums taken in order to develop data driven strategies?
(2) What are the critical success factors for data intelligence implementation in museums?

There is a clear gap in the literature: there is no existing, clear guideline for cultural institutions to start their path on becoming data driven. The sources that are purely focused on museums and cultural institutions are dating back to times where the big challenge was to transform the business model and be more audience-centric, and most of the data-focused academic works are relevant only to private firms.

Answering these research questions will contribute to academia and practice by identifying the critical success factors for data intelligence implementation in cultural institutions and analyse its alignment with a data-driven strategy, thus addressing the existing gap in the literature. The research questions aimed to be answered by using a qualitative cross-case design. Based on the previous literature and semi-structured interviews a research framework will be developed. With this framework the situation of 5 museums from Belgium and the Netherlands will be analysed. The paper will end with a set of propositions on how to become a data-driven cultural institution. However, first, the challenges and obstacles that stand in front of museums today need to be properly understood.

2 Literature Review

2.1 The challenges of the 21st century museum

Museums are ancient institutions, their concept leading back to antiquity. Throughout most of the history museums served as storage places for special objects,

owned by the rich. They started becoming public just in the late seventeenth century as part of universities (Alexander et al., 2017), and ever since then had been operating for many years with a new purpose. They were a place to admire art and culture, to find connection to the past. Due to this, they existed in a special space, isolated from the changing demands of the market (Falk & Sheppard, 2006). For their survival, museums always had to reinvent themselves to the present needs of society, and undeniably, a changing point is happening right now with new emerging trends.

Therefore, museums are unique type of complex institutions that are under constant development with constantly changing definitions. Nowadays, a museum is defined as a "non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment " (ICOM, 2017). Due to many multi-disciplinary functions and their financial and political foundations, it is hard for such cultural institutions to have a transparent, well-structured strategy to handle their operations.

There are many challenges that cultural institutions, and particularly museums have to face in the 21st century. First, museums are being pushed in the direction of social and economic policies instead of cultural ones. They still have to meet national or local cultural policies, but their existence is mostly dependent on the actions of the government (UNESCO, 2006). Consequently, the funding will be more generous to those museums who fulfil certain requirements more successfully. Admittingly, this motivates museums to function more as tourist attractions, a perfect place to visit on a holiday (EMA,2019). Due to this, the fundamental purpose of museums has changed, and while still serving a cultural purpose, they need to consider what they can offer for economy and education.

Second, it is not just about competing with the other museums for survival – museums have to compete with the whole cultural and creative sector, including music, books and publishing, architecture and cultural heritage (European Commission, 2018). As leisure time is becoming more and more appreciated in the fast-paced life, new players are appearing in these industries to provide entertaining activities. Considering the fact that an average EU citizen spends 3% of his/her household expenditure on cultural goods and services (eurostat, 2020), it becomes

incredibly important for organisations in this sector to influence the decision making process of visitors.

Third, there are demographic factors that need to be considered. As the post-war "baby boom" generation grew up, high-level education became more easily accessible for them, and a few decades ago the attendance rates in museums spiked (Burton & Scott, 2003). However, we are facing at the moment an ageing society. When looking at the best museums worldwide, there is no sign of a clear attendance growth; the number of visitors is rather in a decline (TEA, 2019). Consequently, museums have to put more effort into their strategy if they want to attract the active youth, which is going to be their main customer base in the future.

To make matters worse, the COVID-19 pandemic created unexpected obstacles to overcome any of the above-mentioned challenges. The lockdown restrictions starting from 2019 put cultural institutions through an unprecedented suffering. Almost every museum in Europe had to close temporarily, creating great financial losses. The ones that were not able to come up with a digital response contributed to the widening of the already existing gap in digital transition, both in terms of creativity and technology (UNESCO, 2020). Although the restrictions are over, it does not mean that cultural institutions recovered from the crisis. Their suboptimal operation leads to financial instabilities, which means less money for promotion followed by decline in visitor numbers and revenues. As a consequence, investments into the facilities shrink, which ends with further deterioration (Falk & Sheppard, 2006).

To conclude, the survival of museums is being attacked from many angles, whether it is the dependence on public fundings, the tight competition in with the Cultural and Creative Sectors (CCSs), the ageing society, or the recovery from the COVID-19 pandemic. In order to tackle these challenges and ensure self-dependence, a possible solution for cultural institutions is to rely on the data part of their business. Simply, implementing the key drivers of digital maturity such as digitalization of services, marketing, sales and platforms comes along with competitive advantages, improved time on the market and enhanced cost efficiencies (Grebe et al, 2018). Hence, it is extremely beneficial to organisations to adapt themselves to the fast-changing needs of the technology-driven world. Moreover, cultural heritage has an enormous impact not only on social, political, and cultural, but also on economic

development (Council of Europe, 2020). Therefore, the operational optimization of institutions in this area is crucial. And as data is becoming an increasingly valuable asset for businesses to achieve success (B. Marr, 2021), taking a data-driven angle with the implementation of a data strategy could be a key step for cultural institutions. That is why the aim of this paper is to assess the data maturity of museums and look at the critical success factors that are influencing this outcome.

2.2 Data strategies in the cultural sector

There has been extensive research about digital *transformation*. It consists of two steps: digitization, when documents get converted from paper-format to electronic-format; and digitalization, when value gets extracted from these electronic files (Gobble, 2018). However, it is hard to accomplish these without realizing the connection to the business. Hence, with the help of a *digital business strategy* companies can put this digital transformation into context. It is basically the merging of the more internal-oriented IT strategy into the rather external-oriented business strategy (Holotiuk & Beimborn, 2017). Even though different industries and sectors can share similar characteristics, the barriers and enablers they prioritize imply unique frameworks for each case (Reddy et al.,2022). Hence, it is clear that establishing a digital business model is a complex phenomenon, which requires a lot of expertise, effort and nevertheless, money. This may lead to lagging behind of less fortunate organisations with tighter financial constraints and less flexibility to restructure their operation – like in the case of cultural institutions.

Due to the complex nature of this phenomena, most papers focused on just one certain element of the digital business model, so that they could provide more concrete conclusion. The success factors of a digital business strategy have been already identified by Holotiuk & Beimborn (2017). With their extensive research including 21 industries they were able to provide a framework to help firms overcome the challenges of digitalization. The 40 success factors they identified prove the complex nature of this transformation and puts a light on how much effort in the several different fields is needed to a reach success. Correani et al. (2020) realized that establishment of such strategies is not enough. They argue, based on the three digital transformation projects that they were analysing, that there is a great gap between the intended strategy and the actual implementation. They proposed a digital strategy implementation framework that can properly guide firms through

digital transformation. Pappas et al. (2018) showed a bigger picture of the adaptation. They created a Digital Transformation and Sustainability model that presents the value creation, business change and societal change that is possible with the use of big data. They argue that the business analytics ecosystem allows all data actors, including government-funded organisations to address societal needs and helps paving the way to digital data-driven decision making and rethinking of today's business models.

Evidently, all of these studies were focused on for-profit firms. Contrary to them, Jonathan (2020) was analysing the public sector. Although he admits that most of the findings of previous studies are applicable in his case too, the fact that the functioning of public organisations is highly dependent on the political atmosphere implies that managerial decisions are not enough to truly achieve digital transformation. The study of Merhi (2021) also reflects on this, showing that the critical success factors for data intelligence implementation in the public sector differ from the profit-oriented enterprises.

The idea of digital strategies in museums started to surface just recently, mostly as a result of the COVID-19 pandemic. Minoska-Pavlovska (2019) identifies multiple areas where digital technologies can alter museums. On one hand, digital technologies can enhance management of the collections. Digital museum databases with records of museum objects provide a structured overview for all users, ranging from researchers to entertainers. The easier access to, and search for data makes their work a lot easier. Furthermore, the recent trend of presenting the artifacts in 3D either on museum websites or in VR expands the audience even wider. On the other hand, digital technologies can shape the design of the exhibition and as a consequence, the visitor experience. There are several ICT tools that can be integrated into the exhibition ranging from the simplest gadgets to augmented reality.

Although the opportunities proposed by Minoska-Pavlovska (2019) sound promising, the success factors actually making these happen were not mentioned. Contrary to this, LinkFactory, a Danish company specializing in open-source technologies published a report after the COVID-19 lockdowns, focusing especially on the steps of establishing digital strategies for museums. They argue that the main critical success factors for digital transformation are the digital skills at the executive

level, networked organisational structure, constant improvements with testing and digital analytics, user-centric view, creation of a digital production roadmap, investing in digital capacity and skill building, and nevertheless, embracing user-generated content. The latter was the focus of the study from Kamariotou et al. (2021). They realized the importance of interaction with visitors and the benefits of community building and information sharing, and thus built a strategy based on the audience. The pillars include the before-mention transformation of the audience from consumers to content-creators, enabling the audience to participate, and overall, enhance their engagement and experience.

To sum up, there is a wide range of literature discussing digital business strategy and data strategy for private firms. Although there were some cases in the public sector, the current state of the evidence on this topic may be limited and outdated. Fortunately, there is a new wave of digital initiatives among museums, but their main objectives are rather producing tech-savvy exhibitions to attract audience.

2.3 CSFs for implementation of data intelligence in small and medium sized museums

It is obvious that data driven strategies are still in the children's shoes in the cultural sector. One of the best ways to explain this state is by looking at the pre-conditions of adapting data-driven strategies. Hence, by determining the critical success factors for data intelligence implementation decision makers can have a holistic overview about the needs of their organisation.

The existing literature shows that even though private and public firms have some common CSFs, they differ in terms of weight in bigger firms. Namely, while in the case of for-profit firms it is the organizational factors that influence the implementation process the most (Yeoh & Popovic, 2016), while in the public sector it is technological factors that determine the outcome almost by 50% (Merhi, 2021). There are several aspects that can explain this. For instance, profit driven organizations tend to have more hierarchical and profit-driven organizational structures, where decision-making is primarily influenced by financial considerations. In contrast, the public sector often operates within bureaucratic structures with complex decision-making processes. These are influenced both by political, legal, and social factors. Under such regulated circumstances the best way

public organisations can impact the outcome is by maximizing the effectiveness of available technology.

The main difference between these big companies and SMEs in terms of CSFs is naturally the budget. Smaller organisations, like the museums in this case, do not have the adequate resources to hire competent data-oriented managers and to create a well-defined business problems and process. Furthermore, there is an additional factor that needs to be considered: the level of system integration (Olszak & Ziemba, 2012). While large companies usually require an integrated information system, smaller organisations are not forced to do such complicated tasks, because they can still keep track of things with separate systems due to their size.

To conclude, there is no existing literature pointing out the secrets of success for museums in terms of data intelligence implementation. Therefore, the following sections discuss the potential CSFs for data intelligence implementation that could be relevant to small and medium sized museums.

2.3.1 Leadership support

Especially in government-funded museums, the real power for decision making and leadership is in the hands of the directors and the government. The employees in higher positions of the museum are just reduced to a managerial role. But naturally, in order to facilitate technological change in the organization, the ability to control resources is crucial (ICOM, 2022). The behaviour of managers has a visible impact on the performance of the museum. In fact, transformational leadership is an antecedent to achieve coherent functioning and adaptability in the organisation (Nunes et al., 2021). Hence, in the case of data intelligence implementation, the support from both the leadership and the government is needed. Moreover, it is also desired for the people in charge to have digital knowledge. If there is enough trust between the leaders and the organisation, then this digital experience of the leaders can have a positive impact on knowledge sharing and thus pave the path on becoming more data-driven (Lo et al., 2021).

2.3.2 Organisation structure

Contrary to hierarchical organisations, which are vertical, networked organisations are horizontal. This means that the employees are working in smaller groups based on their skills, which emphasises agility and leads to improved

information-sharing and collaboration (Lin et al., 2010). Especially in small and medium sized museums, where employees are not that tech-savvy, a culture of shared values and diverse empowered teams is necessary to gain a holistic overview. Employees need to understand the interconnections and roles of data among the different departments in order to extend trust and confidence and thus improve project outcome (Greene et al., 2017).

2.3.3 Project management

Data intelligence systems are complex. Hence, the planning, implementation and monitoring of the system indicates advanced project management skills (Merhi, 2021). Like the vast majority of SMEs, museums are facing budget constraints, so the project management plays even a heavier stake. There has to be a skilled project leader, who has a managerial attitude, ensures that the system is implemented on time without any generated extra costs and offers alternatives for improvement (Becerra-Godínez et al., 2010). If the original plan is already standing on shaky grounds and there is no clear path to follow, the stability of the system cannot be guaranteed.

2.3.4 Training and education

Especially in the post-COVID world, museum employees have to be prepared for unexpected changes which require creativity and knowledge sharing. The vast majority of museums already changed or is considering developing new skills with trainings and online courses. The most pressing issues they addressed were creating digital content and building a digital strategy (ICOM, 2021). Inevitably, for these, the knowledge gap in the use of data and BI tools need to be closed. This can be done by training the staff members who participate in the use of these tools (Becerra-Godínez et al., 2010). Were the trainings successful, a clear improvement in productivity an organizational effectiveness is expected (Konings & Vanormelingen , 2015), which would otherwise be lacking and could thus cause endless complications for the organization.

2.3.5 Information systems

In general, museums rely on multiple separate information systems, ranging from the e-ticketing to collection archives. These systems are hard to maintain and are causing inefficiencies both for managers and users. Some museums already

managed to integrate these separate parts, where software, hardware, databases, processes, user interface and APIs become united under one server. (Wu, 2016). But for this, considering the diverse data that museums produce, a scalable and flexible framework is feasible. This means, that when implementing a system, the conversion of data has to be accurate and in the same format in order to avoid chaos (Merhi, 2021). Especially in small and medium sized museums with less financial resources it is extremely important to decide whether to integrate the systems or not. This could influence the whole functioning of the organisation and cause long term problems if not handled adequately.

2.3.6 Data quality

Building a data driven organisation starts with the quality of the data. The situation is worrying at the moment, since only 3% of companies do actually meet the basic data quality standard. This is reflected by the fact that in half of the companies more than 57% of the newly-created data records have at least one critical error, and on average this score is 47% (Nagle et al.,2017). This poor data is considered to be the main cause for system failures, which comes along with tremendous costs. It is not just making it harder to execute the strategy and derive value from data; it spreads also to the operation and decision making by lowering the satisfaction of all stakeholders and increasing costs and risks (Redman, 2008). It is useless to talk about the transformation to knowledge and information when there are already troubles in the first step. That is why the establishment of a sufficient data strategy is indispensable of all kinds of organisations.

3 Research framework

In the precious discussion the critical success factors for data intelligence implementation in museums were identified. These factors represent the preconditions of becoming a data-driven cultural institutions. However, in order to evaluate the impact of the prerequisites, the outcomes have to be also measured. Hence, the data maturity of the museums must be assessed in some way.

It can be concluded that the primary challenge museums faced in their journey towards becoming data-driven was the absence of a clear roadmap or guidelines. There was no previous research that provided museums with a framework for achieving digital maturity. To address this gap, a research framework for data-driven

museums was developed, taking into account the unique characteristics of these institutions. This framework comprises two key components.

Firstly, the framework outlines the CSFs for data intelligence implementation in museums, including 6 factors grouped into 3 dimensions, organization, process, and technology respectively. Second, the framework presents the essential steps for small and medium-sized museums to transition into data-driven organizations. These steps are crucial in enhancing the overall performance of museums, and their effectiveness increases with the number and complexity of actions taken.

In the next section a detailed explanation of each step in the second part of the framework will be provided. These explanations will delve into the specific actions and strategies that museums can undertake to advance their data-driven initiatives. By following these guidelines, museums can systematically incorporate data-driven practices into their operations, decision-making processes, and visitor engagement strategies. I the end, the steps to become more data-driven will be connected to the CSFs in the overall research framework for data-driven museums, which offers a comprehensive approach to enable these institutions to leverage data effectively.

3.1 Data-driven strategy for museums

3.1.1 Identify opportunities for the implementation of a data-driven strategy

It is hard to find a business leader today who ignores the power of data. However, especially in complex organisations, the wide range of opportunities for the use of data makes it hard to know where to begin. As first step, organisations need to know what their strategic goals are in the short and long term (Marr, 2021b). Naturally, as museums are non-profit organisations, their goal does not include profit maximizing; their foundation statements usually include preserving and communicating history and science to visitors, thus inspiring communities and building a new generation of intellectuals (Lord & Markert, 2007). But the different focus does not mean that museums cannot use the same tools as for-profits to deliver their social mission. By assessing the data needs of their business, be it the current and potential usage of data, museums can initiate the data driven process. Furthermore, by prioritizing the opportunities for data-driven strategies, whether it is about improving marketing and sales or human resources (Acelera pyme, 2023).

3.1.2 Data collection and analysis

As discussed, museums can produce a wide range of data. After identifying the opportunities for the use of data, they can turn to various data collecting methods: asking for demographic information in the purchase procedure, sending surveys to the subscribers of the newsletter to rate customer satisfaction, tracking the average time visitors spend in the museum as whole and at certain spots, observing web and social media activities and reviews, and so on.

By collecting the data across all system a stable customer intelligence can be built, which is a crucial action to support the institution (LinkFactory, 2022). This collected data can not only serve as an answer to customer or market related questions, but as base for visualization and insights. If these insights are interpreted appropriately, museums can leverage the knowledge to optimize operational processes, transform visitor strategy, etc. (Marr, 2021a). Therefore, effective data collection is extremely important, so that all these data can be analysed through descriptive and predictive analytical methods, either to have an overview of the current situation or of the future expectations.

3.1.3 Implementing a data-driven strategy

If a museum is fulfilling the two steps mentioned above, the organisation can make already use of data. However, unless museums integrate the former step into the actual implementation of a data-driven strategy, all of these efforts will evaporate. First, in order to push stakeholders towards well-informed decision-making, communicating the results of the organisation to them is essential (Longview Strategies, n.d.). These stakeholders do not only mean the visitors of the museum, but everyone from the employees to external partners. Naturally, these stakeholders are impacted differently by the activities of the museum and have different interests, hence the way the organization communicates the results should also differ. For this, a human-centred view is necessary (Stickdorn, 2018), because after all, the goal is the enhance the understanding for all stakeholders, which can be only achieved through their eyes.

Second, the only way to derive IT business value from all this work is to align the data and business strategy. In other words, museums have to integrate their data-insights into the relevant business processes (Tallon, 2007). For instance, the organisation has to make sure that all employees can access the information they

need. According to a recent study of Coveo (2022) an average day for an employee consists of 3.6 hours information search. Moreover, for employees that work in IT-related fields this takes up more than half of their working hours. These hardships with finding the right information comes along with a lot of stress and frustration, thus ruining motivation and productivity. Furthermore, looking at the bigger picture, museums need to find metrics to evaluate their success, which can range from reducing costs to measuring customer satisfaction (Acelera pyme, 2023). By quantifying the invested efforts, employees can be more accountable for their work and thus improve their time management, and it can also inspire decision makers for better resource allocation.

3.2 Connecting data-driven strategy with CSFs

Although allocating museums on the data maturity scale can present an overall evaluation, the interpretation of these outcomes is not meaningful without considering the pre-conditions of adopting data-driven decision making in museums (Figure 1). It is impossible to accomplish a mission without the strong duo of goals

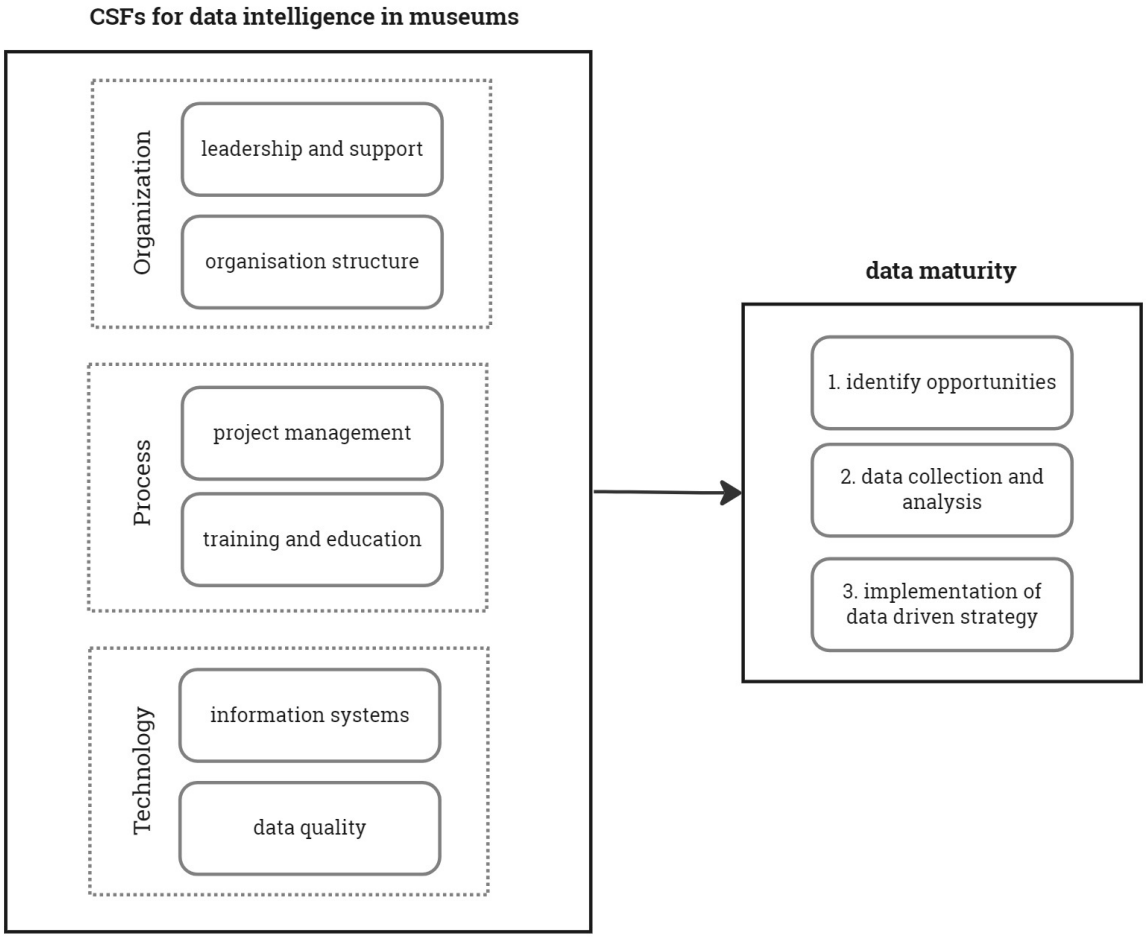

Figure 1. *Research framework*

and CSFs. Inevitably, these two are bound together, since the CSFs are influencing and enabling the strategic goals and objectives (Caralli et al., 2004). Hence, in the research framework both the digital maturity steps and the CSFs that influence the implementation of data intelligence systems in museums are demonstrated. For easier comprehension the CSFs are thematically grouped into the dimensions of organisation, process, and technology. This research framework served as a base for conducting the interviews.

4 Methods

4.1 Data collection

Semi-structured interviews were conducted with employees of five museums, including four Belgian museums, and one from the Netherlands. The interviews took place online and lasted about an hour. To ensure homogeneity and minimize the possibility of confounding factors arising from diversity, museums with the same focus were chosen. This focus is art, history and archaeology, which often go hand in hand considering the wide range of resources a museum can provide on their exhibitions.

The driving factor behind choosing these set of museums was the difference in their digital maturity. Some are bigger, some are smaller, some are behind in technological terms, some are more advanced, and they are spread out across Flanders and the Netherlands. Furthermore, the museums also use different e-ticketing systems, which was the main topic of the interviews. Thus, although the purpose of these museums is the same and essentially, they are conducting the same tasks, their skills, knowledge, and the way they deliver these tasks are far from similar. These differences in the same organizations are crucial in deriving

ID	category	size	position of informant
B1	History and archeology	S	Communication and marketing
N1	History and archeology	M	Head of the Finance and Operations Department
B2	History and archeology	S	Digital Strategist
B3	Art	M	Head of ICT
B4	History and archeology	S	Information management and digitization employee

Table 1. *Information about the participating museums. S=small, M=medium.*

meaningful insights from a cross-case analysis. Table *1.* summarizes additional information of the participating museums.

The museums were contacted by e-mail and were asked to participate in an interview about their e-ticketing system. In the next step the museums have chosen the person in charge of the e-ticketing system related projects and offered and appointment. The function of the participants varied. Two museums provided employees from the business part, three form the IT field. This coincides with the two poles of business intelligence systems: it is cooperation of business and IT. Hence, it is often not clear form which field the person in charge should be.

The interviews were centred around the usage of data intelligence system and in particular the e-ticketing system, the reasons why the museum has chosen it, the current advantages and disadvantages and future plans (see Appendix). This qualitative data is the only data produced in this research. The interviews also included some more direct questions focusing on CSFs of data intelligence.

4.2 Analysis

4.2.1 Method and coding

The five interviews were used to make a cross-case analysis. The purpose of the analysis was to point out the main differences and similarities between the museums and connect it to their data-driven decision making and data maturity. To structure the findings, AI-generated coding schemes were used, that were later grouped into the data maturity and CSF categories. So, while AI was employed as a supportive tool, active human involvement was maintained. There are multiple reasons why this approach can be justified. First, AI algorithms can quickly analyse large volumes of data and generate initial codes or categories based on patterns and similarities identified in the text. Hence, it is an efficient and time-saving approach (Lee et al., 2020). Second, it reduces potential bias and subjectivity that may arise from manual coding. By utilizing algorithms, the process becomes more standardized, ensuring consistency and objectivity (Jiang et al, 2022). Even though they are not meant to replace human expertise, the algorithms can recognize subtle relationships and connections within the data that might not be apparent initially, contributing to the discovery of new insights and themes (García-Horta & Guerra-Ramos, 2009).

Thus, direct content analysis was conducted in which specific elements (CSFs and data maturity steps) were identified and categorized in the data without interpreting or assigning meaning to them beyond what is directly observable. Hence, the analysis is based on predetermined categories or coding schemes that are applied consistently across the data (Hsieh & Shannon, 2005). However, first, the antecedents of adoption among museums need to be properly understood.

4.2.2 The role of COVID-19 forcing change and consequences

Before COVID-19 just biggest museums offered the opportunity to buy the ticket online. Evidently, due to the high visitor numbers these museums needed optimal crowd-management, for which pre-purchasing online is an immeasurable help. However, small and medium museums are usually not overcrowded, they have enough space for the lower number of visitors. Moreover, pre-planning the visit to the museums is not usual - they are not world-famous museums. The visitors do not come to the city in question so that they can visit the museum. They come to the city for the city itself, and later during the trip they discover the museum, and spontaneously go there. For this, naturally, no online solution is necessary, everyone buys it on the spot.

However, the virus forced the museums out of their comfort zone: there was no other option *but* online. Thus, these small and medium-sized museums had to come up with an e-ticketing implementation plan really quickly. In some cases, this meant that they had a “three-week timeframe to take some action” otherwise, they wouldn't be able to open. Luckily, in all cases “the desire to open was stronger than the administrative challenges”, but this did not mean that everything went well. Unfortunately, the number of skilled digital experts in these institutions were scarce. Moreover, museums are in general protected from the shocks of the market and did not have great experience in crisis management and quick decision making. All of these resulted in rash decisions. Namely, most museums just chose the easiest options. Naturally, if there was an online extension of their box-office system, then most museums preferred to just buy the extensions in order to reduce complexity and encourage integration. However, if the existing system did not offer online extensions, museums just turned to companies which can quickly install everything for a relatively good price.

Now, 3 years later, most museums feel the weight of their former decision. None of the interviewed museums were particularly satisfied with their current systems and some of them are already searching for other options. In Belgium, 3 museums of a city joined together to build a software on their own, because they did not find any other solution feasible. In the Netherlands, 7 bigger museums are working together in order to find a software that fits them. They hired a project manager, collected the milestones that they all need in a system, and contacted relevant companies with a survey that contained questions about their criteria. Furthermore, in Gent, the museums are already cooperating in action. All museums are using the same system thus having a shared website and administration office.

Furthermore, since recently, museums in Flanders are obliged to produce yearly reports about the performance of the museum if they want to receive subsidies form the government (Vlaanderen, 2021). This, undeniably incentivised museums to have a look at their data and think of potential insights. However, the analysis process emphasizes practicality over intricate methodologies, relying on common sense to derive meaningful conclusions in most cases. In other words, they use visitor data to highlight the popularity of events and exhibitions during a period, taking into account whether it was school vacation or not.

4.2.3 Key themes

After having an overview of the antecedents, it is not surprising that the most frequent theme appearing was uncertainty (Table 2). This uncertainty included the frustration and confusion not just about the future, but about the present. It was obvious that the participants have extensive knowledge about the data-intelligence systems inside the museum. However, in certain cases they were not sure how they

ID	Uncertainty
B1	“The thing is, it is maybe customer-friendly to allow everything, but on the other hand, sometimes time is wasted on welcoming, that is not good for the customer either. “
B2	"I think it is not necessary to have online ticketing, but we have it. So we can just provide it to our visitors. But at the moment, only about 5% of the visitors book their ticket online [...] So you cannot really predict how many people you will have“
B3	“We would be allowed to have 1,500 people in the museum at a time, so we calculated that too. Then we had to do the distribution and play with it. And yes, we really didn't know anything, did we?”
B4	"And then we also make some reports for the director for every month, I think, (name of employee) does that. But I do not have any idea what the director uses it for personally." "I don't know if it is a good idea of us switching to another system”

Table 2. *Quotes reflecting uncertainty in the museums.*

can use the system to support their operations. This included, group reservations, crowd management, reporting, etc. Besides this uncertainty of finding the proper solution, most museums were not even aware of their current system usage. There existed a notable information asymmetry, as the inner workings of the system and any derived conclusions were not openly shared or widely known. Evidently, this makes it hard to make confident well-informed decisions about the future and creates constant uncertainty in the atmosphere.

4.2.4 Challenges and opportunities of museum ISs

The general dissatisfaction and challenges can be explained by the complex nature of museums. There are a lot of departments from diverse fields that need to be integrated: archaeologists, researchers, cashiers, guides, security guards, administrative employees, finance, communication, marketing and so on. These positions differ in functioning and thus are using different information. For instance, for archaeologists all objects need to be recorded to keep track of inventory but for the cashiers at the entrance this is an irrelevant data, they need to sell tickets and get as much information about the visitors as possible. Meanwhile, the communication team need to take care of public relations and promote the museum and the finance section needs to report to the government due to the dependencies. For small and medium sized companies this is a quite complicated value chain.

Consequently, the biggest challenge that stood in front of museums was to find a business intelligence system that can integrate all parts of the organisation. Although there is a great spike in tech start-ups especially in Belgium and the Netherlands as leading countries in the EU, the systems they offer is never customized purely for museums. For example, the most popular data-intelligence software among Belgian archaeology and history museums was originally planned for swimming pools. As a consequence, museums cannot exploit the system as much as they want. Even if the newest software is advertising that they are a good fit for museums, it is just generalization: they usually create the software for multiple industries such as amusement parks, zoos, concerts, etc. This makes sense, because focusing purely on museums restricts the number of potential customers. Therefore, now these companies have clients from various type of organizations, but none of the clients are fully delighted with the outcome.

Therefore, when assessing the data maturity of the five museums, the shortcomings of their decisions surfaced. All museums were aware of the fact that they are not doing enough to be data driven. Fortunately, they did not close their eyes when it came to identifying opportunities for the implementation of a data-driven strategy. They could all easily come up with examples about improvements that could make their work easier, which are summarised in Figure 2. Most of them mentioned customer segmentation, advanced group reservations, incorporated event-based pages on their website and other platforms, and just simply using their observations and data for decision-making, which is currently not happening. However, it was often pointed out that for this, a "culture shift needs to be made." in museums; they are not ready yet to operate this way.

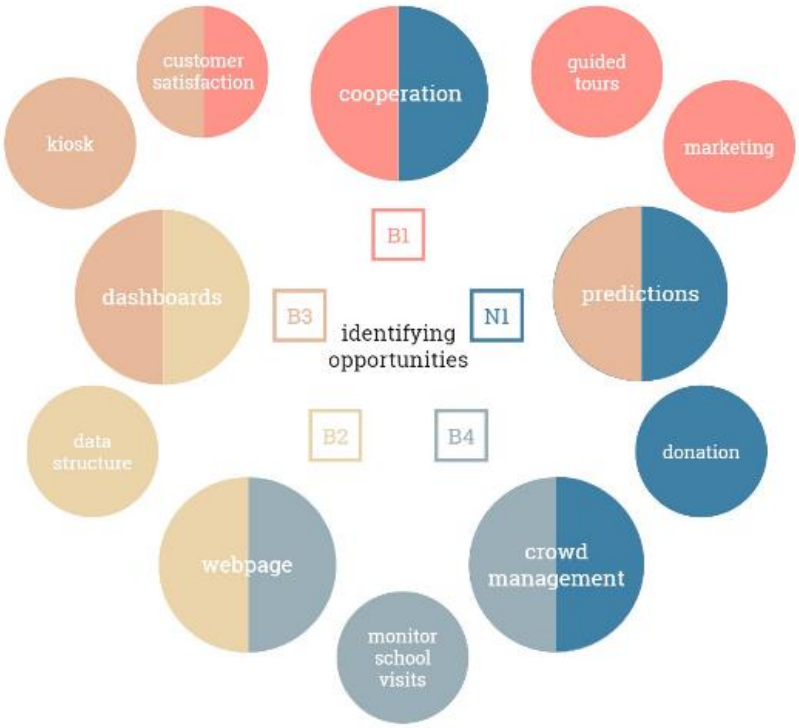

Figure 2. *Identified opportunities to become more data driven.*

4.2.5 Data definitions and standardization

Although each of the museums identified opportunities for the implementation of a data-driven strategy, the current collection and analysing of data was questionable in multiple cases. Even though all museums collect data, they differ in scale and depth. For instance, at B1 valuable data about booking patterns is derived from after-service emails, enabling the formulation of well-informed communication plans. B2 keeps track of how many visitors are living in the city by offering a discount for the local inhabitants. The others do not put more effort into data collection, they just simply collect the visitor data such as age, place of origin, and in the case of online purchases some additional information like e-mail, gender, etc.

There was a frequent problem at the box office with collecting data. Since museums want to collect the demographics about the visitors systematically, usually, instead of a window appearing to fill out the age, the tickets are grouped into age groups and other distinguishable demographic traits and discounts. This means that in some cases, there are over 3000 ticket types that cashiers have to choose from. Obviously, this It "complicates data collection" and to make matters worse, "one has to make separate reports for each admission price", which requires manual consolidation of ticket numbers to derive accurate visitor statistics. Moreover, the introduction of new ticket types for promotions or special offers further complicates the reporting process even more.

In general, it is an 80-20 rule. This means that 80% of the system is feasible, the 20% not. The museums admitted that in theory these failures and unused functions can be fixed, however, they do not have the "time or resources to put a lot of effort in those remaining 20%" and they are just "happy that those 80% at the moment are covered". Fortunately, there were available tools used in some cases to overcome these difficulties.

4.2.6 Examples of data-driven decision making in museums

B3 were dissatisfied with the reporting tools provided by the system, leading them to use Salesforce for reporting. They are in the process of creating dashboards and reports in Salesforce to gain insights into sales and visitor statistics. They recently hired someone to work on the data and expect to delve deeper into it soon. Furthermore, they encountered challenges with forecasting ticket sales for the upcoming week because tickets are often not purchased far in advance.

Contrary to them, at N1 discovered some trends, however not through data-analysis but by simple observation. The informant himself (head of Finance and Operations department) realized that if they multiple the number of online reservations at 8 PM for the upcoming day by five, then they will get the approximate number of total visitors for that day. They use this insight to call for extra staff in case of busier days. This insight can be really useful for museums in general, and if data analytics were used, more accurate predictions could be derived. N1 discovered another phenomenon. Notably, it was observed that visitors obtaining free tickets were more inclined to contribute additional financial support to the museum. As a response to this observation, the company implemented a procedural change: a donation prompt is displayed to individuals after they have ordered a free ticket, encouraging them to provide financial assistance to the museum. Consequently, this initiative generates an additional monthly revenue of 500 euros through online donations, complementing the existing 500 euros acquired from on-spot contributions.

The other museums also put some effort into analytics. B1 sent out emails after the museum visit to measure customer satisfaction. Thanks to the 70% response rate during COVID they "obtained a tremendous amount of information, which was truly beneficial." They used this visitor data to customize their newsletter and promote events that could of interest to the visitor. Furthermore, they developed personas, although it is acknowledged that their alignment with ticketing data may not always be seamless. B2 is standardizing its report with Python thus making it ready for analysis. Finally, B4 is producing reports just on weekly basis about exhibitions and they report on a monthly basis to the director. Due to the desynchronized data, they cannot produce dashboards themselves. For this, they have to hire an external expert. The process of data collection and data analysis is summarized by Figure 3.

To conclude, N1 and B3 is already doing some activities in order to use data analytics in their daily operation, but the still lack a holistic overview and need to deepen their knowledge. However, they are still advanced compared to the rest of the museums, where initiatives were taken, but data analytics were not fully in action. The problem with these museums is that due to their lack of expertise and scarce staff they are rather fixing the problems of yesterday than trying to create a brighter future.

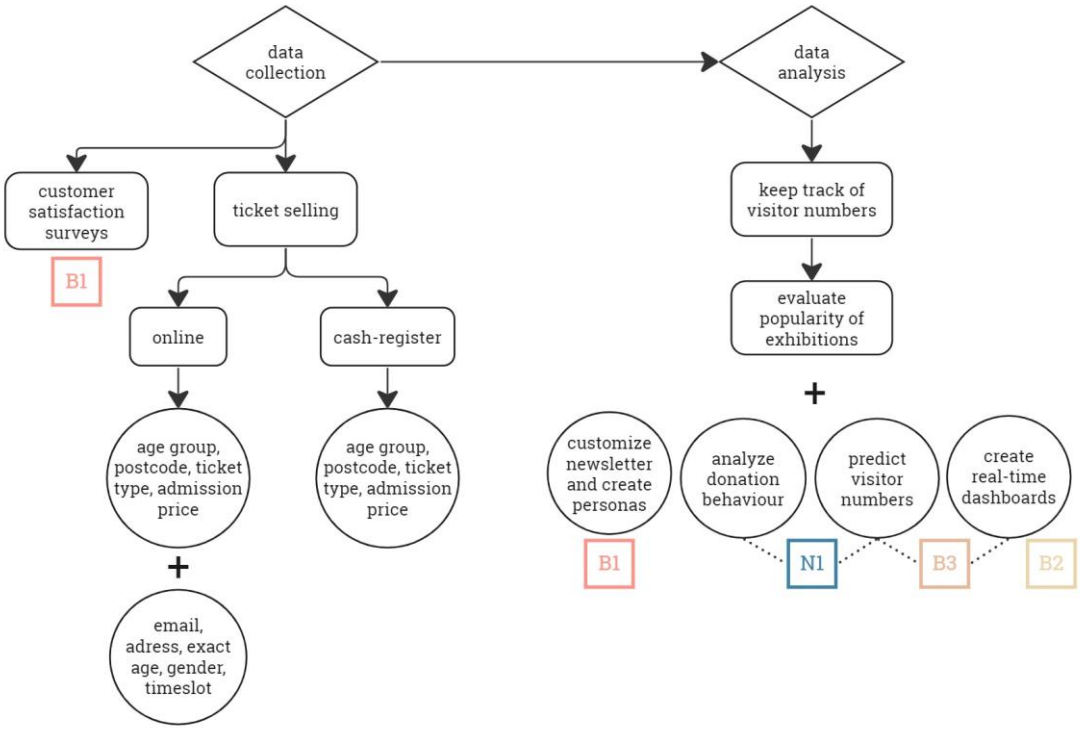

Figure 3. *Data collection and analysis in museums*

4.2.7 Final conclusions regarding data maturity

The division in this former step determines clearly the success of the last one, as presented in Table *3*. Since B1, B2 and B4 did not gain valuable insights from data yet, they cannot do much to integrate their findings into their daily functioning. Contrary, N1 effectively disseminates the insights and outcomes, such as the donation strategy and visitor number implications, to its employees, fostering an informed and engaged workforce. Moreover, at B3 the salesforce shows the reports and dashboards to a customer success manager at the weekly meetings where they address the observations that have a greater impact on several sides. Hence, in N1 and B3 there are already some signs of data-strategy implementation, but naturally it still in an initial phase. Also, these division between the museums could be explained also by their size. Namely, the more advanced N1 and B3 are medium sized museums, while B1, B2 and B4 are smaller ones.

Table 3. *Data maturity among museums*

5 Results

The results of the cross-case analysis will be discussed in the three dimensions of the critical success factors. The general data-intelligence system that these museums were using were implemented a long a time ago, before the selected informants were even working at the organisation. However, there was one recent extension to the data intelligence system that each museum implemented: the e-ticketing system. As discussed, for most museums offering the possibility to buy tickets online was a consequence of the COVID-19 restrictions. The investigation and comparison of e-ticketing implementation cases, along with their integration into pre-existing data intelligence systems, will provide a comprehensive understanding of museums' overall data intelligence systems and reveal factors that contribute to the success of such systems.

5.1 Organizational factors

5.1.1 Leadership and support

The leadership in museum context usually consisted of governments, municipalities, museum directors and the high-up managers. In general, the support from the leadership was expressed in all museums, but on different levels, as presented in Figure 4. In B1 and B4 were difficulties with dependencies on the ICT department and municipality. Sometimes it was hard to be on the same side and to provide appropriate infrastructure for the museums. However, in the end they managed to be on the same page and the museums enjoyed the support of the leadership. In the other museums the leaders took more initiative and try to actively help with the transformation.

For instance, at N1 the impetus for the data-intelligence initiative originated within the organization itself, driven primarily by the informant himself, taking into account their independence from government influence. Subsequently, the initiative gained significant traction when the informant engaged in discussions with the leadership team of another Dutch museum. A shared realization emerged, recognizing the similar challenges faced by both institutions and the imperative to forge collaborations among multiple museums to identify a collective resolution.

Moreover, at B2 the support continued even after the implementation. “The museum director was the driving force behind the switch to the online ticketing, but she's still the driving force behind the more data driven.” Recognizing the limitations of the existing reports from the system, she emphasizes the need for a shift towards interactive dashboards. This would enable her to access key information, such as monthly visitor statistics, more efficiently and swiftly. Finally, by coincidence, B3 intended to close around the same time as the pandemic occurred to renew their permanent collection. Thus, for them, the transition to becoming more digital was already on the agenda. They a did extensive research on what system to choose and enjoyed the support of the leaders and management even under the unpleasant circumstances of the pandemic.

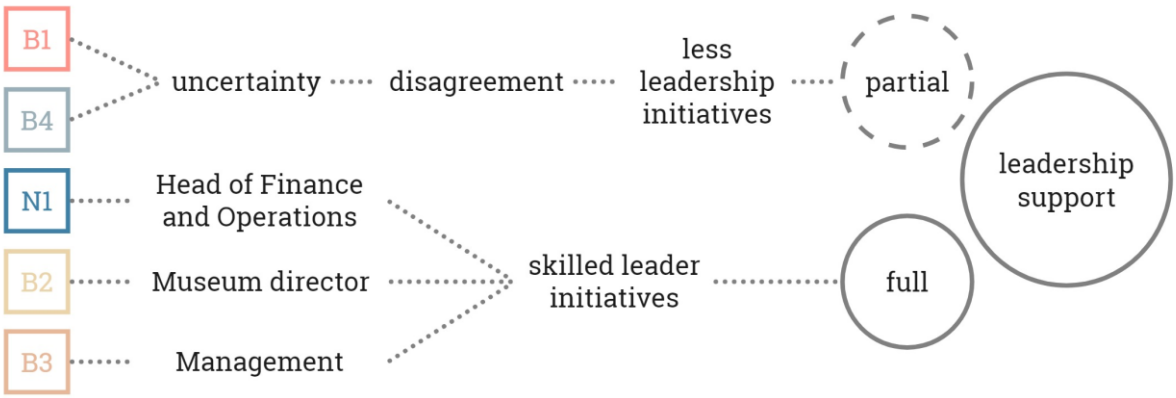

Figure 4. *Leadership and support*

5.1.2 Organization structure

Next to the behaviour of the leaders the structure of the organization as a whole is also playing a crucial role in the implementation. The museums operate within a hierarchical framework at the city level, with various directors and

coordinators overseeing different aspects of cultural policy and leisure activities. However, within the individual museums, the teams are relatively small. While the smaller teams prefer a more collaborative and passionate approach to work, they still acknowledge the need to address hierarchical challenges and make decisions in consultation with the directors (see Figure 5).

Naturally, in the smaller museums B1, B3 and B5, it is easier to maintain a flat organisational structure due to the more frequent contact and collaboration between the employees. Moreover, the lack of resources and expertise under such circumstances evidently lead to more "dependence on both local and national level ICT infrastructure". Thus, a necessary strong cooperation emerged between the departments, who are always in need of help and are keen trying to find common solutions for problems.

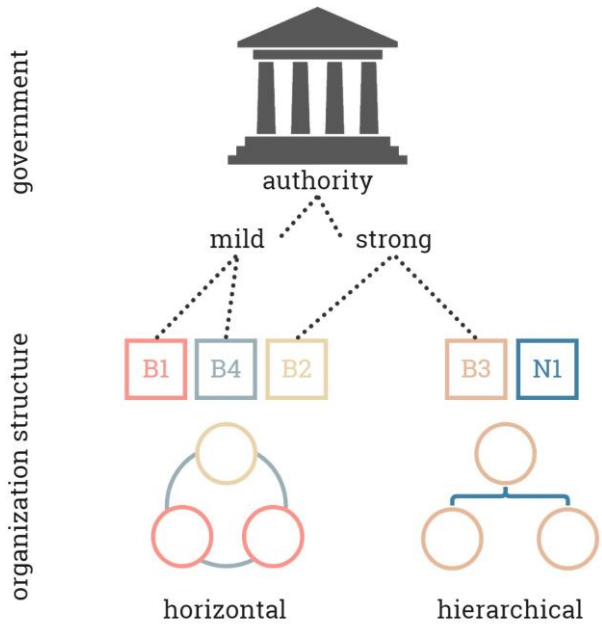

Figure 5. *Organizational structure*

However, in the bigger museums the hierarchy is more tangible with multiple positions coming in-betweens the general employees and the director. In B4, every decision and daily action is defined by the hierarchical structure. Obviously, these characteristics allowed the attempt for modernisation in the museum for which authority is a key component. However, this hierarchical functioning and decision-making takes place without the greater involvement of the average employees who are using the system the most. As a result, the museum chose an "online first" strategy: they sell tickets just online at the website and on spot with a kiosk where visitors can follow the same procedure as in the webshop, but real-time on a big screen at the entrance. Moreover, they made the whole booking process as intuitive and quick as possible with just 4 steps: "choose the tickets, choose the date and time, fill in your data and make the next payment".

Thus, there are just reduced number of receptionist present at the entrance whose role were reduced to simply helping the visitors in case of doubts or questions. Although this might have been a good cost-and time-reducing initiative from the

management, not everything worked out the way as expected. The kiosk has frequent malfunctions which require extra expertise and time to fix, not mentioning the impact on customer satisfaction.

Although in the other bigger museum, N1 organizational structure is also hierarchical, with the informant occupying the highest position as the primary authority figure. Directly beneath him are four managers who oversee the remaining staff members. Notably, the dynamics of their working relationships have evolved into a more informal nature, particularly during the COVID-19 period when meetings were conducted near the coffee machine. This informality has persisted in the organization since then, transforming the organisation into a more horizontal one. This was reflected by the fact the when numerous individuals within the organization were included in the change management who acknowledged the inherent inefficiency of the existing system and emphasized the necessity for a transformative change.

All in all, the organisational structure clearly shaped the success of data intelligence implementation. While in general a networked organizational structure is preferred in the museum, for drastic changes hierarchical power is necessary. Thus, for data intelligence implementation the ideal organisational structure in museums is flat, with a combination of strong hierarchical structure towards the leaders and government. When this right balance is not found, the success of data intelligence implementation is questionable.

5.2 Process factors

5.2.1 Project management

Implementing a new system that were unseen beforehand can be a challenging task, not talking about making effective use of the system. For this, several measures must be taken, which appeared in the case of museums in the form of project planning, organization, timelines, team coordination, risk management, monitoring and evaluation. The participating museums performed differently in these, as presented in Figure 6.

In museums B1 and B4, the project management was quite simplified. They “sat together with a software provider fixing the budget and the planning”. Thus, the implementation was quite quick and obstacle-free. However, the absence of careful

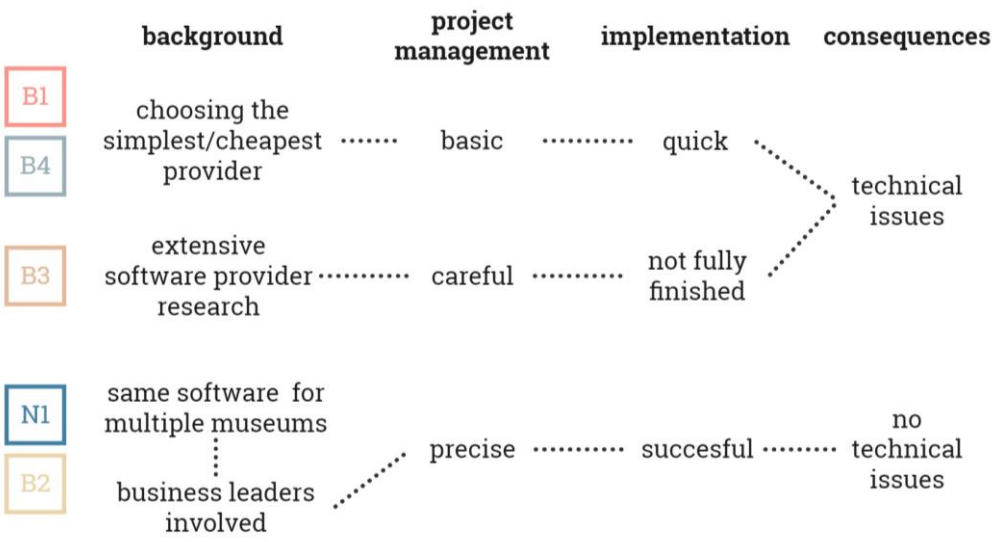

Figure 6. *Project management*

consideration and double thinking resulted in unforeseen issues with the system that had already been implemented. This included integration problems between the online and on-spot ticket selling in both cases, and on top of this B1 also faced problems with payments in the beginning, certain payment methods not being available. However, the museum did not consider this a drawback, stating that "3 months later it was there, so they are also kind of flexible and they listen to you as a customer". Therefore, even though the lack of expertise and well thought-through implementation strategy resulted in later inefficiencies, the museums did not interpret this as a disaster.

Contrary to these two museums, B3 did the planning and evaluation for the choosing of the system really carefully. They took into consideration which players have the "most experience and proximity to the sector" and meanwhile are the most intuitive. Although the option they choose was not the cheapest, they managed to negotiate terms that benefited the museum with comprehensive ticket packages. However, "due to the time constraints, certain parts were not actually finished by the time" they launched their sales. This resulted in significant increase in workload, requiring additional staff. They encountered also unexpected difficulties with the system's own reporting tools. To address this issue, they have shifted their reporting to Salesforce, which caused delays, necessitating adjustments to the project timeline. Thus, the price that they had to pay for this outweighed the benefits, proving that "every integration is a hassle and every API link that is made is also a weakness."

Additionally, team coordination was impacted, requiring additional resources to navigate the integration effectively.

The project management resulted in fully successful implementation only in B2 an N1. In B2 the implementation plan for the museum's system change was primarily driven by the involvement of the city and its separate organizations. Undeniably, it was “the business team, the business director, and the commercial director” who “started project management because then it was not a single museum that switched to the system”, but “six museums which is also commercially better.” Thus, the driving factor behind the more precise project management was in fact the realization that the involvement of multiple museums is only possible with a clear, well-structured plan.

In N1 the project management was also outstanding, and the museum kept this attitude also for future projects. They are planning on having a common system with multiple other Dutch museums, following the example of B2. For this, they have already hired a project manager who is an expert in e-ticketing software and has extensive knowledge about museums. The group of museums has a clear plan, and they have frequent meetings in order to organize and manage the software choosing and implementation process optimally.

5.2.2 Training and education

Overall, the implementation of the system across all museums showcased diverse project management skills. Due to the lack of expertise and experience the one thing that none of the participants could predict was whether the museum will actually be able to use the system. For this, naturally, training was needed (Figure 7). Initially, the training and education was similar across museums: when the e-ticketing system was introduced “consultants were hired to organize workshops and teach the basics” for every employee involved in the use of the system. Usually, this meant just the people at the service desk and a few people in the back with administration and ICT. In general, all systems were quite intuitive, so these trainings did not take up much time and effort. However, as the path advanced, the systems encountered more challenges, and how museums addressed these challenges varied significantly.

In B1 and B4 “the system was getting more complicated, so resistance appeared”, which posed challenges for managing activities, scheduling, and staff backup. In the case of B1, where this resistance was stemming particularly from the reception staff, efforts are being made to include them in the new system's development that the city is currently building with the help of experts. In the case of B4, the ICT employee was trying to customize the system to make it more user-friendly and structured, however the invested time and effort compared to the impact was negligible.

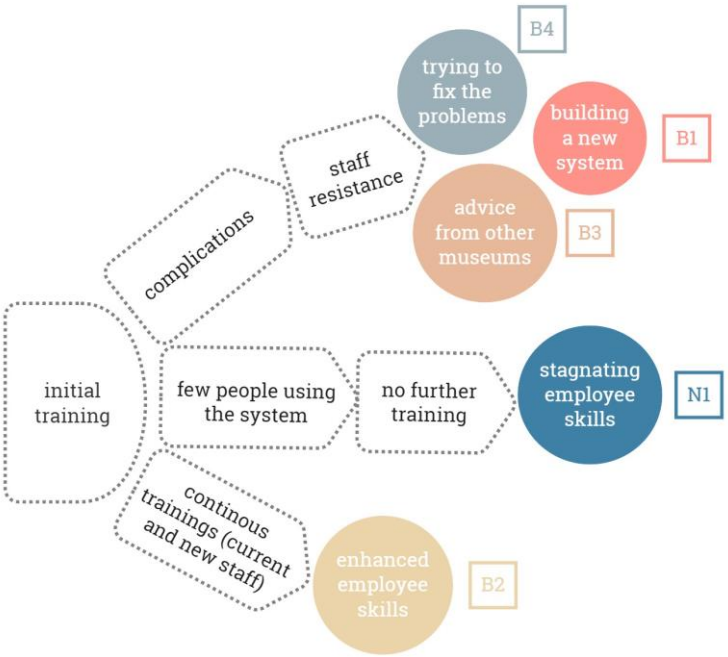

Figure 7. *Training and education*

In N1, the online system relied on a small workforce of one to two individuals, reducing the need for extensive training interventions. In contrast, the service desk, which is inherently complex, was initially approached with a comprehensive "tech everything" strategy, requiring the acquisition of broad technical knowledge from the beginning to effectively handle its intricacies. B3 had a similar strategy, however, they encountered multiple technical problems even after trainings. Therefore, they took the initiative to contact other museums in Belgium and the Netherlands using the same system. They soke for advice from these more experienced museums and collected useful information about how these organisations handled the same problems, if occurred.

B3 implemented the most advanced strategy in terms of training and education. The museum actively organizes trainings and workshops to facilitate the use of the new system, not only for “current staff members working with the robotics”, but also for “new people coming into the organization”. This approach extends beyond the new system to include other systems such as Teams and

OneDrive, where similar trainings and workshops are conducted to ensure efficient utilization by staff members.

5.3 Technology factors

Considering that in all museums the data quality and the information system quality were highly dependent on each other, the results about the technology factors of data intelligence systems are handled jointly (Figure 8). Were the network of information systems not well integrated, it resulted in bad data quality. Evidently, this is also influenced by the share of online ticket purchases, since the online data outperforming the on-spot collected data. In each case museums must put a lot of effort and time to increase the data quality and exploit insightful information about their operation. Some museums choose to improve their information systems and data quality by integration projects and data manipulation (B2 and B3), some just lack the resources to enhance anything (B1, N1 and B4). Therefore, it is no coincidence that each museum of the second group is currently searching for alternatives to their systems.

B1 relies on two separate systems. The box office for bookings currently operates separately from the e-ticketing system. Consequently, they "have to put the separate data together when making the annual report, and combining those two visitor figures is cumbersome". In the past, they attempted to create a dashboard to consolidate data, but its usage has dwindled due to a decrease in online bookings. In N1 the situation is even more complicated, since next to this, the gift shop also functions with a different software. Thus, the current operational setup of the museum involves the utilization of three distinct systems. While the existing cash

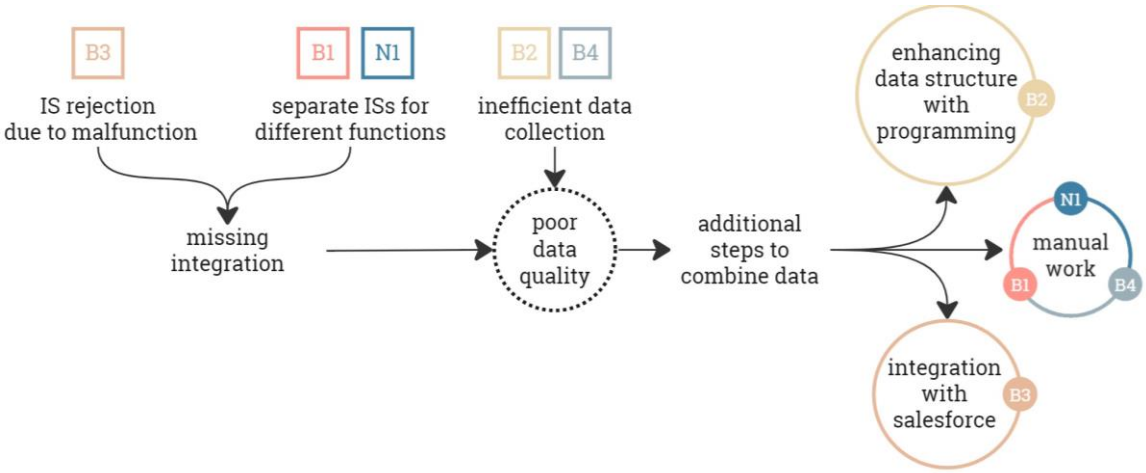

Figure 8. *Information systems and data quality*

register system fulfils the essential requirements of ticket sales, encompassing both individual and group bookings, it is noteworthy to highlight that this system is antiquated and lacks contemporary functionalities. Despite its capability to handle the necessary tasks, the outdated nature of the cash register system hinders the museum's ability to leverage modern technological advancements and potentially inhibits operational efficiency and customer experience enhancements.

In B3, which followed a more tech-savvy approach, the information systems did not function optimally either. They began selling everything online but encountered difficulties, particularly with group bookings, as people found it challenging to navigate the system. As a result, they temporarily "stopped selling group bookings online and started receiving bookings over the phone" due to the incomplete integration. This resulted evidently in loss of potential visitors and decline in data quality. Moreover, they could not extract data properly, so they had to integrate the system with the Salesforce and the guides, where the CRM was also impacted. On top of that, there were also malfunctioning with the kiosk which "regularly has those bugs that the screen jumps to wrong pages, the printer is acting weird, the paper is cut wrongly, and weird tickets come out ". This is against the original idea of the kiosk, which was meant to ease the ticket purchase and information collection process.

5.4 Overview

Since B2 and B4 have the same back-end system, so they are facing the same problems. Namely, the only way they can collect on spot data about the visitors, such as their age, is by creating ticket subtypes. This means, that all data is extracted in the form of these hundreds of different categories. Naturally, it requires a lot of manual formatting so that the data is in a useable format. B4 does not have employees with advanced technological skills, so they are struggling with this. Furthermore, they faced integration problems with the on-spot and online ticket purchase, and as a result the service desk was forced to fill in the online reservation data manually, thus ruining the whole point of online ticketing. On the contrary, B2 has the necessary resources to make a change. The digital strategists are "writing a tool at a moment by reading the standard reports into Python and changing it into a database structured way of data." As a next step, self-made automatic dashboards can be built out of the high-quality data.

Table *4* summarizes the findings about the CSFs and data maturity in the context of museums. What is apparent is that the smaller museums are categorized as immature compared to the medium-sized museums, regardless of the preconditions. In other words, even though the museum that performed overall the best in CSFs is B2, this is not reflected in its current data maturity. This is due to the fact that the museum has the foundations and motivation to become more data-driven, but their transition process is not finished yet. Hence, this maturity could already change in the upcoming years. This is less likely in the case of B1 and B4, where there were too many missing elements that serve as base for data-centric organizations. While B4 did not do any steps yet for improvement, B1 has already tried some data-driven approaches, they failed due to the lack of online purchases and poor data quality.

Therefore, the most advanced in data maturity are N1 and B3, the two medium sized museums. They already felt the taste of what it is like to take the opportunities and put them into action. They have the frameworks to communicate the insights and integrate them into the operations. However, these insights are not gained by traditional data analysis, but rather by personal observations. Hence, a deeper dive

	crtitical success factors	B1	N1	B2	B3	B4
organization	1. leadership and support	✓	✓	✓	✓	✓
organization	2. organizational structure	✓	✓	✓	✓	✓
process	3. project management	✗	✓	✓	✗	✗
process	4. training and education	✗	✗	✓	✓	✗
technology	5. information systems	✗	✗	✓	✗	✓
technology	6. data quality	✗	✗	✓	✓	✗
	data maturity					
	1. identify opportunities	✓	✓	✓	✓	✓
	2. data collection	✓	✓	✓	✓	✓
	3. data analysis	✗	✓	✗	✓	✗
	4. implementation	✗	✓	✗	✓	✗
	overall	rather immature	rather mature	rather immature	rather mature	immature

✓ adequate
✓ rather adequate
✗ rather inadequate
✗ inadequate

✓ successful
✓ rather successful
✗ rather unsuccessful
✗ unsuccessful

Table 4. *Combined results of CSFs and data maturity*

into data is still missing from these institutions to make them completely mature and data driven.

6 Discussion

The aim of this paper is on one hand, to discover the steps museums have taken in order to develop data driven strategies, and on the other hand, to identify the critical success factors for data intelligence implementation in museums. Overall, museums are not fully data-driven yet. The steps they have taken to improve differ based on size, history, and organizational culture. Several studies (Acelera pyme, 2023; Future Museum, 2021; Gobble, 2018) indicate that many organizations, regardless of their size or background, have not fully embraced a data-driven approach. While larger museums have been more proactive in implementing data strategies, smaller museums lag behind due to resource constraints and limited expertise. The findings suggest that there is still a gap between the potential of data-driven decision-making and its actual implementation in museums. Furthermore, the findings highlight the current state of data-driven practices in museums and emphasises the need for further efforts to promote data-driven culture.

6.1 Opportunities and Transformations for Museums in the Digital Age

First, all museums identified opportunities for the implementation of a data-driven strategy. This means, that although they are not data-centric institutions in their nature, they see the value of fast-changing technological developments and are open for adjustments. Consequently, museums are poised to undergo significant transformations akin to the early 21st century when they had to restructure their business models to emphasize commercial viability. Recognizing the need to adapt to the evolving landscape, museums now envision the next era, which involves formulating comprehensive data strategies to address present challenges through the effective utilization of data and technology. This mentality is in harmony with the recent technological initiatives among more advanced museums (Future Museum, 2021; LinkFactory, 2022), thus proving that they are on the right path.

Second, some museums, especially smaller-sized institutions, face limitations in advancing beyond the stage of data collection due to resource and expertise constraints, resulting in a lag in harnessing the full potential of data analysis. Although data collection is a common practice among museums, in each case the

collection ended with poor data quality. Essentially, quality data is a precondition for data analysis, and unless measures are taken to enhance data quality, progress beyond this stage is not viable due to various challenges. Smaller-sized museums, in particular, encounter difficulties in moving towards comprehensive data analysis. This limitation is often attributed to their limited resources, including budgetary constraints and a lack of specialized personnel with data analysis skills. Consequently, these museums struggle to fully exploit the wealth of insights that can be derived from data analysis, inhibiting their ability to make informed decisions and develop effective strategies.

Previous studies on technological advancements in museums, such as those by Kamariotou et al. (2021) and Minoska-Pavlovska (2019), primarily concentrated on big museums and did not adequately consider the situation of smaller museums. Thus, this finding contributes to the existing body of knowledge by emphasizing the specific challenges faced by smaller museums in advancing beyond data collection towards comprehensive data analysis. By highlighting the resource and expertise constraints, this study sheds light on the need for targeted support and interventions to empower smaller museums in leveraging data effectively. Understanding these limitations can inform policy and resource allocation decisions to enhance the data analysis capabilities of smaller museums, ultimately benefiting the cultural heritage sector as a whole.

Third, the medium-sized museums have made significant progress in adopting data-driven practices by integrating systems and reorganizing their data infrastructure. This proactive approach will enable them to effectively visualize the data and use it as a foundation for informed decision-making. So, in contrast to smaller museums, medium-sized museums have taken more steps in data maturity. Their efforts indicate a readiness to embrace data-driven strategies, even though complete implementation may not be present at the current moment. This finding contributes to the understanding that medium-sized museums are actively working towards becoming data-centric institutions.

6.2 Critical Success Factors for Data Intelligence Implementation

After evaluating the data maturity of museums, the preconditions of the outcomes were identified by analysing the CSFs for data intelligence implementation in museums with the example of introducing e-ticketing at the emerge of the COVID-

19 pandemic. The CSFs were analysed in three dimensions, namely, organisation, process and technology.

6.2.1 The Role of Government-Museum Relationship

The findings indicate that organizational factors play a significant role in shaping the implementation of data intelligence systems in museums. The study revealed that most museums had a flat organizational structure within their institution, but there existed a hierarchical relationship between the museums, directors, and government officials. The strength of the government authority correlated with the level of leadership power during the implementation. Consequently, in governments with strong authority, the leadership had greater control over the implementation of data intelligence systems, leading to more expressed support and technology-related skills. While a flat structure inside the museum promotes collaboration, creativity, and flexibility, the findings highlight the necessity of a strong vertical tie due to the public dependencies of museums.

The study suggests that without a strong hierarchical government-museum tie, the leadership is unable to provide the required support and knowledge for the successful implementation of challenging data intelligence projects. This does not completely align with prior research arguing that for effective utilization of the system, it is crucial that the motivation for implementing new systems originates from within the organization (LinkFactory, 2021; Merhi, 2021). Hence, this study is contributing to previous research by emphasizing the recognition of the unique context of museums, where a balance between a flat internal structure and a strong vertical tie is crucial. By highlighting the need for effective leadership support and knowledge sharing, this study provides valuable insights for museums seeking to implement data intelligence systems successfully.

6.2.2 Project Management and Continuous Learning

The presence of effective project management and trainings significantly influenced the success of implementing data intelligence systems in museums. Museums lacking strong project management champions with clear plans, strict time schedules, risk management, and evaluation processes faced ongoing complications. These complications resulted in additional staff, costs, time, and effort requirements, impacting the overall functioning of the museums. Conversely, museums with

competent and ambitious project planners successfully implemented the systems within the designated time frame, experiencing no malfunctions or complaints. Furthermore, the evolution of the system is highly dependent on employee skills. Museums which do not encourage continuous learning cannot fully exploit the opportunities of the system, no matter how well the project management was.

This finding aligns with previous studies that emphasize the importance of project management in the successful implementation of systems (Becerra-Godínez et al., 2010; Merhi, 2021). It echoes the notion that neglecting project management skills can lead to long-lasting complications and hinder the functioning of organizations. Conversely, strong project management practices contribute to smoother implementation and operational efficiency. This study contributes to the existing literature by stressing the importance of project management in the context of data intelligence system implementation in museums. It points out the need for clear plans, strict time schedules, team coordination, risk management, and evaluation processes to ensure successful outcomes. Furthermore, the study underscores the importance of continuous learning and seeking external advice for improved performance, which was not highlighted in previous studies (Konings & Vanormelingen , 2015; Becerra-Godínez et al., 2010). It also raises awareness of the limitations of providing only initial training, suggesting the need for ongoing training and education to maximize the potential of data intelligence systems in museums.

6.2.3 Integration and Data Quality Challenges

Lastly, the technological factors were undoubtedly the weaknesses of museums, influencing their operation drastically, particularly in terms of information systems and data quality. Small and medium-sized museums face challenges due to the lack of full integration between different systems and inefficient data collection. This issue stems from the historical transformation of museums, where additional systems were implemented instead of reconfiguring existing ones to meet new requirements. As a result, many museums have multiple separate systems that struggle with data integration and encounter difficulties in maintaining appropriate data quality. The poor data quality necessitates extensive editing and manual work, which wastes the museum's resources. Consequently, the visualization of data through dashboards remains a challenging task for these cultural institutions, leading to confusion in deriving insights.

This finding aligns with previous studies discussing the impact of technological factors on data intelligence (Merhi, 2021; Redman, 2008; Wu, 2016). It reinforces the notion that fragmented and non-integrated systems can hinder data quality and slow down the effective utilization of technology in museums. The challenges related to data integration and visualization is not only restricted to museums, since it is resonating with the technological limitations in the whole cultural sector. Thus, this study suggests the need for comprehensive system integration and data quality improvement to enhance operational efficiency and optimize resource utilization. Addressing these technological weaknesses is crucial to empower museums in effectively leveraging the potential of data-driven insights.

6.3 Implications for Practice and Research

Based on the findings, this study poses several implications for practice to put museums on the right path to become more data driven. First, museums should consider the CSFs for data intelligence implementation before taking drastic measures. A crucial precondition for success is the structure of the organisation itself. Museums should establish a healthy, flat work environment inside the museum to work efficiently and realize the values of the measures. However, unless there is a clear hierarchical relation towards the government, which is providing its high-skilled officials and support, the implementation will likely fail due to the lack of professional planning.

Second, this professional planning is inevitable for sufficient project management. Museums should take advantage of their special situation and show their need for the government in the effective implementation. Would the government not take much responsibility for the project, either champions from the organization or external experts should be contacted to lead the project. Furthermore, while initial introduction to the software is evident, managers should encourage continuous learning with organized workshops in order to keep up to date with everything and harness undiscovered opportunities.

Third, museums must recognize the vulnerability of fractured, disconnected information systems. They should take the initiative to prepare integration plans or just simply invest into a completely new integrated system. Even after the unification, they have to pay special attention to data quality. They must make sure that the data is easily extractable and in a proper format in order gain a holistic overview of their

activities. Furthermore, it is advised to ensure that all departments have access to the relevant data, in order to accelerate information flow. If these measures were taken, the chances of successful data intelligence implementation and operation optimalization will be higher. Thanks to these measures museums will not have to be stuck on the level where they just recognize the potential opportunities, but they will have the capabilities to actually make a change, thus closing the gap between intentions and actions.

The overall conclusion of the study is that museums differ from business organisations. While in business organisations the decision making is in the hands of the organisation leaders, museums have to find the balance between the dependency on the governments and initiation from the museum itself. That makes any kind of organisational change a more complex phenomenon in museums. Furthermore, due to these dependencies' museums were for long protected from the shocks of the market and they have neither the experience nor skills to keep up with the technological advancements on their own. There is no clear role assignment for who should oversee digital transformation in museums. If the museum is lacking the digital champions who will lead the way and are well-knowledge in the field, the incentives to become more data-driven is unlikely. This is lack of experts is reflected by the fact that it is the technology factors that museums are lagging behind the most, and the gap between data collection and a data analysis is depriving them to use their resources to improve.

General businesses are self-dependent organizations which are constantly competing and thus are forced to be innovative and do individual improvements for their survival. Conversely, even if this this urge for innovation is present in museums, it is way harder to start the process. Hence, the digital transformation in museums should be rather a collaborative, than an individual approach. The findings show that museums jointly can achieve much more, since this common purpose and greater commercial power inspires the building of the necessary infrastructure and attracts investments. Moreover, the museum sector is a uniquely homogenous sector, where the operation and culture of museums are extremely similar, with just a few additional differences. This serves as a great base for efficient cooperation and insightful information exchanges, thus making it possible for museums to help each other in their development journey.

6.4 Limitations and Future Research

Obviously, the cross-case study included museums from the Low Countries. Especially in publicly funded organisations the decisions are greatly dependent on governments. Naturally, these governments differ not just on country level, but on municipal level. Consequently, the situation of the museums in this study might differ from the situation of other museums in the world. Furthermore, no quantitative metrics were used, the research relied purely on existing literature and the conducted interviews. AI-generated code schemes were applied to make interpretations more objective and to prevent the conclusions to be biased, but manual organisation was necessary to structure the interviews into an insightful structure. Moreover, the conducted interviews were conducted online, which is undeniably less effective than in person.

As the cultural and creative sector is rising, the role of cultural institutions is becoming bigger and bigger. Cultural institutions, and in particular, museums, are great sources of socio-economic development and deserve more focus. The chosen museums were eager to participate in the interviews and suggested further coworking between each other in order to overcome the challenges all of them are facing. The idea of a museum association could be great start for a common representation of the challenges that museums are facing in the digital era. The findings of this study can be taken as a starting point for taking real actions in museums. For future research an empirical observation is suggested to see whether the success factors truly cause measurable improvements in museums.

7 Conclusion

The purpose of this study was to examine the progress made by five small to medium-sized museums in implementing data-driven strategies and identify the necessary conditions for their data maturity. These conditions were identified as critical success factors for the implementation of data intelligence, categorized into organization, process, and technology dimensions. The results indicate that the museums perform well in terms of organizational factors but lag behind in technological factors. In general, the identified critical success factors are essential prerequisites for museums to become data-driven organizations. However, meeting these prerequisites alone is insufficient for achieving complete data maturity.

Currently, individual tasks present a significant challenge for museums to accomplish. Hence, collaborative efforts among museums are required to fully utilize their potential and establish innovative, technology-oriented processes.

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Appendix

Themes	Questions
General questions	1. Which e-ticketing system are you using and why? 2. How is the process of booking the ticket both for guests and employees? 3. How do you use the visitor data from the system? 4. What are the main advantages and disadvantages of the system? 5. What are your plans for the future?
Data maturity	6. **Identifying opportunities:** did you think of opportunities regarding what you can do with the data (crowd management, marketing, human resources, etc.) 7. **Data collection and analysis:** • What types of data is the museum collecting? • Do you use the collected data for analysis, for example in the form of spreadsheets and data visualisation software? 8. **Implementing data strategy:** • What do you do with your results? Do you publish it or share it with the different stakeholders? • Do you measure and evaluate the impact of the efforts? • Do all employees have access to the relevant data information?
Critical Sucess Factors	9. What do you think are the most important factors that influence the success of the implementation of e-ticketing systems? 10. **Leadership**: was there support from the leaders of the organisation in the implementation of the system? By leaders I mean both museum directors, the city, the municipality, whoever was in power of decision making. 11. **Organisational structure**: How is your organizational structure? Do you have a hierarchical or more networked organisational structure? So in other words, is there a clear vertical distinction between positions or are the employees working horizontally, in small teams based on their skills? 12. **Project management**:how was the implementation process planned, and did go everything as expected? 13. **Training and education**: Do the employees know the system well? Did you organize trainings and workshops to improve their skills?

Table 5. *Interview questions.*

Statement of originality

By signing this statement, I hereby acknowledge the submitted thesis (hereafter mentioned as "product"), titled: **Data-Driven Strategies in Museums: A Cross-Case study in the Low Countries** to be produced independently by me, without external help.

Wherever I paraphrase or cite literally, a reference to the original source (journal, book, report, internet, etc.) is given.

By signing this statement, I explicitly declare that I am aware of the fraud sanctions as stated in the Education and Examination Regulations (EERs) of the SBE.

Place: Maastricht

Date: 20.06.2023

First and last name: Blanka Móri

Study programme: Business Intelligence and Smart Services

Course/skill:

ID number: i6295037

Signature:

Sustainable Development Goals (SDG) Statement

Name Blanka Móri
ID i6295037
Supervisor Lars Rieser
Date 20/06/2023

Through the research conducted for this master's thesis, I seek to contribute to one or more of the 17 SDG(s) set forth by the United Nations (https://www.undp.org/sustainable-development-goals). Specifically:

SDG Code(s): 8,9,17

Explanation (max. 300 words):

Firstly, this study enables museums to improve their operational efficiency and visitor experiences, thus fostering economic growth. Through visitor data collection and analysis museums can tailor their exhibitions and events according to the demand. The result of this approach is growth in revenue due to the rise in ticket sales combined with improved visitor satisfaction and merchandise. Consequently, by using the findings of this study museums can contribute to local economies by creating employment opportunities and generating income for local businesses.

Secondly, data-driven strategies promote industry, innovation, and infrastructure within the museum sector. The adaptation of digital technologies and data analytics tools is a fundamental principle for museums to attract the young

generation and thus spread the knowledge about culture and history. For the implementation of these technologies a collaboration with technology companies is necessary, which fosters an ecosystem of innovation leading to the growth of the digital economy.

Moreover, data-driven strategies encourage partnerships for the goals by facilitating collaboration between museums, academia, government institutions, and private sector organizations. Data and knowledge sharing in this diverse network can generate new insights and as result, inspire research, and educational initiatives. Cooperation between museums helps in data analysis and interpretation, which is crucial to identify social and cultural trends. These partnerships enhance the overall impact of museums, creating the base for effective policy making while promoting societal inclusion, education, and cultural preservation.