



The role of AI in museums' journey towards sustainable development: Socio-technical imaginaries of a cultural and organizational transformation

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ABSTRACT

Artificial Intelligence (AI) is beginning to revolutionize numerous sectors, including that of museums. This paper explores the socio-technical imaginaries (STIs) held by key stakeholders in the sector to examine how the introduction of AI may influence the socio-economic and environmental dimensions of museums, both positively and negatively.

Adopting a qualitative approach, the paper analyzes the perceptions and expectations regarding AI integration in the museum based on semi-structured interviews with museum representatives, public administration officials, private sector representatives and cultural and visitors' associations. The four emerging STIs provide an overview of the current perspectives of various stakeholders. For each imaginary, the socio-economic and environmental contributions of AI adoption are examined using the Sustainable Development Goals (SDGs) of the 2030 Agenda as a reference framework. Additionally, the paper identifies and discusses the tensions related to these contributions as perceived across different imaginaries.

The study outlines managerial and policy implications to facilitate AI integration that is both sustainable and inclusive, while ensuring the protection of cultural heritage and the well-being of sector professionals.

1. Introduction

AI, defined as a set of emerging technologies “that can sense their environment, comprehend the collected information, learn, and derive actions based on interpreted information and their implemented objectives” (Collins et al., 2021, p. 7), is increasingly recognized as a transformative force across various sectors (Appio et al., 2023; Dicuonzo et al., 2023; Leone et al., 2021). Alongside the many studies that tend to focus on largely utopian corporate visions of AI (Hilb, 2020), other studies adopt a more nuanced perspective, exploring both the positive and negative contributions of AI (Etzioni and Etzioni, 2017; Nazareno and Schiff, 2021). Recent research examining the socio-economic and environmental contributions of AI highlights that these effects can vary significantly across different sectors, emphasizing the importance of sector-specific studies (Vinueza et al., 2020).

In this context, one of the fields where AI is expected to play a crucial role is the museum sector (Wang, 2021). Indeed, such a sector is beginning to be studied through a range of AI applications, from

tailoring visitor experiences—for example, through the creation of AI-based chatbots to suggest personalized exhibition routes (Gaia et al., 2019)—to implementing methods for art preservation (Liu et al., 2024; Prados-Peña et al., 2023), and even using AI to analyze visitor behavioral data to optimize exhibition layouts (Ivanov, 2023; Ciecko, 2017).

However, a comprehensive analysis, based on the perceptions of those operating in this context, of the positive and negative socio-economic and environmental contributions of AI's introduction has yet to be conducted. The need to address this gap in the literature is clearly highlighted by recent policy documents. Given AI's actual and potential power, as well as its associated risks, national and supranational institutions (e.g., Council of Europe, 2024) are working to regulate AI to limit applications that may generate ethical risks (Astobiza et al., 2021). In this context, the European regulation, through the AI Act, explicitly cites museums as spaces where rules should be enforced to ensure the optimal integration of AI with minimal negative impacts (European Parliament, 2024). To date, even though some restrictions have already been identified, the potential contributions of AI in the

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cultural sector, including museums, remains partially explored.

Examining the contribution of AI in museums is pivotal, also in light of the new central mission of museums: sustainability. In 2023, the International Council of Museums (ICOM) redefined museums as “[...] permanent institutions in the service of society that research, collect, conserve, interpret, and exhibit tangible and intangible heritage. Open to the public, accessible, and inclusive, museums foster diversity and sustainability [...]” (ICOM, 2023). In this context, AI might enhance operational efficiency and visitor engagement while supporting the broader sustainability goals of modern museums. However, the adoption of AI in museums, as in other industries, might bring uncertainties and potential negative consequences.

In line with these premises, the present study explores the future use of AI through the conceptual framework of STIs (Jasanoff and Kim, 2013). It specifically aims to reconstruct the “collectively held, institutionally stabilized, and publicly performed visions of desirable futures” (Jasanoff, 2015, p. 6) for AI use in museums, based on the perceptions of various stakeholders. While the STI framework has been widely used to reconstruct imaginaries by analyzing policy documents written by nation-state actors (e.g., Hermann et al., 2022), in this research, we sought to reconstruct imaginaries based on the perceptions of various stakeholders in the sector who may play a role in shaping and driving technological development, business adoption, and, also, influencing policy implementation, which is still largely in progress (Foka and Griffin, 2024).

By reconstructing imaginaries, this paper highlights diverse perspectives on AI’s potential positive and negative contributions to museums, as well as the tensions that arise between them. To evaluate these contributions, the study uses the SDGs outlined in the United Nations’ 2030 Agenda (UN General Assembly, 2015). The 2030 Agenda identifies 17 SDGs, and 169 specific targets aimed at guiding public and private actors toward a more sustainable global scenario. By analyzing contributions through the lens of the SDGs, the paper seeks to fully understand how AI can support the broader sustainability goals of museums.

The study was conducted through an extended national case study in Italy, based on semi-structured interviews with a sample of 29 key actors. Numerous studies on the subject examine Italy as a significant case, as it is regarded as a global reference point for arts and culture due to its rich cultural heritage and the high number of sites, thus highlighting its importance (Raimo et al., 2022; Pencarelli et al., 2017; Vesci et al., 2020). Moreover, Italy is among the countries with the highest number of museums worldwide, and represents also a leading country in the implementation of digitalization technologies in museums (UNESCO, 2020), making it an ideal context for analyzing the adoption of artificial intelligence in museums and its implications for cultural heritage management.

The contribution of this paper is multi-layered. By identifying four STIs, it provides an overview of the current perspectives of various stakeholder groups on the evolving contribution of AI in museums and the tensions among these imaginaries. Additionally, it enriches the debate on the conceptual framework of STIs, particularly by contributing to the analysis of imaginaries in sustainability transitions (Birch, 2017; Bulathwela et al., 2021) and, more generally, on how AI can serve as a catalyst for sustainable development (Appio et al., 2024). Finally, the paper offers a series of managerial suggestions and policy implications to mitigate potential tensions between different imaginaries.

2. Socio-technical imaginaries as a lens for understanding the introduction of AI in museums

To investigate the implementation of AI in museums we employ the conceptual framework of social imaginaries. Social imaginaries represent widely shared aggregations of conjectures and stories that are rooted in perceptions, standards, principles, and life experiences (Steger and James, 2013; Taylor, 2004). These imaginaries shape how individuals and groups understand their roles, relationships, and the

functioning of society, influencing everything from daily interactions to larger societal structures and institutions. Imaginaries can be likened to cultural models that aid in comprehending and guiding people’s interpretations of practices, experiences, or, for instance, emerging technologies. Contemporary literature has brought to the forefront the concept of STI (Jasanoff and Kim, 2013; Jasanoff, 2015). STI are regarded as cultural resources’ instrumental in understanding and actualizing new technologies. Jasanoff (2015, p.6) defined STI as “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology”. In the proposed definition, Jasanoff (2015) emphasizes the word “desirable” because initiatives to create new socio-technical futures are usually based on optimistic views of social advancement. Still according to Jasanoff (2015) visions of desirable and desired futures are linked, either implicitly or explicitly, with their opposites, common fears of potential harm from invention and innovation, or the possibility of failing to innovate.

Once specific socio-technical changes have been integrated into corporate and political agendas, stakeholders may begin engaging in various methods of foresight and technology assessment. This allows for a more systematic examination of socio-technical futures, their implications, and opportunities (Georghiou et al., 2008). Imaginaries within a specific technology in a certain sector might play a vital role in shaping and perpetuating the STIs that drive technological development, businesses adoption and influence policy implementation. For instance, Lin et al. (2008) point out that the main public imaginary represented a key market driver affecting the progress of military robotics and the establishment of relevant regulations. Policymakers also might choose among different forms of regulation based on the imaginary created diverting public and private funding or affecting governance choices (Natale, 2019). In other words, the power of STI “is so profound in that they can guide and coordinate action across techno-epistemic networks, establish key political decisions, justify new investments in science and technology, promote certain development pathways, and, even, justify the inclusion or exclusion of certain actors in the decision-making process” (Delina, 2017, p. 49).

The framework of STI has been used in several contexts of empirical investigation. STI has largely been used to understand the design, development, and implementation of energy innovations (Levenda et al., 2019; Chateau et al., 2021). Studies have shown that these imaginaries, which encompass collectively held social beliefs and values, not only shape innovation processes at the national level, but also interact with socio-cultural and political-economic contexts to produce alternatives to national visions (Levenda et al., 2019). STI were used also in consumer research; for instance, Sörum and Fuentes (2023) showed that consumers’ experiences of datafication are shaped by broader STIs that influence how consumers interact with and respond to data-collecting devices. More recently STI were used also to explore AI technology. For instance, Sartori and Bocca (2023) examined narratives of hopes and fears associated with AI, revealing how these STIs shape societal views and interactions with such technology.

STI in the framework under analysis can be represented by collective ideas, perceptions but also hopes and fears about how museums should be organized, managed and experienced by employees and visitors, and how AI can contribute to realizing this vision. These imaginaries might influence not only technological development within museums but also the decision of the business actors, cultural policies and social norms that govern them.

Several studies point out that there are always multiple imaginaries in circulation that are more or less powerful (Mager and Katzenbach, 2021; Van Lente, 2021). Thus, our analytical approach is inspired by prior studies that employed comparisons of imaginaries as an analytical instrument (Strand et al., 2018). In more detail, we aim to understand the STIs related to the introduction of AI in the museum sector and the potential socio-economic and environmental contributions of AI within these imaginaries. The specific research question we aim to answer in

our study is as follows:

RQ1: Which are the STIs associated with the introduction of AI in museums and how do they envision its socio-economic and environmental contributions?

According to [Jasanoff \(2015\)](#), various imaginaries can simultaneously exist within a society and may often be in tension with one another. Nonetheless, certain imaginaries tend to become dominant and deeply integrated into the general operations of societal actors. Imaginaries that critique or oppose these hegemonic ones can be referred to as counter-imaginaries meaning they offer potential alternatives to the prevailing ones ([Sörum and Fuentes, 2023](#)).

STI tensions emerge from actors' bottom-up perceptions and priorities and manifest as points of friction, conflict, or divergence, each presenting distinct values, priorities, and interpretations of how technology might address problems and deliver benefits ([Hermann et al., 2022](#)). In this context, alternative imaginaries seek to articulate different socio-technical arrangements that reflect varying values and notions of progress. STIs oriented toward visions of progress and economic growth may highlight AI's potential to improve working conditions by reducing workload and optimizing workers' time. However, these perspectives may conflict with imaginaries that emphasize how automation could diminish employment opportunities by replacing workers. Thus, sustainability, understood through the triple bottom line framework ([Alhaddi, 2015](#)), can serve as a benchmark for examining these tensions ([Miller, 2005, 2020](#)).

Within the context under investigation, the 2030 Agenda can thus be considered a framework for mapping and evaluating these tensions, offering insight into how conflicting visions of progress—such as those prioritizing economic growth, social equity, and environmental sustainability—coexist and challenge one another in societal contexts. Indeed, the heterogeneity of the SDGs, with some being more socially oriented, others environmentally focused, and others economically driven, allows them to be used for monitoring unbalanced approaches to AI implementation that selectively pursue certain SDGs while neglecting others or overlooking potential negative impacts ([Ferrón Vílchez et al., 2022](#)).

Studying these tensions provides insight into how different imaginaries become institutionalized and the mechanisms through which certain visions gain dominance over others. It helps to reveal the processes of production of social order and technology, where imaginaries not only reflect but also shape societal values and norms. Thus, the second research question we aim to answer in our study is as follows:

RQ2: Which are the main tensions between the existing STIs associated with the introduction of AI in the museum sector?

3. Methods

3.1. Research design

We conducted an extended case study in Italy to address the identified research questions. Extended case studies provide the opportunity to gain a comprehensive understanding of a contemporary phenomenon within a real-life context ([Yin, 2013](#)). In more detail, the research design is articulated into three distinct phases: data collection, data analysis, and interpretative narrative construction.

3.2. Data collection

With regards to the data collection phase, 29 semi-structured interviews were conducted and subsequently analyzed. A semi-structured protocol was designed to allow for an in-depth exploration of specific aspects, facilitating the collection of comprehensive information ([Raworth, 2012](#)). The selection of interviewees has been strategized to encompass critical stakeholders gravitating around the museum

including: museum practitioners, public administration officials, private sector representatives and visitor associations representatives of civil society, ensuring a holistic understanding of the subject matter ([Table 1](#)).

The interviewee selection has started from the national museum's analysis and has followed two main paths. First, the researchers analyzed the Ministerial list of the institutions accredited to the National Museum System.¹ A set of 25 key museums have been selected according to average annual number of visitors (to have different perspectives related to the dimension), the location (to ensure a full coverage of the national perimeter) and their attitude to be digital. The attitude considered reflects a general disposition towards digital technologies. Specifically, the digital attitude was evaluated with a score ranging from 0 to 2 through an analysis of the official websites (if available) of each museum and the official descriptions provided by the Ministry of Culture. The digital attitude score was determined based on the presence of a website, the availability of online services, AI-based pilot projects for AI implementation. Identifying these characteristics enabled the researchers to diversify the selected sample, ensuring that museums with different variables were included in the analysis and that the emerging results accurately reflected the sector's diversity. The researchers have contacted each of the selected museums by email inviting the directors to take part in an interview, explaining the aim of the research and introducing the semi-structured protocol. Eight of the 25 institutions contacted have positively answered the invitation.

Secondly, at the end of each interview, the researchers asked interviewees to provide further contacts of individuals with roles or responsibilities in the museum sector who might offer relevant experience or perspectives on the topic. New stakeholders have been contacted until the researchers have perceived the achievement of saturation ([Yin, 2013](#)). In mapping potential interviewees and key stakeholders in the museum sector, we aimed to ensure the inclusion of all major actors in this field, drawing on relevant literature (e.g., [Pencarelli et al., 2017](#)).

The benefit of having this double channel of selection is that biases coming from the researchers' perception have been reduced and the maximum variation sampling have been obtained ([Patton, 2014](#)). At least, two researchers took part in each interview. One researcher had the role of conducting the interview, while the other had to take extensive notes. All the interviews have been recorded and subsequently verbatim transcribed.

The interview protocol was designed in four main sections to gather information related to (1) the individual perception and future vision/expectation about the AI application in the museums, (2) the stakeholder vision/expectation about the use and the presence of AI in the museums, (3) the necessary policies to integrate or hinder the AI in such contexts and, (4) the potential socio-economic and environmental contributions, both positive and negative, of AI application in the museums.

3.3. Data analysis

In the inductive analysis phase, we coded the interview data by identifying spontaneously emerging topics during the interviews. The entire coding procedure was conducted using NVivo 12, which allowed for the systematic extraction and counting of occurrences for each code ([Adams, 2015](#)). By adopting the approach outlined by [Gioia et al. \(2013\)](#), we analyzed the interviews using open, axial, and selective coding procedures, which allowed us to identify first-order concepts, second-order themes, and aggregated dimensions.

Initially, we conducted open coding to identify preliminary concepts and define first-order concepts. One researcher first delineated these concepts from the data, after which the other researchers collaborated to discuss and refine them. We then applied axial coding to interpret the

¹ <http://musei.beniculturali.it/wp-content/uploads/2020/01/Elenco-de-i-musei-aderenti-al-Sistema-museale-nazionale-aggiornato-a-maggio-2022.pdf>.

Table 1
Interviewees' profile.

Type of Interviewee	Role	Dimension*	Digital attitude	Id. Cod.	Interview duration (Minutes)
Museum representatives	Director	Small	0	D1	77
	Director	Medium	2	D2	71
	Director	Small	2	D3	48
	Director	Medium	2	D4	49
	Director	Large	2	D5	40
	Director	Large	1	D6	41
	Director	Medium	1	D7	47
	CEO	Medium	2	M1	60
	Digital Manager	Large	2	M2	50
	Digital manager	Large	2	M3	48
	Curator	Medium	1	M4	57
	Multi-media manager	Large	1	M5	55
	Responsible	Small	1	M6	44
	Curator	Small	1	M7	45
	Curator	Small	0	M8	45
	Tour Guide	Large	2	G1	49
	Tour Guide	Medium	2	G2	42
Public administrations representatives	Cultural officer	N.a.	N.a.	PA1	51
	Cultural Officer	N.a.	N.a.	PA2	37
	Ministry of cultural heritage Officer	N.a.	N.a.	PA3	44
	Ministry of cultural heritage Officer	N.a.	N.a.	PA4	47
Private sector representatives	Employee	N.a.	N.a.	PS1	37
	Manager	N.a.	N.a.	PS2	59
	Director	N.a.	N.a.	PS3	56
	CEO	N.a.	N.a.	PS4	60
Cultural association representative	Member (museum association)	N.a.	N.a.	A1	47
Visitor representatives	Founder (visitors associations)	N.a.	N.a.	VA1	57
	Member (Visitors' association)	N.a.	N.a.	VA2	42
	Member (Visitors' association)	N.a.	N.a.	VA3	67
					Tot. 1472

first-order concepts and group them into second-order concepts. In this phase, second-order concepts represent more abstract notions identified by researchers rather than those explicitly mentioned in the interviews (Gioia et al., 2013).

The final stage involved selective coding, where second-order concepts were reorganized into aggregated dimensions. This process also included an analysis and comparison of second-order concepts and aggregated dimensions with relevant AI literature. This iterative and collaborative approach was instrumental in mitigating interpretative biases, thereby enhancing the validity and reliability of our findings. The representation of first-order concepts, second-order themes, and aggregated dimensions is displayed in Fig. 1.

To categorize the different perspectives of the respondents and identify possible imaginaries from the interviews, we employed a clustering approach. Specifically, we used the eight aggregated dimensions identified and mapped their presence or absence in each interview. For each interview, the eight aggregated dimensions were thus binary coded and weighted equally. Subsequently, a hierarchical cluster analysis was conducted, following previous research (e.g. Michelini et al., 2018). Ward's method was applied to define the clusters, while squared Euclidean distance was used to assess similarities between interviews. The data was processed using SPSS 23 software. A four-cluster solution was selected based on cluster size and interpretability (see Appendix 1).

3.4. Interpretative narrative construction

In the final phase of our study, the interpretive narrative, our objective was to construct a narrative interpretation of the emerging STIs, starting from the four clusters identified in the hierarchical cluster analysis. After identifying the imaginaries, we linked each imaginary to its corresponding SDG contributions. This phase involved synthesizing and interpreting the themes that emerged from the inductive analysis. In some cases, the data offered direct or indirect insights into the holistic concept of sustainability as outlined by the United Nations. Our interpretive effort focused on establishing connections between the integration of AI in museum practices and its positive or negative contributions

to the targets of the 2030 Agenda. These aspects were subsequently identified *a posteriori* based on the analysis of the collected data. In other words, once the textual coding of all interviews was completed, the passages in which participants explicitly referred to the different SDGs were identified, distinguishing mentions based on whether they were of a positive nature (e.g. potential opportunities, advantages, desirable effects) or negative (e.g. potential challenges, future concerns, unfavorable impacts).

Finally, to identify the relevant tensions among the imaginaries, we calculated the percentage of participants within each imaginary who made at least one positive or negative mention of the SDG in question, providing a comparable indicator despite the different numbers of participants in imaginaries. Comparing these values enabled us to determine which SDGs exhibited the most pronounced divergences and, consequently, which tensions emerged among the different imaginaries.

4. Results and discussion

The hierarchical cluster analysis and the interpretive narrative enabled the identification of four distinct imaginaries, named: the "infinite canvas" imaginary, the "silent AI" imaginary, the "attraction paradox" imaginary, and the "overruled muse" imaginary. The socio-economic and environmental contributions of each imaginary, mapped to the SDGs, are presented in Fig. 2.

4.1. The infinite canvas imaginary

The "infinite canvas" concept encapsulates a vision in which AI is used to enhance various aspects of museum management and audience engagement and is associated with a numerous of positive contributions (Fig. 2). Proponents of this imaginary envision a future with wider and permanent use of AI for data management, audience analysis, and the creation of interactive, accessible content that caters to the diverse needs of visitors. This comprehensive approach aims not only to streamline administrative functions but also to enrich the cultural and educational experiences museums offer, thereby potentially reshaping the business

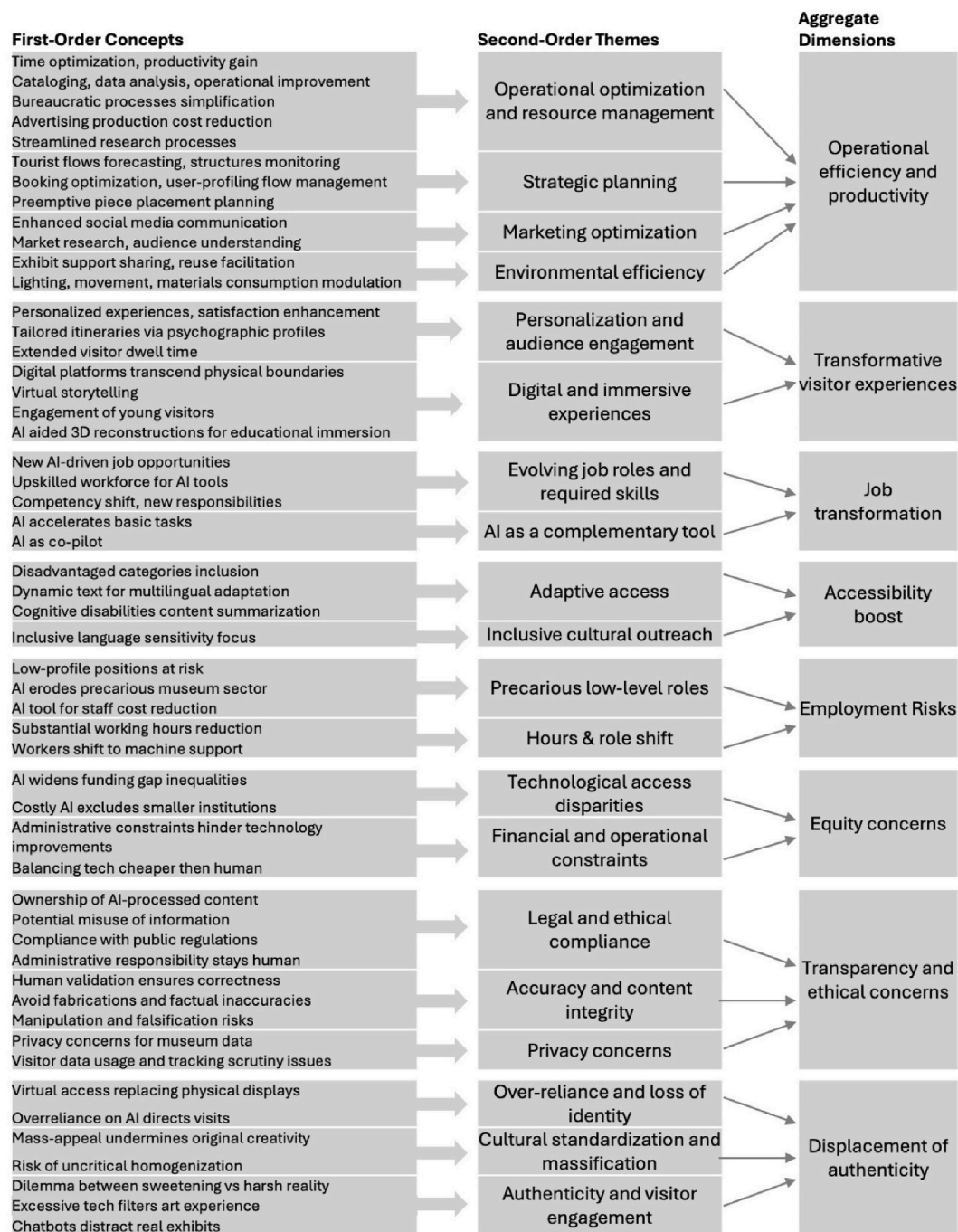


Fig. 1. First-order concepts, second-order themes, and aggregated dimensions emerging from interviews.

model within this sector. A similar imaginary is supported by literature that sees the role of digital technologies impacting several dimensions of museums' value creation processes, including identification, conservation, restoration, exhibition, communication, and marketing (Simone et al., 2021).

The "infinite canvas" imaginary is held by a small number of individuals, mainly directors and managers of large museums. The proponents of this imaginary emphasize that AI technologies are increasingly integrated into both strategic and daily activities. For example, [D5] mentions using AI for "interaction with visitors, forecasting tourist flows, and monitoring structures", while [A1] also mentions its extensive use "for cataloging and data analysis". This growing integration is further reinforced by public expectations, as reflected in the words of [D5]: "stakeholders expect the continuation of our mission to protect and

enhance heritage, and to that end, to seize all opportunities offered by new technologies, such AI". The proactive and comprehensive approach to integrating AI within museums, emphasizing it as essential for future readiness and responsibility, is also reinforced by [D5] saying: "the digitalization of entrusted heritage and the adoption of AI-based technologies is not an option but a necessity and also a duty towards future generations". Indeed, the interviewees suggested several applications in which AI could support the protection and safeguarding of cultural heritage (Target 11.4). And in particular, "the identification and planimetric restoration of structures and environments that are still buried, as well as the reconstruction of archaeological remains [...], it will be useful support in monitoring structures or in predicting the impact of tourist flows on them" [D5]. AI technologies are indeed increasingly being used in the conservation and restoration of cultural heritage, providing tools for more

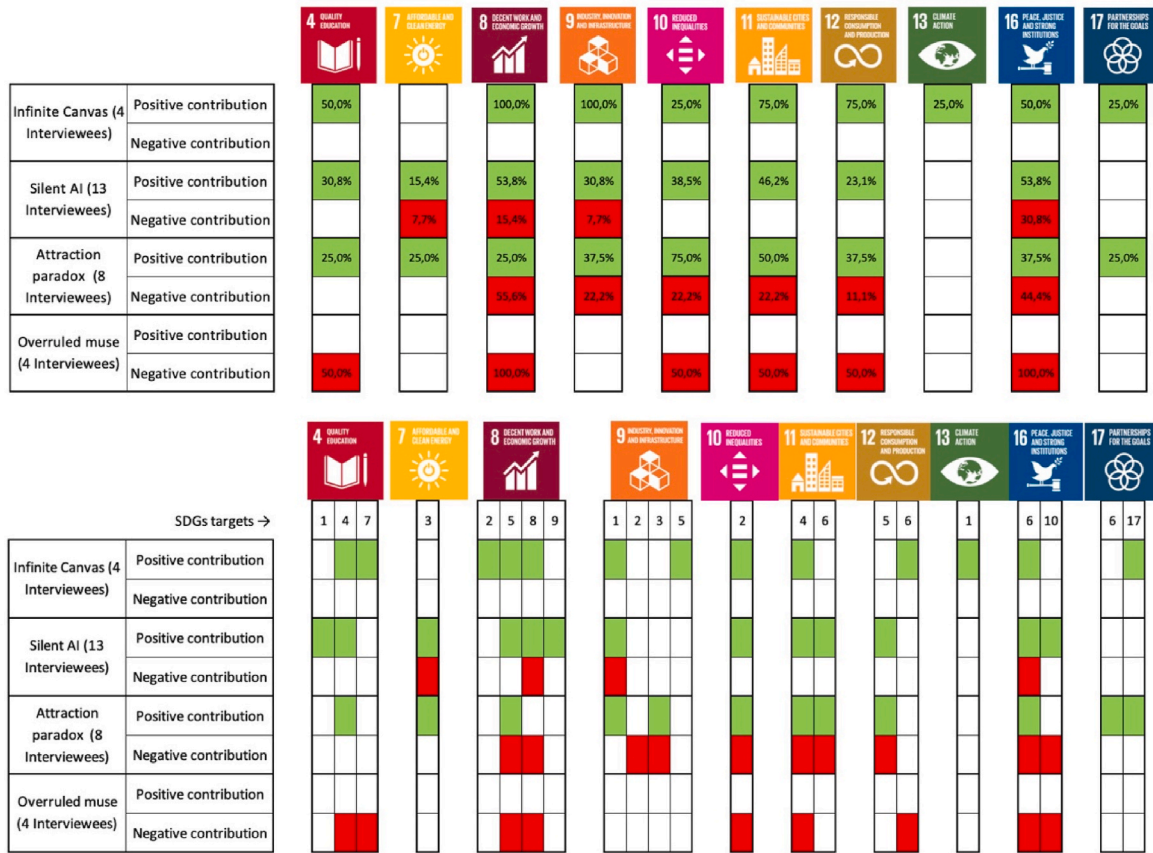


Fig. 2. Contributions of AI for each of the imaginaries in connection with the SDG targets of the 2030 Agenda.

Note: The figure illustrates evidence from interviews highlighting AI’s potential positive or negative contribution to achieving each SDG target. The upper section shows the percentage of interviewees from each imaginary who mentioned a positive or negative contribution concerning various SDGs. The lower section provides a detailed view of individual SDG targets. For each SDG, specific targets are marked in green or red, indicating that AI could have a positive or negative contribution, respectively. The absence of highlighting signifies a lack of identified evidence. The content of this figure is based on the representation proposed by [Vinueza et al. \(2020\)](#); for a full description of the SDGs mentioned, see [Appendix 2](#).

precise and effective interventions ([Prados-Peña et al., 2023](#)).

Moreover, as [M2] suggests: “the entire aspect of analysis and research could be conducted by AI without necessitating a high investment”. AI is also regarded as a tool to optimize staff time, as [A1] notes: “to optimize the available time for workers” and make the work of museum staff more productive (Target 8.2).

The vision of subscribers of this imaginary on the contribution of AI in the museum labor market is well represented by the words of [D5]: “the progressive spread of AI will lead to a reshape of certain professional roles currently operating directly in the cultural sector or around it, but at the same time, it will open up new job opportunities”.

This imaginary also places a strong emphasis on using AI to overcome barriers for various audience groups. [A1] points out: “AI could enhance accessibility. Often, many museums fall short in inclusivity, not only in terms of architectural barriers”. This perspective highlights the transformative potential of AI in making museums more inclusive for different age, gender, abilities and cultures (Target 10.2) thanks to the adoption/use of personalized/customizable experiences. Moreover, a recurrent theme for this imaginary, which is also supported in the scientific literature (e.g., [Ivanov, 2023](#)), is that AI can contribute to tailoring experiences to individual needs and improving overall visitor satisfaction, thereby enhancing their long-term economic sustainability.

4.2. The silent AI imaginary

The concept of the “silent AI” imaginary, shared by a consistent group of 13 interviewees, mainly directors of large and medium

museums, envisions a future with a limited yet harmonious integration of AI in museums. This imaginary, as described by those who embrace it, suggests that AI will blend with the preservation of the human element, complementing rather than overpowering or radically altering the essence of the museum sector. This perspective proposes a view where AI is seen as a useful adjunct for certain museum-related activities, rather than as an agent of fundamental transformation in the field. As [Boyd and Holton \(2018\)](#) argue: “the various transformative impacts claimed for robotics and AI cannot be assumed as inevitable, necessary or historically unprecedented” (p.334); this vision aligns well with the “silent AI” imaginary, highlighting the potential for AI to complement human roles rather than replace them, thereby supporting the notion of a balanced integration. For example, [D7] posits that: “in a temporal horizon [...] I do not believe that there will be radical transformations”. The limitation of utilizing AI for only a few specific functions is intricately tied to a pervasive disillusionment regarding the allocation of funds for these technologies. As [PA1] elucidates: “while it is straightforward to allocate funding for innovation, securing funds for the routine administration, management, and maintenance of these technologies proves to be exceedingly challenging”.

Regarding the core activities of museums, the interviews imply that these will remain fundamentally human-centric. Furthermore, [D7] notes: “when a museum organizes an exhibition [...] it takes a definite stance; this responsibility cannot be delegated to AI, thus maintaining curatorial accountability”. According to [M5] this aspect is a matter of responsibility, and it can negatively contribute to the credibility and transparency of public institutions in general (Target 16.6): “as a public

entity, we cannot misuse information; it is a question of legality, integrity and transparency". Thus, adherents of this perspective are reluctant to risk initiating a process that delegates decision-making authority to an unaccountable entity (Placani, 2024). However, less critical aspects of the cultural and organizational activities could be replaced. For instance, the "writing of captions could be initially undertaken by artificial intelligence and subsequently refined by human intervention" [M5], similar examples of integration were mentioned by [PA1]. From the visitor's perspective, as [VA1] highlighted, "the visitor will not expect to directly see or understand where AI is being used in museums". This statement is not intended negatively but rather underscores that AI integration should be seen as a complementary tool, enhancing the museum experience without altering its essence. This reflects the core of the "silent AI" imaginary: while AI is indeed present, it is designed to function in a subtle, almost invisible manner.

The imaginary is also institutionally stabilized through the implementation of specific policies and practices, which indicate an established protocol where AI is integrated into routine tasks while maintaining human oversight. For instance, this is acknowledged in the training program already adopted in a museum, which is dedicated to all functions "to use those forms of generative AI to which everyone now has access" [D4].

This imaginary is not just internally recognized but also publicly represented. For instance, a museum began using AI for exhibition purposes, such as allowing visitors to interact with historical figures to ask about historical events. In this context, the visitor engages with AI supported by a museum guide, and as the director notes, AI is used "to enhance certain aspects of the museum, without radically transforming our cultural mission" [D4].

It is interesting to see how this imaginary underscore a low level of concern in relation to the risk that humans will be replaced at work by AI; as confirmed by all the holders of this imaginary: "the most powerful device available are the educational operators" [M5]. For instance, [PA1] underline: "people will not be replaced [...] on the other hand I imagine that there will be instead a growth in professionalism linked to the management of AI tools" (Target 4.4). AI emerged also as key management tool for the coordination the different professionals that coexist within a museum, reducing the risk of information asymmetries, [PA3]: "AI could support museum directors in managing human resources by ensuring cross-functional communication between roles so that the museum team works as a coordinated equipe. Such application will probably improve also the financial performance" (Target 16.6). Moreover, opportunities have been identified in relation to the conversion of personnel from night security staff to daytime staff to support the museum management: "The necessary safety standards will be maintained while rationalizing and optimizing the human resources available for other activities" [D7] (Target 8.5). In the same way, a curator confirmed [M7] "the AI will support the preparation of the bureaucratic documentation necessary for the exhibit set up. The curator will dedicate time to the physical phases of the exhibit and to perform only a control function with respect to the AI work".

The role of AI in supporting the environmental transition toward sustainability is, however, considered a challenge. While it could be useful for the smart management of buildings (Target 11.6), the environmental impacts of the supply chain, such as energy consumption, are becoming a potential concern for the holders of this imaginary: "soon it will be necessary to verify how much computing power we will need to run it" [M5] (Target 7.3).

4.3. Attraction paradox imaginary

The concept of the "attraction paradox" presents an imaginary where individuals collectively envision a future where AI has taken on some roles in museums, but the potential benefits of implementing AI are counterbalanced by an equal number of drawbacks (Fig. 2). Museums will face the dilemma of whether to introduce AI even more or revert to a stage without AI. The term "attraction paradox" reflects the state of

ambivalence experienced by those who subscribe to this perspective. This imaginary is collectively shared by eight interviewees, mainly representatives of medium to small museums and public administration officials. The imaginary hinges on the broader paradoxes associated with AI-enabled technologies, which, despite their risks, are often deemed to offer greater overall benefits (Du and Xie, 2021; Kreps et al., 2023). Central to these paradoxes are the myriad challenges that accompany the adoption of AI technologies. These include issues such as AI biases, ethical and moral judgment in decision-making, unemployment spurred by automation, and the alignment of goals between AI systems and human beings (Du and Xie, 2021).

The concept of the "attraction paradox" is well represented by the words of [D1]: "survival is a fundamental theme; most small to medium-sized museums lack personnel, resources, or budget", and AI could represent a survival tool. However, there is a high risk of losing "the physical materiality of a museum" [D1] thereby potentially destroying it as an institution.

Subscribers to this notion emphasize that there is a growing structured approach and financial support from public administrations for integrating AI and digital technologies into certain museum activities. This is also expressed by the fact that, as [D6] states: "we have received solicitations over the recent years from companies that provide such services to museums".

Holders of this imaginary are convinced that museums will become more accessible. According to [G1]: "AI can be a tool that, depending on the visitor's country of origin and cultural background, allows for directed communication and message transmission". In alignment with the same conceptual perspective, [D1] notes that "texts found in museums are often overly scientific and not just unsuitable for communication but also inaccessible for young visitors and individuals with cognitive disabilities", indicating that AI could significantly improve the accessibility and comprehension of museum content, leading to relevant and effective learning outcomes (Target 4.4). In this context, AI can also enable economic accessibility to culture, promoting affordable education (Target 4.4). [M1] points out: "organized groups can afford a guide, while individual visitors less so". There is a common recognition of the role of AI's will have in marketing, potentially increasing museum visitation. [M1] supports the usefulness of AI tools based on "facial recognition to assess the public's interest in various works [...] not only aimed at improving the visitor experience but also at collecting data on user behavior and developing marketing strategies".

However, these positive aspects are counterbalanced by concerns about AI reducing employment opportunities in the museum sector (Target 8.5). [M1] discusses how AI might replace jobs in the museum-related industry, foreseeing a "reduction in staff, for example in communication agencies", while [D1] reflects on the loss of jobs directly within the museum system and particularly "eroding an already precarious sector like that of culture".

As a positive contribution to SDG 17, the will to generate partnerships to enhance environmental sustainability has been suggested several times by respondents. In particular, [D6]: "an interesting opportunity is linked to the sharing of exhibit equipment (i.e. protection systems for goods or display cases equipped with ventilation and lighting for specific goods); the implementation of AI will help to map, catalogue and share equipment to extend their life and also achieve economic optimization of resources".

4.4. The overruled muse imaginary

The concept of the "overruled muse" imaginary suggests an imaginary where AI has taken and will continue to take a dominant role in museums and the cultural field, but not without adverse consequences (Fig. 2). The "overruled muse" imaginary is shared by four interviewees, two of whom are members of visitors' associations. This imaginary is represented through scholarly sources, popular culture, and public discussions that highlight AI as a potential threat to human. As noted by

Braidotti (2013), AI systems are often portrayed as potential threats to human roles and status, reinforcing this imaginary in the public consciousness.

Indeed, one of the principal narratives underpinning this imaginary is the recognition of AI's potential to replace human roles within museums (Target 8.5). [M8] affirmed: *"to date, museum workers are considered desperate intellectuals. It is convenient not to hire more people and it is a big mistake, the museum worker can also feel a form of affection for the goods he guards, the machine does not"*. The permeation of generative AI in this context fosters the belief that AI will *"nullify the efforts of so many people who have been involved in art for years, who have studied"* [PS1] ultimately leading to their replacement. Research indicates that museum professionals are increasingly perceiving their roles as diminished due to the integration of new technologies, contributing to a sense of ongoing transformation within these cultural institutions (McCall and Gray, 2014; Modliński et al., 2023). Additionally, Booth et al. (2020) argue that museum employees perceive information technology as a restrictive agent that may obscure the foundational cultural mission of museums. The deployment of technologies for both culturally oriented and auxiliary tasks has been reported to incite apprehension and opposition among museum staff (Modliński et al., 2023), indeed [M8] explains: *"whoever programs the machine is not always intellectually honest and can deliberately direct our activities"*.

Another perspective shared by holders of this imaginary is the notion that AI's predominance may obscure the authenticity of the human and cultural experience, creating an illusion of progress that could, in reality, diminish the museum experience. For instance, interviewee [PS1] argues: *"An AI, no matter how many emotions and anecdotes it can convey, will never fully satisfy what truly constitutes a guided tour by a historian who is undoubtedly better than that machine"*. In line with this aspect, [VA3] emphasizes that *"the public will not be particularly intrigued by the use of artificial intelligence"* if its implementation is disclosed, as they may struggle to understand the reasons behind its use.

The anthropomorphism of AI, as reported by Salles et al. (2020), can enhance the user experience and/or facilitate the educational process; however, it also raises a discussion about the risk of increasing fear towards AI technologies and misunderstandings about their capabilities, as seen in the "overruled muse" imaginary. Indeed, regarding the application of the AI collecting information for reading users' emotions aimed at improving the visit experience, the holders of this imaginary expressed: *"I don't want to be monitored, whether I am aware of it or not. How short is the step from reading emotions to a machine being able to induce them?"* [M8].

Holders of this imaginary are also concerned about the integrity of information and the accurate representation of historical and cultural content through AI-driven tools. A visitor association [VA2] explained that even if *"AI can fill all the lack of material heritage"* significant concerns persist regarding how AI might reconstruct materials and the risk of *"museums losing ownership of those materials"* [VA2]. Moreover, the use of generative AI to support the understanding of destroyed goods opens uncertainties about the quality and accuracy of the shared information (Target 4.4): *"people are very impressed by what they see and it will be difficult to pull apart the information that I have shared through the image that I have artificially created, which seems real, but is not [...] it is necessary to build mental immune defenses against the effects it can have on fragile minds"* [M8].

Finally, as suggested by [PS1], *"the implementation of technologies could lead to an increase in costs and therefore to the exclusion of certain museums"* thus negatively impacting especially small ones (Target 10.2).

4.5. Tensions between imaginaries

By analyzing mentions of positive and negative contributions to the SDGs across different imaginaries (Fig. 2), it is possible to highlight key tensions among imaginaries arising from diverse stakeholders' perspectives on socio-environmental and economic contributions.

The results indicate broad agreement on AI's potential contribution to certain SDGs, particularly regarding SDG 4. In three out of four imaginaries, interviewees recognized AI's positive role in customizing content to enhance interactivity for diverse students and visitors. A similarly low level of tension is noted for SDG 7, where respondents recognized the potential of AI-driven efficient museum management systems. Low levels of tension are also evident regarding the role of AI in fostering industry innovation and infrastructure development (SDG 9) within museums, where in most imaginaries it is emphasized that AI can significantly enhance the quality and reliability of museum infrastructure through advanced data management, predictive maintenance, and resource optimization to monitor structural integrity.

A moderate level of tension is detected concerning SDG 10, where some imaginaries highlight AI's ability to make museums more inclusive, while in two imaginaries it is strongly emphasized that the cost of technology will exacerbate the differences between small and large museums. Slight tensions arise regarding accessibility: while AI enhances understanding for diverse visitors, the resulting higher ticket prices may hinder affordability. Similarly, for SDG 11, while AI aids in protecting cultural heritage, it risks diminishing the museum's physical presence, potentially undermining its spatial role.

Three imaginaries have identified this aspect as an opportunity to reduce waste production, as promoted by SDG 12. However, in the imaginaries of the "attraction paradox" and "overruled muse", it was noted that the rapid wear of specific devices used to make AI interactive with visitors could lead to the production of new hazardous waste.

Finally, in the imaginaries where SDG 17 was mentioned, interviewees emphasized the importance of AI-driven actions for generating sectoral and transnational networks, particularly highlighting AI's primary applications in enhancing collaborative planning among museums and facilitating the sharing of resources.

4.5.1. The worker enhancement-replacement tension

A prominent tension between imaginaries emerges around the coexistence of workers and AI in the museum industry in relation to SDG8. Our results underline that the perception of job replacement is more prevalent in the imaginaries held by workers and directors of small museum entities. These groups view AI as a complete threat to job security. Considering the seminal work of Frey and Osborne (2017), which highlights the susceptibility of various occupations to computerization, the fears of the holders of the "overruled muse" imaginary seem justified. According to their findings, several occupations related to museums have a high probability of being replaced, such as tour guides and escorts, museum technicians, conservators, and archivists. On the other hand, only curators may be spared (Frey and Osborne, 2017). This outcome also aligns with recent research on the impact of ChatGPT on human skills (see, for instance, Giordano et al., 2024). Additionally, large-scale empirical evidence from millions of Claude conversations (Handa et al., 2024) suggests that AI usage is predominantly concentrated in tasks involving routine or codifiable knowledge, potentially posing serious risks to guides, archivists, and conservators.

The option of the "symbiotic relationship" (Zirar et al., 2023) or "augmentation" (Daugherty and Wilson, 2018) in which workers and AI can enhance productivity and job satisfaction, is mostly represented "silent AI" imaginary held mainly by directors of large museums. In such imaginary, where AI is used in specific, limited functions such as writing captions or managing simple tasks, thus supporting rather than replacing human work, is fundamentally different from the concept of "augmentation" which implies continued close interaction between humans and machines to accomplish complex tasks (Daugherty and Wilson, 2018). This approach allows for complementing a machine's abilities with humans' unique capabilities, such as common-sense reasoning. The extreme simplicity of the tasks envisioned in respondents' interviews, which are relatively routine and well-structured (Davenport and Kirby, 2016), lends itself to a gradual substitution of some tasks rather than merely being supported by AI. Even in

experiments where AI emerged to be used for exhibition purposes, such as interacting with historical figures, the human role is to support the machine (e.g., ensuring it is connected, can start correctly) rather than vice versa.

Finally, the theme of creating new jobs based on new skills, is recurrent in the “infinite canvas” imaginary, which highlights how some positions will be reshaped, and others will be created. However, the upskilling/reskilling (Ramachandran et al., 2024) for AI competencies to create new types of jobs can be costly and time-consuming (Haenlein and Kaplan, 2019), with the risk that large museums will have access to these resources, impacting the large portion of museum sector workers who will not have this advantage.

Certainly, one viable approach to alleviating these tensions involves the training of workers, notwithstanding the potential barriers to accessing such training. By promoting exchange programs between large and small museums, workers can gain exposure to new skills and practices related to AI within diverse contexts. This strategy could help equalize training opportunities and mitigate the disparity between museums with differing capacities to access resources for upskilling and reskilling. Brekelmans and Petropoulos (2020) posit that the AI revolution is unlikely to induce job polarization, as it will impact low-skilled, middle-skilled, and high-skilled occupations. Within this framework, advocates of “infinite canvas” and “silent AI” imaginaries may appear overly confident in their positions or possess a myopic view of AI’s ramifications.

4.5.2. The efficient governance-transparency tension

Substantial tensions between imaginaries also exist in relation to SDG 16. In this context, the primary source of conflict concerns the implementation of AI to bolster operational efficiency, perceived by some as integral to good governance, versus the imperative to uphold high standards of responsibility, transparency, accuracy in the information provided, and visitor/employee privacy protection, thereby preserving the museum’s institutional credibility.

Particularly, holders of the “attraction paradox” and “silent AI” imaginaries express apprehension that AI could diminish the level of responsibility and transparency in museums (e.g., delegating exhibition design to AI), potentially leading to a diminution of the museum institution’s cultural authority. In this framework, AI’s role could undermine the museum’s function as an “arbiter of art” (Rodner and Preece, 2015). This concern is particularly significant for public museums, which must ensure their integrity and reliability. In the “overruled muse” imaginary, similar concerns are amplified, especially regarding AI’s influence on cultural representation, raising issues on the authenticity of artworks.

Conversely, adherents of the “infinite canvas” imaginary, while cognizant of the challenges associated with AI in museums, primarily advocate for the regulation of AI usage through legal frameworks, acknowledging that regulatory measures alone may not be wholly sufficient. Li (2023) posits that the European AI Act, despite being an ambitious attempt to regulate AI, exhibits several deficiencies. For instance, the transparency obligations it mandates might not be adequate to mitigate the risks associated with generating unverified and potentially misleading content. Additionally, regulatory instruments may not be sufficiently agile or adaptable to keep pace with the rapid advancements in AI, thereby creating a disparity between current regulations and the ideal regulatory framework (Longo, 2024).

Closely linked to issues of responsibility and transparency is the concern that AI might severely flatten the capacity of museums in how culture is represented, consequently homogenizing cultural experiences and reducing the ability of museums to serve as spaces for debate and critical reflection, thereby hindering the potential political debates that art can generate. This issue is primarily perceived by holders of the “attraction paradox” imaginary, while those of the “infinite canvas” focus on sector innovation aimed at enhancing the user experience. As highlighted in the literature, AI might tend to reiterate pre-existing

patterns, the so-called “stochastic parrots” (Bender et al., 2021), which can lead to flattened visions of an artistic phenomenon rather than promoting new interpretations capable of creating cultural and political debate.

In this context, a potential way to overcome these tensions is to frame the use of AI in specific, targeted roles. For instance, AI could be employed to simulate visitor reactions to exhibitions, providing insights into both user experience and the political debates that may arise. This data could then serve as an informative resource for fine-tuning exhibitions. By adopting this approach, the museum institution should uphold the necessary standards of transparency and responsibility while ensuring that curatorial decisions are well-informed. This would facilitate the creation of more engaging and meaningful exhibitions, increase the enjoyment level of the visitor experience and fostering a more dynamic cultural discourse.

An additional aspect of the institutional responsibility of museums in using AI solutions relates to the preservation of visitors’ and employees’ data privacy. Privacy concerns are particularly heightened in the “overruled muse” imaginary, present as a hidden cost in the “attraction paradox” imaginary, and not addressed in other imaginaries. In the “silent AI” imaginary, privacy concerns may be underestimated, as AI appears to be relegated to marginal tasks in the future. In the “infinite canvas” imaginary, an excessive focus on efficiency and a generally optimistic narrative of technology as a problem-solver lead to the perception of privacy as a secondary concern. The balance between privacy and tailor-made content for visitors is one of the main tensions between efficiency and transparency, requiring specific solutions to overcome these challenges. In this context, the museum sector appears to be an ideal playground for testing and disseminating knowledge of approaches such as local AI models, homomorphic encryption (allowing data analysis without decryption), and differential privacy (adding noise to data to protect individual privacy) (Yang et al., 2024), offering guarantees for museum visitors and employees in the application of AI.

5. Implications

5.1. Implications on the socio-technical imaginaries framework

Among the conceptual contributions of this study is the expansion of the novel STI framework by promoting a more nuanced understanding than that presented in initial studies, which primarily attributed the formation of these imaginaries to nation-state actors (Jasanoff and Kim, 2013). Our study aligns with and enriches ongoing scholarly discourse aimed at reconceptualizing STIs as complex, future-oriented visions that are articulated and enacted not only by nation-states but also by a diverse array of actors, including businesses, civil society, research communities, and other organized entities (e.g. Mager and Katzenbach, 2021; Sörum and Fuentes, 2023). By documenting the detailed divergences in the visions and perceptions across these varied actors, the study underscores how imaginaries are socially constructed phenomena, emergent from specific institutional and cultural contexts, and molded by actors with disparate interests and perspectives. This approach closely aligns with recent research emphasizing that STI studies can lead to significant inquiries into the role of individual actors in constructing, shaping, contesting, or extending STIs, as well as how these individual-level dynamics interact with collective visions (Kuchler and Stigson, 2024).

In light of the methodological ambiguities that pervade the literature on STI analysis (Kuchler and Stigson, 2024), our research proposes the strategic use of semi-structured interviews as a methodological innovation in STI analysis, supplementing or even supplanting the traditionally dominant reliance on document analysis. This approach allows for a more systematic and nuanced coding and identification of the key themes and concerns that arise from the diverse imaginers involved. Interviews, as an underutilized yet critical instrument within the STI framework, provide a unique means of capturing the complex

motivations, opinions, and perspectives of participants, which are often elusive in document-based analyses (Patton, 2014), despite the latter's widespread use in STI research.

Lastly, this study makes a broader contribution to the ongoing research that employs the STI framework to detect and delineate imaginaries in sustainability transitions (Birch, 2017; Hermann et al., 2022; Bulathwela et al., 2021). It introduces a methodological advancement in the analysis of STIs related to sustainability by incorporating the lens of the 2030 Agenda framework to systematically identify and examine the tension points among competing imaginaries. This approach has the potential to enrich the STI framework and catalyze further research at the intersection of sustainability and emerging technologies.

5.2. Managerial implications

In light of the delineated imaginaries and the inherent tensions between them, several managerial considerations can be identified. One of the principal considerations concerns the use of ethics guidelines as a potential strategy for mitigating tensions. Although such documents for AI usage are proliferating (Hagendorff, 2020), they tend to focus excessively on technical issues, often neglecting the implications of organizational practices underlying AI use (Attard-Frost et al., 2023). Since museums are not developers but merely users of AI, it is more appropriate to define and adopt the second type of guidelines, that are—those based on business practices for AI use and aligned with the SDGs, as suggested by Astobiza et al. (2021). In this case, the guidelines should cover all organizational practices where AI can be applied, from supplier selection practices to managing the entire AI technology life-cycle, and protecting jobs in the sector. Although these guidelines can be created by a third party for all museums (e.g., ICOM), individual museums should establish a cross-functional team comprising curatorial, educational, IT, and administrative staff to adapt the guidelines to their specific context and update them regularly. This is crucial, as the rapid pace of technological advancement and changing societal needs can quickly render ethical guidelines obsolete (Jobin et al., 2019). In this context, the role of ethics auditors (Mökander and Floridi, 2021) emerges as potentially significant, particularly with regard to external professionals who oversee compliance with common sectoral guidelines and certify adherence to bespoke standards tailored for individual museums. This evolution signals the introduction of new professional roles and consulting services, as well as the potential emergence of third-party certifications and certification bodies, across this and many other sectors.

Given the emerging nature of this phenomenon, it is advisable to establish an SDG-based monitoring system capable of evaluating the impacts of AI applications on museums. In this context, the structured integration of sustainability into a Performance Management System (Hristov et al., 2022) is proposed, encompassing not only social, environmental, and economic dimensions but also indicators of organizational governance. These indicators should be designed to monitor factors such as the efficiency of information systems, organizational oversight, innovation, as well as cultural dimensions including processes of learning and growth, leadership, and cultural integration.

We further recommend that museum managers integrate the perspectives of diverse external stakeholders (e.g., other museums, visitors, visitor associations, external museum guides, etc.) in the process of adopting and tailoring guidelines for AI usage and impact monitoring systems. As revealed by the interviews, the imaginaries and narratives associated with AI are intricately connected to the specific roles individuals occupy within the museum and the nature of the activities they engage in.

Finally, as highlighted by some holders of imaginaries, these constructs are significantly shaped by perceptions surrounding the use of technology within museums. In this context, it is imperative for museums to transparently disclose their employment of AI to users, or even

involve them in comprehending its applications, to cultivate and sustain a trustful and transparent relationship among the parties involved. Consistent with the broader discourse on AI ethics, where transparency is typically correlated with enhanced trust in AI use and the alleviation of concerns about potential misuse (Hine and Floridi, 2023; Cath et al., 2018), museums that embrace a transparent approach—particularly in relation to data usage and privacy—not only adhere to ethical standards but also foster a deeper sense of trust with all stakeholders engaged in museum activities.

5.3. Policy implications

The tension arising from imaginaries about the risk of creating a two-speed cultural sector should primarily be addressed through targeted policies. AI, like other technologies before it, has the potential to exacerbate disparities among institutions (Marston et al., 2011; Pantano and Vannucci, 2019), a concern that also emerged in the interviews as particularly relevant for museums. Those with the resources to rapidly adopt and integrate these technologies will gain advantages in scalability, flexibility, and operational cost reduction, while smaller museums may struggle to keep pace. This issue is further compounded by tensions related to the coexistence of workers and AI. As revealed by the analysis, the lack of financial resources might also be coupled with the inability to train human resources with the specific skills needed to guide or support the integration of AI within museums.

In this regard, policymakers are urged to develop tailored national, regional, or local strategies for AI application to mitigate technology inequalities, as demonstrated in the literature (Gao and Rai, 2023). Customized measures for micro, small, medium, and large museums could serve as tools to guide these institutions toward digital advancement in line with their financial capacities. In this context, funding should be specifically assessed both ex-ante and ex-post with SDG-oriented indicators, linked to project planning and socio-economic-environmental impacts, to alleviate rather than create new tensions.

To foster local innovative capacity (Bathelt et al., 2004), and in line with the transversal principles of the 2030 Agenda, collaboration among museums of varying sizes—such as through temporary mobility programs for training purposes—should be promoted or mandated by institutions through specific measures to ensure that no one is left behind. In this framework, ICOM, as the leading international museum organization, could play a pivotal role by promoting the sharing of best practices, both in contributing to the SDGs and in leveraging AI solutions to enhance the sustainability of the sector. This would, in turn, promote a capacity-building process oriented towards sustainability across the entire museum ecosystem.

6. Conclusions

The paper explored the nuanced interplay between AI implementation in the museum industry and the achievement of socio-economic and environmental goals through the lens of STI. The conducted interviews led to the identification of four distinct imaginaries held by various stakeholders, which can be considered representative of all key figures and entities within the museum sector.

Among the four identified imaginaries, the “silent AI” imaginary appears to be the dominant one, not only representing the largest number of interviewees but also encompassing a diverse range of perspectives. Counter-imaginaries, such as the “overruled muse”, remain confined to the vision of a few individuals and are relatively homogeneous. The research also highlights the tensions between imaginaries and consequently proposes a series of managerial and policy recommendations aimed at mitigating these emerging tensions.

Despite the relevance of the findings presented, it is necessary to acknowledge certain limitations. A primary limitation lies in the geographical scope of the stakeholders interviewed, which may not fully

capture the diversity of STIs across different cultures. Expanding the focus to include other countries could reveal different perspectives shaped by varying socio-economic and cultural environments. Indeed, for socio-economic peripheral contexts AI still not represents an issue or a priority since their museums are working to survive or to ensure, at least, the minimum level of service to the users net of the human and economic resources available.

A further limitation of the research is connected to the potential bias within the AI community and industry, where self-interest may lead to an exaggeration of the positive impacts of AI in the sector.

Another limitation is that the research captures a snapshot of STI at a single point in time, specifically when AI begins to be concretely applied across various sectors; however, this perspective does not account for the dynamic and evolving nature of technology and societal expectations. In this context, it is crucial for future research to address this gap by investigating how changes in technology or societal values influence these imaginaries over time, potentially through a longitudinal or iterative study design. Such an analysis would not only deepen the understanding of the research subject but also contribute significantly to expanding the conceptual framework of STI.

The paper also identifies a broad area for new and future research. In particular, it underscores the ongoing need to develop and test new strategies, governance models, and new areas of activity (e.g., certifications) within the museum sector to monitor and regulate museums' use of AI, with the aim of effectively addressing the ethical considerations raised by AI integration. Future studies could delve deeper into these strategies, governance models, and new areas of activity involving a broader range of stakeholders in the decision-making process.

Moreover, as clearly indicated by the paper and supported by recent literature on the use of AI across various industrial sectors, the mechanisms by which tensions can be overcome and transformed into complementarities represent a crucial theme for future research. Finally, our research deliberately excluded the perspectives of artists; future studies

could approach the topic by incorporating their viewpoints to explore the presence of additional imaginaries.

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Filippo Corsini: Writing – review & editing, Writing – original draft, Validation, Project administration, Investigation, Formal analysis, Conceptualization. **Nora Annesi:** Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation. **Marco Frey:** Validation, Supervision.

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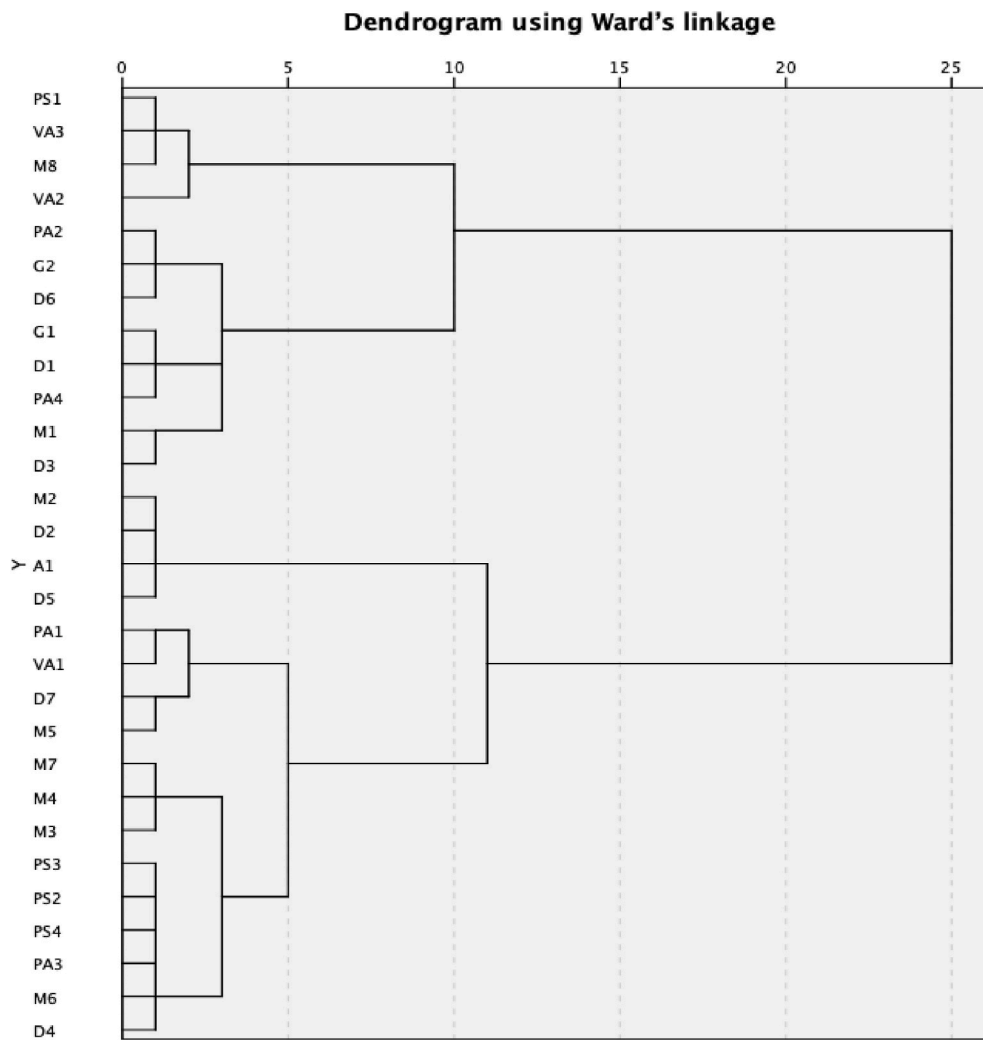
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Appendix 1. Identified clusters and distribution of interviewees across clusters



Appendix 2– SDGs and related targets mentioned

SDGs and short titles	Targets
SDG 4 - Quality education	4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes 4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship 4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development
SDG 7 - Affordable and clean energy	7.3 By 2030, double the global rate of improvement in energy efficiency
SDG 8 - Decent work and economic growth	8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors 8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value 8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment 8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products

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SDGs and short titles	Targets
SDG 9 - Industry, innovation and infrastructure	<p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries</p> <p>9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets</p> <p>9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending</p>
SDG 10 -Reduced inequalities	<p>10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status</p>
SDG 11 -Sustainable cities and communities	<p>11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p>
SDG 12 - Responsible consumption and production	<p>12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
SDG 13 -Climate action	<p>13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries</p>
SDG 16 - Peace, justice, and strong institutions	<p>16.6 Develop effective, accountable and transparent institutions at all levels</p> <p>16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements</p>
SDG 17 -Partnerships for the goals	<p>17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism</p> <p>17.17 Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships</p>

Data availability

Data will be made available on request.

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