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Diffusion of Digital Innovation in Museum Education: Pandemic Effects and Adopter Characteristics

Elina VIKMANE, Gints KLĀSONS

Institute of Arts and Cultural Studies,
Latvian Academy of Culture,
24 Ludzas Street, Riga, Latvia

elina.vikmane@lka.edu.lv, gints.klasons@lka.edu.lv

Abstract. This study is the first known attempt to employ Roger's diffusion of innovation (2003) theory to analyse how innovation spreads across Latvia's entire museum sector over time and how the museums classified as earliest innovation adopters in museum education differ from the rest of the pool. The study rests on a quantitative strategy. The results of the study suggest three aspects that differentiate earlier adopters from non-adopters in museum education: (1) financial aspect – resources, funding diversification and dynamics during pandemic, (2) museum aspirations towards overall digital development and (3) communication function performance to serve the society. Moreover, available funding per se is insufficient to predict the adoption of digital innovation in museum education. Although, it has a substantial impact, it plays out only in conjunction with two other factors – prior experience in onsite museum education and prior introduction of digital innovation in other areas of museum work.

Keywords: digital innovation, diffusion of innovation, museum education, innovation adopters

1. Introduction

Digital innovation raises high expectations for tackling the so-called 'grand challenges' - globally significant problems, including complex social issues such as inequality, poverty, (George, 2020), access to culture and knowledge (Vikmane and Lake, 2021). Spread of digital innovation in the Fourth Industrial Revolution is expected to have 'predominantly positive consequences in terms of economic opportunities and future jobs, rising income levels and improved quality of life for people around the world' (Caruso, 2017). The 'scalability and low barrier to entry' of digital innovations are believed to lead to widespread participation and democratisation of innovation (Yoo et al., 2010). Technology implementation plays an essential role in enabling socio-cultural sustainability (Zacher, 2017), for instance, by helping to preserve culture, facilitating new skills across vulnerable populations, reducing exclusion (Weber and Zink, 2014). Museums' desire to upgrade their communication tools and means and to improve their relationships with stakeholders through digital innovation can be interpreted both as a

reaction to the numerous technological advancements of today and as an effect of the global pandemic when museums were forced to shut down their physical premises, which necessitated looking for other ways to connect with the audience - 'giving access to educational content, improving visitor experiences online and planning ahead for when they will return to exhibition halls, and continuing the digitalisation of museum collections' (Vikmane and Kristala, 2022).

The study aims to explain how museums that innovate in their educational role differ from other members within this social system by exploring the applicability of the innovation diffusion theory (Rogers, 2003) across Latvia's entire museum sector. The research objectives include (1) performing a critical analysis of relevant literature on diffusion of innovation; (2) identifying museums' digital innovation priorities during the pandemic; (3) determining and comparing the characteristics of early and late digital innovation adopters in the field of museum education.

2. Innovation diffusion framework

2.1. Diffusion of digital innovation

In the early 1900s, long before digital innovation became the mainstay of our daily life, researchers were already working to explain how new ideas spread. In other words, they were curious 'why, given one hundred different innovations conceived at the same time – in the form of words, in mythological ideas, in industrial processes, etc. – ten will spread abroad while ninety will be forgotten' (Tarde, 1903).

In his life's work, Diffusion of Innovation, published in five editions (1962–2003), Rogers defined the diffusion of new ideas as 'a kind of social change, defined as a process by which alteration occurs in the structure and function of a social system' (2003) and social change as a 'sequential process involving invention, diffusion and consequences' (Rogers and Shoemaker, 1971). Rogers has devoted his entire career to the subject, and his work is widely considered the principal theory on innovation diffusion (Srivastava and Moreland, 2012). Although in the 1960s, the subject was tackled by several researchers (Fourt and Woodlock, 1960), (Mansfield, 1961), (Floyd, 1962), (Chow, 1967), (Bass, 1969 and 1980), Rogers' framework proved to be the most viable over a long period across different academic disciplines, as evidenced by his citation numbers in academic literature (Meade and Islam, 2006). Since the first edition of Rogers' Diffusion of Innovation, researchers have used the framework to study the adoption and diffusion of a wide range of ideas and practices across the world (Srivastava and Moreland, 2012), analysing how (1) new ideas (2) diffuse (3) over time (4) within a specific social system. Thus, although diffusion is researched in different scientific disciplines, it has 'become a single integrated framework of concepts and generalisations' (Rogers and Shoemaker, 1971), providing an empirical and quantitative basis for theories of social change, while diffusion principles have permitted to assess development (Wejnert, 2002).

In the most recent, fifth edition (2003), Rogers acknowledges that the concept of diffusion he developed in 1962 has since been expanded and modified. For the purposes of this study, it is relevant to mention that one of the reasons for the need of a fifth edition in Rogers' view is 'the large number of diffusion of innovation studies related to the spread of communication technologies such as the Internet and mobile phones' (2003). This is also shared by other researchers who highlight a proliferation of studies

on the characteristics and unique features of digital innovations – their nature, process and consequences (Nambisan et al, 2020). Barbara Wejnert stresses that 'global technologies play a key role in [innovation] diffusion by stimulating and enhancing the innovation adoption process' (2002). While it is stressed that technological innovation diffusion is promoted for the growth of multinational corporations (Rosegger, 1991), (Silverberg, 1991), it should be acknowledged that diffusion is also promoted by the generally low threshold of technological innovation diffusion (Mahajan and Muller, 1994) and the growing demand for global connectedness (Wejnert, 2002).

Initial scepticism about the diffusion of innovation theory has been directed at its viability in general. It has even been compared to 'a problem for parents of children born out of wedlock who are interested in social and cultural change – too big to ignore but unlikely to be fully recognised' (Fliegel and Kivlin, 1966), although critics simultaneously acknowledge the empirical results of diffusion researchers as useful for integrating diffusion research into fields that study social and cultural change. Another criticism is linked to the observation that adoption of digital innovation is overwhelmingly associated with positive effects. Rogers calls it the 'positive bias' that arises because innovation, especially technological, is associated with the betterment of our daily life or perceived as 'a good word in modern society' (Rogers, 2003), that 'symbolise the progress and innovation of society as a whole' (Holtgrewe, 2013). Caruso calls this 'techno-optimism' (2017) based on the new possibilities created by the wave of technological innovation – interacting robots, machine learning, artificial intelligence, 3D printers, the Internet of Things, cloud computing, big data analysis, etc. MacElroy calls this the idea of 'techno-utopian liberalism', propagating the notion that digital technologies can and will 'prevent "world ills", spread information freedom in real-time to all, and telescope the "left behind" and "uninformed" parts of the globe into a techno-utopian future' (McElroy, 2017). Rogers has openly acknowledged and agreed to criticisms of his pro-innovation bias, admitting that researchers know much more about innovation adoption success than failure. However, the diffusion of innovation theory has proved its viability over time, gaining widespread popularity. Its prominent position is evidenced by publications in the world's 'most prestigious academic journals in every scientific discipline' (Rogers, 2003), and it successfully serves as an explanatory framework to understand how adoption of new ideas leads to change (Singhal, 2012) in any sector, field, social group or society.

2.2. Digital innovation adopter characteristics

The dominant view of diffusionists is that social change is caused by 'inventions', the process by which new ideas are discovered or created, and that diffusion is a gradual process (Rogers, 2003). However, it was Tarde who put forward the idea that the diffusion of innovation into a social system is not equally rapid in time but can be represented as an S-shaped curve (Fig. 1). In it, the innovation starts diffusing slowly, followed by a solid and increasing rate of growth, which then slows down and stops in the final stages of diffusion (Tarde, 1903). Rogers confirmed this based on an analysis of empirical studies and incorporated and further developed the notion in his diffusion of innovation theory (1962–2003).

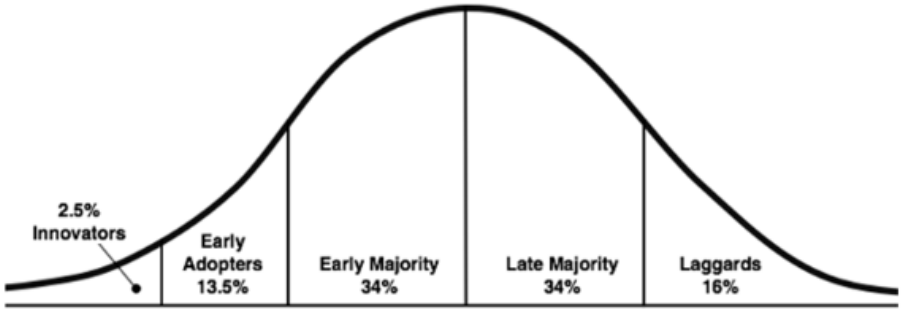

Figure 1. Rogers' digital innovation diffusion S curve, Rogers, 2003

In 1971, together with Shoemaker, Rogers proposed that the system should distinguish between five (1) exhaustive, (2) mutually exclusive, (3) categories based on common classification principles, based on the relative speed with which a given member is willing to introduce new ideas (Rogers, 2003). According to decades of empirical research, *'innovators'* comprise, on average, 2.5% of participants in any system and have a crucial 'gatekeeper' function as, through them, innovations from outside the system enter to spread further within. However, they may not be respected or valued on the inside as they are often perceived as 'deviants from the social system' (Rogers, 2003). They are followed by '*early adopters'* at 13.5% – actors in a social system with the highest degree of opinion leadership (Rogers, 2003). They are respected by peers, aware of the need for change and willing to have success stories learnt from them so that they can pass on their experiences to others, reinforcing their leadership status. Opinion leader behaviour might serve as a role model for other categories of innovators, who then imitate the former. *'Early majority'* or 34% of the actors are rarely system leaders but remain close to other actors and accept new ideas earlier than the average actor. Rogers argues that their 'unique position in the system, between early and late adopters, allows them to become an important link for the innovation to spread widely' (2003). Although this category introduces new ideas willingly, the process is slower than in the previous categories, as the actors need more time to deliberate. Once the early majority adopts an innovation, a critical mass of adopters is reached, and further diffusion becomes self-sustaining (Rogers, 2003). The *'late majority'* of 34%, also known as sceptics (Rogers, 2003), are cautious about accepting new ideas and tend to implement them after previously described categories have already done it. For them, adoption results from rational necessity or motivational pressure from other actors within the system. Finally, *'laggards'* have a narrow, local perspective and look to the past, continuing to do things the way they have been done before. They resist innovation, especially if there is even a slight chance for it to fail. The name suggests that these actors in the system do not have a positive bias against innovation. Importantly, Rogers defends the negative implications of the label, arguing that 'if they were called by any other name, it too would soon acquire a negative connotation' (2003).

Although, according to research, 'organisations, like individuals, adopt innovations in ways that show different levels of resistance to accepting a new idea' (Rogers, 2003), regarding organisations as adopters, Rogers introduces an additional term of a 'champion'. These 'charismatic individuals drive innovation by overcoming the

resistance or indifference an organisation might have to a new idea' (Rogers, 2003). Even back in the early days of innovation diffusion research, claims were made about the critical role of innovation champions, emphasising that 'a new idea either finds a champion or dies' (Schon, 1963). Desouza puts forward a similar idea, referring to 'resourceful and entrepreneurial employees who take the initiative to create, develop and implement ideas for innovative solutions' as 'intrapreneurs' (2011) or 'promoters'– employees who 'actively and intensively support the innovation process by offering their resources, such as knowledge, influence in the organisation, communication or networking skills, to overcome resistance barriers' (Fichter, 2009).

Innovativeness has been defined by many authors (Feaster, 1968), (Wang and Ahmed, 2004), (Hult et al., 2004), (Menguc and Auh, 2006), (Woodside, 2005) as a positive attitude towards innovation and the changes it might bring, the benefits for organisational development and openness as part of organisational culture (summarised by Zawawi et al., 2016). Innovativeness can be studied by both investigating the adoption of a particular innovation and in the analysis of the innovativeness of actors. In the latter case, an earlier innovation adoption is seen as a standard measure of innovativeness for actors in the system and is linked to various factors. Socioeconomic characteristics such as larger-sized units and higher social status (income, possessions of funds, occupational prestige) are linked to earlier adoption as well as rationality, education, a more favourable attitude towards change and science, higher aspirations, broader social participation, connectedness, exposure, greater knowledge of innovation, a higher degree of opinion leadership (Rogers, 2003) and many other factors.

One cannot help noticing that the described variables, although named and categorised differently, reflect Bourdieu's famous forms of capitals (1984, 1986, 1989, 1992), a crucial force and a fundamental principle underlying the immanent regularities of the social world, which make 'the games of society – not least, the economic game – something other than simple games of chance offering at every moment the possibility of a miracle' (1986) or, in other words, the combination of accumulated labour of all kinds (either economic capital directly convertible into money or property rights, or convertible immaterial capitals such as cultural capital that can be institutionalised in the form of education and social capital – made up of connections) determines the chances of success for practices. The idea of the capital convertibility for its reproduction (1986) provides an opportunity to further explore and explain innovation in social systems such as the museum sector – characterised by relatively scarce economic resources but high levels of professional prestige and public credibility. Rogers suggests that each case be treated as an open question (2003), the conclusions of which are to be determined empirically.

3. Research design

The study is based on a quantitative research design. Primary data was obtained through a quantitative survey of accredited museum representatives. The questionnaire was programmed in the LimeSurvey online environment and piloted in 5 museums. Test respondents gave feedback on whether the questions were understandable and their sequence logical. Then the questionnaire was tweaked to resolve all identified problems. The survey fieldwork was carried out between 3 and 24 September 2021. Top managers of the country's all accredited museums (n=111) were invited to participate in the survey. Ultimately, 97 accredited museums (87.4% of the cohort) completed the

questionnaire. The sample is representative and allows the data to be interpreted with a +/-3.5% sampling error (at a 95% confidence interval). The questionnaire included questions on museum characteristics and 53 digital innovation parameters divided according to the basic museum functions – collection, research and communication (Van Mensch, 1992). For each innovation, museums were asked to indicate whether it had been introduced before or during the pandemic or was planned for the coming years. The answer options also included negative variants – 'decided against introducing', 'have not thought about introducing' or 'difficult to say'. The scores of these 53 parameters form the core data of the study. Two indicator types characterise digital innovation in museum education: (1) online educational activities, such as lessons or guided tours in Zoom or MS Teams, and (2) digital-only educational products, such as quizzes, games and digital worksheets, etc. The survey was not anonymous (museums identified themselves by name), so the authors could introduce secondary data from annual museum statistics, such as visitor numbers and target groups, income and expenditure, museum activities and staff characteristics. The secondary data were aggregated by the Ministry of Culture and provided to the authors of this study. These variables enabled a greater variety in cross-section analysis.

The primary and secondary data were combined in a single data file, and statistical and mathematical analysis was performed with IBM SPSS Statistics software. The first step involved descriptive statistics: measures of frequency (count, per cent, frequency), measures of central tendency (mean, median), measures of dispersion or variation (range, variance, standard deviation), measures of position (percentile ranks, quartile ranks). As a result of this analysis, cross-tables were produced to characterise the differences in innovation practices across different cross-sections (museum activities, staff numbers, income, etc.). As the second step, binary logistic regression identified which specific museum characteristics affect the adoption of digital innovation in museum education.

4. Results and discussion

4.1. Museums' pre-pandemic digital development and pandemic effects

The role of digital technologies in our everyday life has been growing over the past 20 to 25 years, and this study suggests that Latvian museums see digital technologies primarily and overwhelmingly as an image building tool as well as the tool to serve the society better (Fig. 2). 91.8% of museums claim digital technologies boost their overall image and popularity, and 87.6% believe they can help meet the needs of the 21st-century public. With that, museums are less likely to acknowledge the role of digital technologies play in improving and adapting museum content to different target groups. Thus, 70.1% of museums consider them important in engagement with audiences, 64,9% for accessibility for people with functional or intellectual disabilities, and 61.9% in improvement of visitor experience.

The data on digital innovations already implemented by Latvian museums suggests the pandemic was a powerful catalyst for digital development and attitude change across the sector. Although, before the pandemic, digital tools were mainly used for informing purposes, during the pandemic, museums introduced new digital products and forms of online content (Fig.3). For instance, before the pandemic, more than half of the museums had implemented digital technologies such as social networks (81.4%), museum website

(70.1%), interactive elements in exhibitions (59.8%) and emailing newsletters (51.5%) (Figure 3).

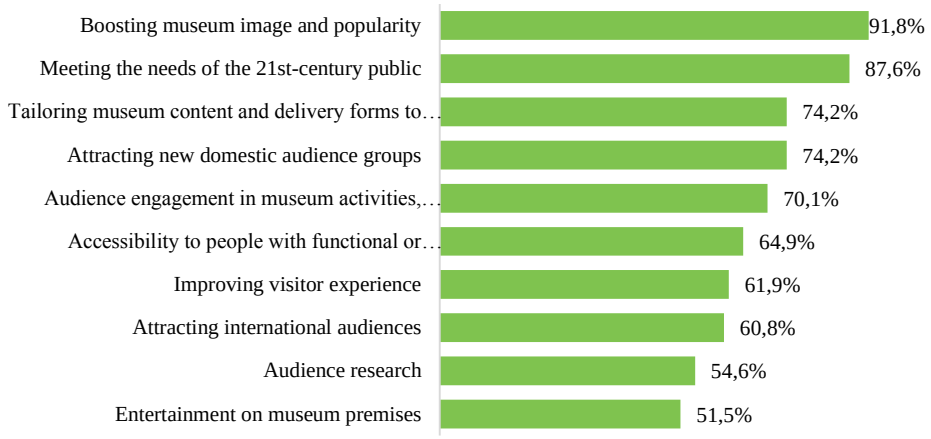

Figure 2. Role of digital technologies in museum work with their audience.
Note: Answers 'very important' and 'important' combined

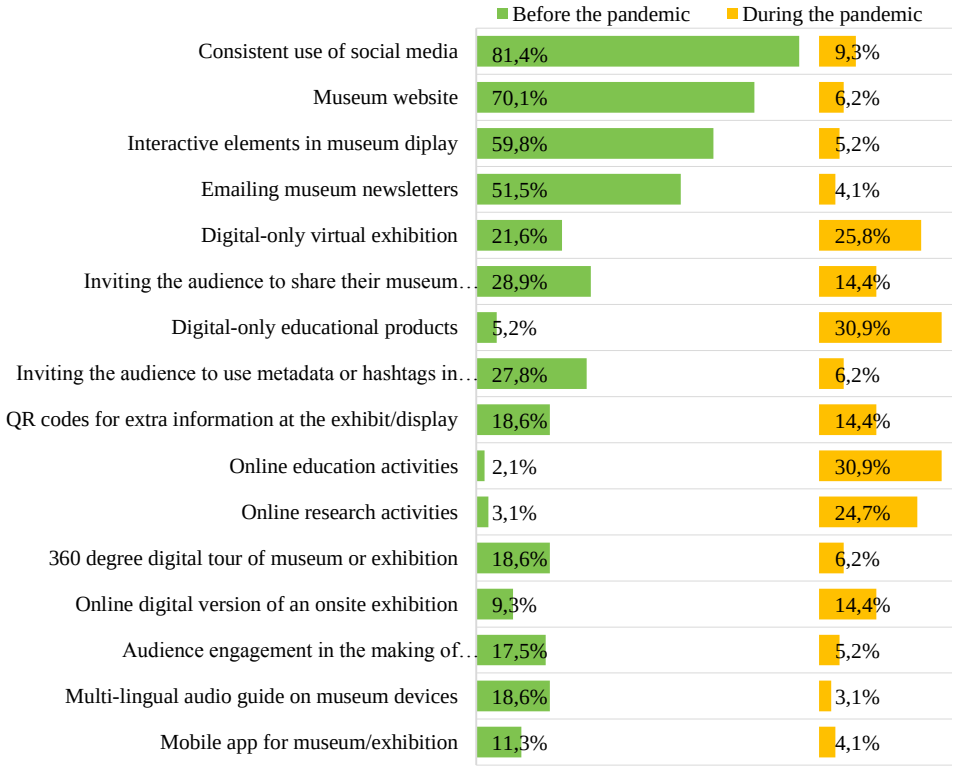

Figure 3. Digital innovation in museum work with their audience before and after the pandemic (selection of most significant indicators)

Meanwhile, during the pandemic, museums actively introduced digital innovations such as a digital museum education tool (30.9%), online educational activities (30.9%), virtual exhibitions in the digital environment (25.8%) and online conferences, workshops, or other research activities (24.7%). Crucially, instead of continuing with the digital activities they had already implemented during the pandemic, museums introduced digital innovation – new ideas, products, or practices. Primarily, these were innovations in museum education, with online research activities a close second, followed by virtual exhibitions that had been implemented by very few museums but evolved significantly during the pandemic.

4.2. Characteristics of digital innovation adopters

Digital innovation in museum education has been the area to experience the most striking pandemic effects. Before the pandemic, only 5.2% of museums had implemented at least one type of digital innovation towards visitor education (online educational activities or digital-only educational products). In contrast, 22.7% of museums had implemented both types during the pandemic, and another 16.5% at least one (Fig. 4). Overall, 39.2% of Latvian museums report implementing online educational activities and/or digital museum education tools during the pandemic.

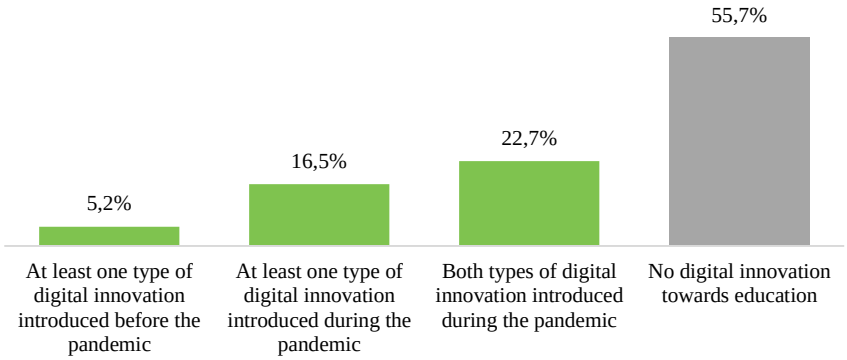

Figure 4. Digital museum education before and after the pandemic

Comparing the profile of museums that introduced both online educational activities and digital-only educational tools during the pandemic (Group A) with those that did not introduce any digital developments towards visitor education (Group B) suggests that larger museums (in terms of visitor and staff numbers and higher income) have been more active with digital innovation in museum education. This is consistent with Rogers' broad suggestion that earlier adopters have larger-sized units than later adopters and his conclusion that 'socioeconomic status and innovativeness appear to go hand in hand' (Rogers, 2003). Although no straightforward cause-and-effect relationship can be determined, the financial aspect, visitor numbers, and institution size stand out as significant factors, even if they alone cannot explain complex innovation adoption behaviour. However, a more detailed look at available statistics and survey data allows authors to identify and conceptualise three broader aspects that differentiate the two

groups: (1) financial aspect – resources, funding diversification and dynamics during pandemic, (2) museum aspirations towards overall digital development and (3) communication function performance to serve the society.

Financial aspect. The first major difference can be observed in the aspect of museum income. In Group A (digital innovation implementers), half of the museums have an income of over 430 thousand EUR; in contrast, the median figure for Group B (non-implementers) is only 78 thousand EUR (Table 1).

Secondly, among the earlier innovators or Group A, more museums have a diversified income structure. Thus, 95% of the innovators provided paid services, 86% had ticket revenues, 77% received grants from the State Culture Capital Foundation, 45% attracted sponsorships and donations, and 18% received grants from international foundations. At the same time, tickets and paid services are also important sources of income for those museums that have not introduced museum education innovations (Group B).

Thirdly, during the pandemic, the extent of any museum's financial resources depended on the degree to which it was funded by the founder. For instance, financial resources might remain the same for a free-admission museum 100% funded by its municipality. That said, financial resources plummeted for some of the museums relying on diverse income sources. Given that heritage institutions could participate in several state-funded support programmes during the pandemic, including one specifically aimed at new digital tools and targeted work with visitors with disabilities, their financial resources may have actually increased. The study suggests that 77% of the innovators (Group A) have seen their financial resources decrease since the pandemic, while half of the non-innovators have seen their funding remain unchanged.

Table 1. Financial aspect – income, financial diversification and income dynamics during the pandemic

Variables	Group A	Group B
Income, 2019		
Income, median	430 618	78 356
Diversification of financial resources, 2019		
State Culture Capital Foundation, %	77	38
International foundations %	18	6
Ticket sales %	86	81
Museum services %	95	68
Sponsorships and donations %	45	19
Income dynamics during the pandemic, 2021		
Increased %	9	6
Unchanged %	14	50
Decreased %	77	44

Source: Museum statistics aggregated by the Ministry of Culture

Overall, digital innovation in museum education has taken place in the context of dwindling financial resources. Rogers gives two possible explanations. Firstly, innovation might be costly, so adopters must have initial outlays of capital. In our case, Group A still has a significantly higher income than Group B, even though their budgets have gone down. Secondly, Rogers suggests that greater profits usually go to the first adopters, meaning the innovator gains a financial advantage through relatively early adoption of the innovation (Rogers, 2003). In Latvia's museum sector, online educational activities during the pandemic were included in the state-funded Latvian School Bag programme, compensating for the loss of income Group A incurred when school groups stopped coming to museums in person.

Museum aspirations towards overall digital development. Aspirations can be defined as achievement motivation (Czaika and Vothknecht, 2012). They tend to be 'future-orientated, driven by conscious and unconscious motivations, and they indicate an individual or group's commitments towards a particular trajectory or end point' (Hart, 2016). In the survey, museums were asked to self-evaluate according to the descriptions of ideal types for Rogers' adopter categories. According to the findings, museums identified as earlier adopters have been more active in implementing digital innovation in museum education (Table 2). Thus, 41% of Group A say they want to be among the

Table 2. Museum aspirations towards overall digital progress: self-evaluation, digital development strategy, implementation of different digital innovations

Variables	Group A	Group B
Self-evaluation according to descriptions for Rogers' ideal types		
Innovator, %	5	7
Opinion leader, %	41	9
Early majority, %	55	61
Late majority, %	0	20
Laggard, %	0	2
Digital development strategy		
Separate digital development strategy, %	9	0
Digital development mentioned in the general development strategy or policy documents, %	68	44
Digital development mentioned in other museum policy documents, %	14	17
No mention of digital development in museum policy documents, %	9	39
Digital innovation implementation		
Number of innovations introduced before the pandemic, median	18	7
Number of innovations introduced during the pandemic, median	8	3
Number of innovations introduced in total, median	26	11

Source: survey data by authors

first to introduce new digital innovations in Latvia's museum sector ('innovators') or that they want to be opinion leaders and mentors for other museums ('opinion leaders'). At the same time, 55% of Group A project they should be open to digital innovations after opinion leaders have implemented them, tested the risks and benefits and evaluated the effectiveness of the new practice ('early adopters'). Importantly, this attitude towards digital innovation is also shared by 61% of Group B. Nevertheless, there are no museums in Group A that describe themselves as 'rather sceptical about digital innovations, waiting until the majority have introduced them, tested the risks and benefits in the museum sector and found them useful' ('late majority') or report being 'very sceptical and cautious about digital innovations in our museum, waiting until almost all museums have introduced them and found them useful' ('laggards'). Meanwhile, in Group B, 22% of museums self-evaluate as late majority or laggards.

Rogers suggests that earlier adopters have greater rationality than later ones, meaning the 'use of most effective means to reach a given end' (Rogers, 2003). The capacity to aspire includes not only the ability to set goals and generate aspirations but also knowledge of how to achieve those goals (Dalton et al., 2010). Overall, survey data suggest that only 3.1% of museums have developed digital development strategies, and 48.5% of museums have included digital development in their overall development strategy. Around one in three museums do not mention digital development in their strategic planning (Fig. 5).

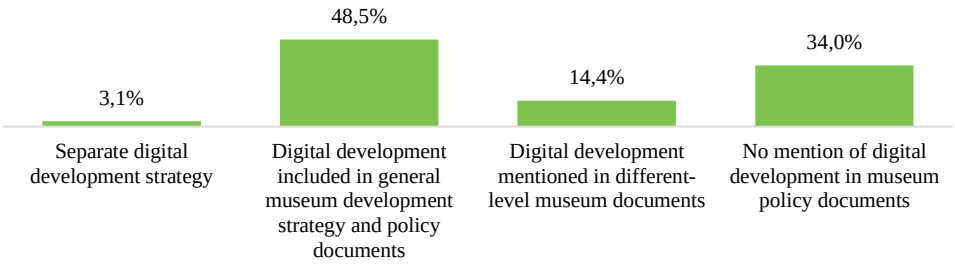

Figure 5. Digital development in museum planning documents

Museums implementing digital innovations in museum education are significantly more likely to mention innovation development in their strategic documents (Table 2). Thus, 9% of Group A have a separate digital development strategy, while 68% include digital development in the overall development strategy or primary policy documents. That said, it cannot be argued that the adoption of digital innovation alone is highly correlated with its strategic planning. The data shows that 9% of innovators make no mention of digital development in any planning documents, while 44% of the museums that have not introduced any museum education innovations mention digital development in their strategic documents.

Rogers suggests that earlier adopters are less dogmatic and have more favourable attitudes to change and science because innovation is often the product of scientific research (Rogers, 2003). This study demonstrates that Group A has also been active in implementing other digital innovations. The median number of innovations implemented

by Group A before the pandemic is 18 (meaning that half of the earlier innovators have implemented more than 18 digital innovations before the pandemic), dropping to 8 in the Covid period.

Communication function performance to serve the society. A museum embracing the mission to 'serve the society and its development' (ICOM, 2007) can be characterised by variables that show activity in the 'communication function', which includes exhibitions, publications, educational programmes, and events (van Mensch, 1992); in other words, the museum-audience interaction. This study suggests (Table 3) that Group A is more likely to have been active in museum education before the pandemic (the median number for Group A – 184, compared to only 22 for Group B or museums that did not implement innovations in museum education). Group A was also more active in other communication activities, such as giving tours, holding lectures, and creating exhibitions.

The introduction of digital innovation in museum education correlates with the overall communication activity in the pre-pandemic period.

Table 3. Communication function performance to serve the society: visitor numbers, communicative activities, staff numbers and age, and having an innovation champion

Variables	Group A	Group B
Visitor numbers, 2019		
Total visitor numbers, median	30 127	4 900
Visiting school groups, median	4 878	627
Communicative activities		
Tours by museum staff, median	201	63
Lectures, median	12	1
Museum education activities, median	184	22
Exhibitions, median	18	7
Staff numbers, 2019		
Staff numbers, median	24	6
Staff by age groups, 2019		
Staff under 30, %	90	42
31 to retirement age, %	100	98
Retirement age, %	76	48
Employee who encourages introduction of digital technologies ('innovation champion' according to Rogers)		
Yes, %	64	46
No, %	9	20
Difficult to say, %	27	33

Source: museum statistics aggregated by the Ministry of Culture, survey data by authors

Communication function performance is heavily linked to the audience the museum interacts with and the staff that implements and performs the activities. The median visitor number for Group A is 30.1 thousand (meaning that half of these museums have more visitors than the given figure). Meanwhile, the median number in Group B is considerably lower – only 4.9 thousand visitors. There is also an essential difference in the median number of visiting school groups (4.8 thousand to 627 respectively). Staff numbers and their characteristics are another distinction between innovators and non-implementers of educational innovation. The data suggests that half of Group A has more than 24 employees, compared to just 6 in the non-innovator group. According to Rogers (2003), 'earlier adopters are no different from later adopters in age'. However, this study suggests that younger staff might be an important factor in the organisation's ability to innovate and that the ratio of young employees to seniors is significant. Although most innovators or Group A have retirement-age employees, the proportion of younger staff is higher. Meanwhile, in Group B, the ratio of young and retirement-age employees is roughly equal.

The study paid particular attention to the so-called innovation 'champions' – 'charismatic individuals driving innovation by overcoming the resistance or indifference an organisation might have to a new idea' (Rogers, 2003). Group A has more museums with a staff member who actively encourages the introduction of digital technologies (64% of museums have such a person). The percentage is significantly higher in museums with more employees under 30 (90% of these could identify at least one such person). Nevertheless, the role of innovation 'champions' is ambiguous, as 46% of Group B museums could also identify an innovation champion within their organisation. Aspirations can be seen as a product of a stimulating social environment (Collier 1994). The authors speculate that if the champion is identified in a museum where all other variables contradict an innovation-conductive environment (no digital strategy as a clear development priority, a different ratio of younger and retirement-age employees, financial constraints and poor overall communication function performance), the obstacles might be too overwhelming for the champion to overcome the resistance.

4.3. Predicting the implementation of digital educational innovation

The study identified three broad aspects that differentiate Group A (earlier adopters who have introduced digital innovation in museum education) from Group B (rejecters who have not introduced any digital innovation in museum education, neither online activities nor digital tools). These include resources, funding diversification and dynamics during the pandemic, museum aspirations towards overall digital progress, and communication function performance to serve the society. Although, descriptive statistics exposed these factors as differentiating Group A from Group B, however, in isolation, neither is sufficient to reliably predict whether an institution will introduce digital innovation in museum education. Therefore, the authors used binary logistic regression to identify which variables reliably predict the implementation of digital educational innovation. 11 factors were tested, which were hypothesised to affect the introduction of digital innovation in museum education (target variable), yet only 3 were found to have a statistically significant P-value in relation to educational innovation (Table 4). These are

Table 4. Binary logistic regression: Sample output

P value >0.05
Staff numbers
Funding dynamics since the pandemic
Attitude to digital technologies
Innovation in strategic planning
State Culture Capital Foundation assignations
Total number of museum activities
Proportion of staff under 30
Number of pre-pandemic innovations
P value <0.05
Total innovation numbers
Total number of museum education activities
Total income

total innovation numbers, total number of museum education activities and total income. Combining these three factors enables making reliable predictions about the implementation of digital educational innovations. Thus, the findings suggest that if a heritage institution is active with onsite museum education activities and implements digital innovation in other areas, one can reliably predict that it will also implement digital innovation in education. Therefore, a statistically significant factor for implementing digital innovations in museum education is experience with museum education and other digital innovations. Another important factor is the available resources, represented here by total income. However, available funding has an impact only in conjunction with both factors described above.

Conclusions

Research data suggests a few significant aspects characterise the practice of digital innovation in museum education. The pandemic has been a massive factor that has forced museums to innovate around education, making it the leading digital innovation field in Latvia's museum sector at this period.

First, the museums whose financial resources have dwindled in the pandemic have been more active educational innovators. Thus, external pressure in the form of pandemic restrictions across the museum sector as well as shrinking financial resources has been conducive to innovation. The second significant factor is the museum's general orientation towards innovation and development. Educational innovations have been more actively implemented by museums that make strategic plans for innovation and feature it in their planning documents. A closer statistical analysis of the data suggests that educational innovations follow in the steps of other digital innovations. This means they are not the first on the museum agenda. The third factor is linked to age composition of available human resources and capacity of digital innovation champions,

nevertheless if other factors contradict an innovation-conductive environment, obstacles might be too overwhelming for the champion to overcome the resistance.

Finally, available funding per se is insufficient to predict the adoption of digital innovation in museum education. Although, it has a substantial impact, it plays out only in conjunction with two other factors – prior experience in onsite museum education and prior introduction of digital innovation in other areas of museum work.

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