

The Importance of Implementation Constraints for Next-Generation Technologies in Theatres*

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Abstract

The implementation of next-generation technologies may improve the efficiency of theatre operations and help theatres address contemporary financial and organisational challenges. However, the technological transformation of theatres is associated with numerous implementation constraints that may limit the effectiveness of these processes. Despite the growing importance of technological transformation in cultural institutions, the existing literature provides limited evidence regarding the factors constraining the implementation of next-generation technologies in theatres.

The aim of this study is to identify and assess the importance of implementation constraints related to next-generation technologies in theatres. The study applies the Analytic Hierarchy Process (AHP) method to compare and rank implementation constraints identified in previous research. The analysed factors were grouped into four categories: economic constraints, institutional constraints, technological and infrastructural constraints, and constraints related to competence and organisational culture.

The findings indicate that economic constraints and competence- and culture-related factors constitute the most significant barriers to technological transformation in theatres. Financial constraints were identified as the most influential factor overall, followed by the way theatre is defined and the habits and characteristics of theatre audiences. Institutional and technological constraints were found to be of secondary importance. The results suggest that the implementation of next-generation technologies in theatres is shaped primarily by economic and identity-related factors rather than by technological limitations alone.

Keywords: theatre management, technological transformation, digital transformation, implementation barriers

Introduction

Nowadays, organisations operate in an environment of intensive change, driven primarily by the dynamic development of next-generation technologies and the resulting complexity of the operating environment (Gong and Ribière, 2021). This has a direct impact on the way all economic entities operate, including cultural institutions, which, despite their specific nature, are subject to similar adaptive mechanisms. Next-generation technologies place new demands on the cultural sector. Theatres, museums, art galleries, libraries, and other cultural organisations face the dilemma of deciding on the scope and direction of technological transformation (Dixon, 2007).

Theatres, as organisations operating at the intersection of art, management and technology, and under the influence of public opinion, are particularly susceptible to the impact of changing audience expectations and rapidly developing technologies (Horváth, 2024). The implementation of modern technologies supports artistic creation, as well as theatre management, the promotion of performances, the analysis of audience preferences, and comprehensive audience management. Thanks to these technologies, more immersive experiences are created for audiences, thereby increasing the accessibility of performances (e.g. through online streaming).

However, the process of implementing next-generation technology in theatres is associated with numerous barriers and constraints that significantly affect the pace and effectiveness of these changes. The implementation of new solutions involves making strategic decisions that set the direction for the further development of theatres, the allocation of resources, and the formation of relationships with the surrounding community, which is crucial for organisations of this nature.

Next-generation technologies allow, to some extent, for counteracting the effects of paradoxes associated with theatre operations, particularly regarding funding. An example is Baumol's cost disease (Baumol and Bowen, 1966), according to which the productivity of artistic ensembles does not grow at a rate comparable to the costs of running artistic activities. Given these circumstances, research into the implementation processes of next-generation technologies in these organisations is necessary.

Effective adaptation to new technological solutions depends not only on the availability of these solutions, but also on the theatre's ability to integrate them with existing practices. This is particularly important, given the need to preserve the essence of artistic activity and the way it is received by audiences. Technological transformation encompasses not only the technologies themselves, but also necessitates organisational changes that take the social context into account (Ciancarini, Giancarlo, and Grimaudo, 2023).

Therefore, the aim of this study is to determine the importance of factors limiting the implementation of new-generation technologies in theatres. In reference to this aim, the following research questions have been defined:

RQ1: What is the relative importance of the various groups of constraints on the implementation of next-generation technologies in theatres, and their internal structure?

RQ2: Which constraints on the implementation of next-generation technologies are of the greatest importance globally?

RQ3: What is the nature of the implementation processes for next-generation technologies, from the perspective of the constraints on these processes?

This objective has been achieved and the research questions have been answered through a review of the literature and a discussion of the results of empirical research. The results obtained may serve as a basis for further consideration of the directions of theatre development in the context of rapidly advancing technological change, as well as for the formulation of recommendations for theatre managers aimed at streamlining existing implementation processes and increasing the effectiveness of the implementation of modern technological solutions.

The next-generation technology in theatres – theoretical background

Contemporary theatre institutions are increasingly using next-generation technologies. Examples include: robotics including stage robots (Lu and Smart, 2011, Sovhyra, 2021); immersive technologies such as VR and AR (Pike, 2020); intelligent lighting systems (Hsieh and Kao, 2025); projection mapping (Derkach et al., 2023); sales systems with an audience personalisation module (Price et al, 2019); computer vision used to track audience movement and response (Cai and Wang, 2024); artificial intelligence models used for scriptwriting (Elias et al., 2025; Ren, 2024) or real-time performance creation (Mathewson and Mirocki, 2018); systems to support theatre management processes (Pathak et al., 2025).

Next-generation technologies are leading to a change in audience profile (Plebańczyk, 2023). The use of AI in marketing processes is becoming increasingly common (Jia, 2025). New technologies are stimulating processes of evolution of the functions of contemporary theatre institutions and the emergence of new ones (Karcz-Ryndak and Zapata-Aguirre, 2025). Modlinski and Pinto (2020) emphasise the substitutive (replacing human

labour) and complementary (supporting human labour) nature of the new generation technologies being implemented in cultural institutions, including theatres.

At the same time, there is a lack of research in the literature on the deployment processes of next-generation technologies in operational environments. In particular, there is a lack of structured research on the implementation constraints associated with these processes. In the literature, studies can be found that focus on the broader context of the cultural sector as a whole (Yordanova and Todorova, 2025), other cultural entities such as museums (Nikolaou, 2024), or on selected aspects such as legal (Klinowski and Szafarowicz, 2023). A study designed for theatres was conducted at the Cracow University of Economics as part of the research project “Managing contemporary theatre under conditions of progressive technological change with an international perspective” (Karcz-Ryndak, 2024). During qualitative interviews involving 11 theatre managers, a catalogue of key factors limiting the implementation processes of new technologies was identified (Table 1).

Table 1: Implementation constraints of next generation technology in theatres

Implementation constraints of next generation technology in theatres	Description
Lack of digital competence of employees	Inadequate skills among theatre staff in handling digital tools and next generation technologies inhibits the implementation of modern solutions, delays the digitisation process, and leads to next generation technologies not realising their full potential.
Insufficient level of digital maturity	A lack of digital awareness among managers and lower-level staff makes it difficult to select appropriate technologies and implementation methods. Given the rapid pace of change, this can result in less effective solutions being selected, which can consequently disrupt the institution's digital development.
Financial constraints	With the rising costs of implementing new generation technology, the budgets available to theatres are insufficient. Priority is given to staff salaries and maintaining core artistic activities, which significantly affects the effectiveness of long-term planning and limits the ability to channel resources to innovate.
Resistance of theatre staff	Resistance to technological change is due to psychological, competence, and organisational factors. Due to a lack of digital competence, theatre staff (especially senior staff) display a reluctance towards new developments. This is compounded by fears of excessive workload and job insecurity, automation, and loss of control over the creative process. Negative experiences of employees during the pandemic period further perpetuate resistance strategies, making it difficult to develop effective solutions and build an organisation conducive to technological adaptation. Resistance to technological change is due to psychological, competence and organisational factors. Due to a lack of digital competence, theatre staff (especially senior staff) display a reluctance towards new developments. This is compounded by fears of excessive workload and job insecurity, automation, and loss of control over the creative process. Negative experiences of employees during the pandemic period further perpetuate resistance strategies, making it difficult to develop effective solutions and build an organisation conducive to technological adaptation.
Early stage of development of individual technologies	The early stage of technology development is an implementation challenge, due to the underdevelopment of technology innovations selected for implementation. This carries the risk of product defects and rapid obsolescence of the technology's usefulness. In an underfunded cultural sector, the risk of investing in uncertain tools can contribute to the inefficient use of a theatre's already limited financial resources.
Difficult to predict market development scenario	Theatre managers are concerned that investments in next-generation technology may not be appropriate, due to unknown audience preferences and regulations that are difficult to predict. Market uncertainty forces theatre managers to be cautious, which in turn delays investment decisions, thus reinforcing the tendency to observe trends rather than create them.
Habits and specificity of the audience	Often among audiences, attending a performance is treated as a repetitive ritual linked not only to the performance itself, but also to the specific atmosphere of the venue, the presence of the actors and the direct experience of the event. As a result, too intensive

	implementation of technology can disrupt the expected form of reception and raise fears of loss of audience loyalty.
How theatre is defined	The artistic vision determines the extent to which technological interference in the creative process is accepted. Some artists perceive theatre as an art based on the actor-spectator relationship, with technology as an unnecessary addition or even a threat to the authenticity of the message. Part of the community perceives the potential for development, fearing, however, the too fast pace of change.
Deficiencies in the basic technical infrastructure of the theatre	Many theatres have outdated equipment and insufficient technical facilities. The pandemic period has highlighted the scale of these deficits - it has become apparent that a significant proportion of theatres are not hardware-ready for more advanced digital solutions, and upgrading legacy solutions can generate additional costs and prolong the implementation process.
Initial costs of entering a given technology	Theatres often do not have the resources to purchase more advanced solutions, the associated staff training and infrastructure upgrades. Investing in new technologies often involves significant financial risk due to the high purchase price, while the return on such investments is difficult to estimate.
Resistance from advisory bodies of theatres	Theatre advisory bodies act as guardians of tradition and artistic quality. They are typically composed of individuals who are firmly rooted in the traditional model of theatre operations and may therefore be sceptical of technological innovations, particularly those that impact the repertoire and performance formats.
Tenure of managers in public theatres in the context of changing perceptions of technological transformation	Tenure in manager positions affects the continuity of strategic implementation projects of new technologies. A change of manager during the implementation process may trigger the need to review decisions made earlier, especially when the new management has a different artistic vision.
Lack of dissemination of selected technological solutions	The limited availability of suitable equipment among audiences and the low level of digital competence among some of them contributes to a lower interest in selected solutions, e.g. VR broadcasting or mobile applications. As a result, this translates into a failure to achieve the anticipated audience figures, especially among older audiences who prefer traditional forms of contact with the theatre, including the purchase of tickets.

Source: based on: (Karcz-Ryndak, 2024).

Methods

The study was conducted using the heuristic AHP (Analytic Hierarchy Process) method (Forman and Selly, 2001; Petrillo and De Felice, 2023; Saaty, 2000 and 2003). The analysis was carried out in several steps: 1) constructing a hierarchical model concerning the implementation constraints of new-generation technologies in theatres; 2) developing a questionnaire for experts; 3) conducting an expert panel, during which the experts made pairwise comparisons of individual criteria based on the questionnaire; 4) drawing up a preference matrix and determining the weights of local and global criteria; 5) assessing the consistency of individual matrixes; 6) compiling and analysing the results.

In accordance with Saaty's proposal (1994a), the experts selected the more important element in each of the compared pairs and then assessed the level of importance on a scale of 1, 3, 5, 7, 9, where: 1 (equivalent, equally preferred), 3 (moderate advantage), 5 (strong advantage), 7 (very strong advantage), 9 (extreme advantage). Experts could also use the intermediate values 2, 4, 6, 8.

The expert panel, within which the criteria were compared, met on a regular basis until the matrix was consistent, and the experts present were able to make adjustments based on the discussions held. The experts included theatre directors representing a variety of organisational and repertoire forms. The composition of the expert panel was selected deliberately (Palinkas et al., 2015; Pasikowski, 2023), based on the researcher's knowledge of the theatre industry. This approach helps to overcome issues related to the availability of the research sample.

Due to the small size of the matrix, more strict criteria were adopted in the context of assessing the consistency of comparisons. For the 4x4 matrix, values of $CR \leq 0,08$ were adopted. Matrixes of smaller dimensions were accepted for values of $CR \leq 0,05$. The CR index was calculated as the quotient of the consistency index (CI) and

Saaty's random index (RI) (Saaty, 1994b). RI=0,89 was adopted for 4x4 matrixes and RI=0,52 for 3x3 matrixes. For 2x2 matrixes, the RI index was set to 0. At the same time, it was assumed that a CI level of $\leq 0,1$ is acceptable in terms of consistency. Local and global priorities were determined based on the geometric mean.

The hierarchical model is based on the findings of qualitative research into the barriers to the implementation of new technologies in theatres (Karcz-Ryndak, 2024). The aim of this study is to determine the relative importance of individual constraints. Given this problem, the research question is: What is the relative importance of the identified constraints on the implementation of new-generation technologies in theatres, in the opinion of experts?

In creating a hierarchical model suitable for the AHP method, the aforementioned implementation constraints of new-generation technologies in theatres were divided into four groups: economic constraints (A), institutional constraints (B), technological and infrastructural constraints (C), and constraints at the level of competence and organisational culture (D). This situation is presented in detail in Table 2.

Table 2: Criteria and sub-criteria adopted in the AHP model

A	Economic constraints
A1	Financial constraints
A2	Initial costs of entering a given technology
A3	Difficult to predict market development scenario
A4	Habits and specificity of the audience
B	Institutional constraints
B1	Resistance from advisory bodies of theatres
B2	Tenure of managers in public theatres in the context of changing perceptions of technological transformation
C	Technological and infrastructural constraints
C1	Deficiencies in the technical infrastructure of the theatre
C2	Early stage of development of individual technologies
C3	Lack of dissemination of selected technological solutions
D	Constraints at the level of competence and organisational culture
D1	Insufficient level of digital maturity
D2	Lack of digital competence of employees
D3	Resistance of theatre staff
D4	How theatre is defined

Source: Own study.

The application of the factor classification presented in the model also makes it possible to determine the significance of entire clusters of factors that constrain the implementation of next-generation technologies in theatres, and to analyse their internal structure, taking into account subcategories.

Research findings

The data obtained from the comparisons were used to construct input matrixes and subjected to the AHP method. As a result of these procedures, local and global weights were obtained for each criterion (Table 3).

Table 3: Results of the AHP analysis

Main criteria		Priorities of the main criteria	Subcriteria		Local priorities	Global priorities
A	Economic	0,5232	A1	Financial constraints	0,5403	0,2827

	constraints		A2	Initial costs of entering a given technology	0,0624	0,0326
			A3	Difficult to predict market development scenario	0,1228	0,0642
			A4	Habits and specificity of the audience	0,2745	0,1436
B	Institutional constraints	0,0580	B1	Resistance from advisory bodies of theatres	0,8333	0,0483
			B2	Tenure of managers in public theatres in the context of changing perceptions of technological transformation	0,1667	0,0097
C	Technological and infrastructural constraints	0,1411	C1	Deficiencies in the technical infrastructure of the theatre	0,7514	0,1060
			C2	Early stage of development of individual technologies	0,1782	0,0251
			C3	Lack of dissemination of selected technological solutions	0,0704	0,0099
D	Constraints at the level of competence and organisational culture	0,2777	D1	Insufficient level of digital maturity	0,0714	0,0198
			D2	Lack of digital competence of employees	0,0777	0,0216
			D3	Resistance of theatre staff	0,2951	0,0819
			D4	How theatre is defined	0,5559	0,1544

Source: Own study.

Local weights determine the significance of implementation constraints for new technologies within individual groups (A–D). Global weights, on the other hand, refer to the entire catalogue of constraints covered by the study.

As can be seen in the table above, the experts highlighted the predominant importance of economic constraints (A; 0,5232) and constraints relating to competence and organisational culture (D; 0,2777). In their opinion, technological and infrastructural constraints (C; 0,1411) and institutional constraints (B; 0,0580) play a lesser role.

Within the group of economic constraints (A), the most significant factors were financial constraints (A1; 0,5403) and the habits and specificity of the audience (A4; 0,2745). In the experts' opinion, they also highlighted the difficulty to predict market development scenario (A3; 0,1228), whilst giving marginal weight to the initial costs of entering a given technology (A2; 0,0624).

In the case of institutional constraints (B), the experts had only two constraints to compare. In their view, resistance from advisory bodies of theatres' (B1; 0,8333) is significantly more important than the tenure of managers in public theatres in the context of changing perceptions of technological transformation (B2; 0,1667).

Among technological and infrastructural constraints (C), deficiencies in the technical infrastructure of the theatre (C1; 0,7514) are of paramount importance, complemented by the early stage of development of individual technologies (C2; 0,1782). The ranking in this category is brought up by lack of dissemination of selected technological solutions (C3; 0,0704).

Within the group of constraints relating to competence and organisational culture (D), the most significant factors are how the theatre is defined (D4; 0,5559) and resistance from theatre staff (D3; 0,2951). Lack of digital competence among employees (D2; 0,0777) and insufficient level of digital maturity (D1; 0,0714) are of significantly less important.

From the perspective of the topic under consideration, the ranking of barriers to the implementation of next-generation technologies in theatres, based on global priorities, is particularly significant (Figure 1).

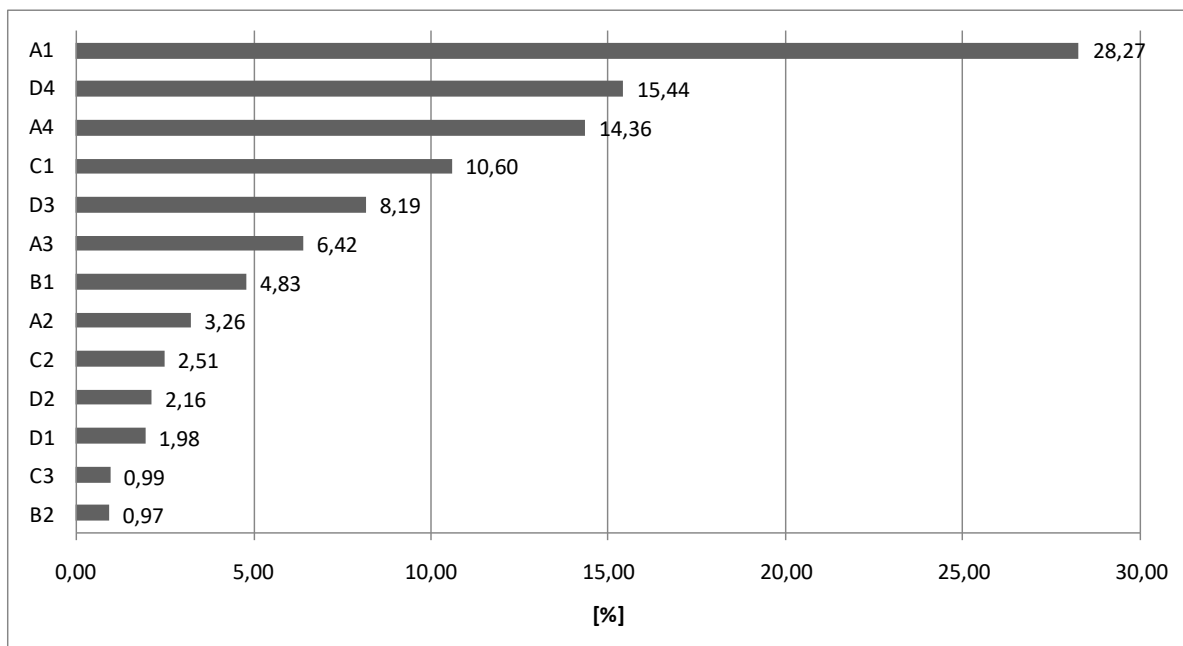


Fig 1. Ranking of implementation constraints for next-generation theatre technologies

Source: Own study.

Overall, the most significant factor was financial constraints (A1; 28,27%); the second most significant was how theatre is defined (D4; 15,44%). Habits and the specific nature of the audience (A4; 14,36%) were of similar importance. Also of great significance are deficiencies in the technical infrastructure of the theatre (C1; 10,60%); resistance from theatre staff (D3; 8,19%); and difficult to predict market development scenario (A3; 6,42%). Slightly less significant are resistance from advisory bodies of theatres (B1; 4,83%) and initial costs of entering a given technology (A2; 3,26%).

Ranking lowest among the barriers to implementing new-generation technologies in theatres (from 0,97% to 2,51%) are the early stage of development of individual technologies (C2), lack of digital competence among employees (D2), insufficient level of digital maturity (D1), lack of dissemination of selected technological solutions (C3), and the tenure of managers in public theatres in the context of changing perceptions of technological transformation (B2).

The results obtained are reliable given the positive assessment of the consistency of the individual matrixes (Table 4).

Table 4: Consistency analysis – parameters

Matrix	Matrix size	RI	CI	CR	Consistency assessment
Matrix of main criteria	4x4	0,89	0,0562	0,0631	Consistent matrix
Matrix A (Economic constraints)	4x4	0,89	0,0668	0,0751	Consistent matrix
Matrix B (Institutional constraints)	2x2	0	0,0000	0,0000	Consistent matrix
Matrix C (Technological and infrastructural constraints)	3x3	0,52	0,0145	0,0279	Consistent matrix
Matrix D (Constraints at the level of competence and organisational culture)	4x4	0,89	0,0538	0,0605	Consistent matrix

Source: Own study.

As can be seen from the table above, both the matrix of main criteria and the matrixes for the individual categories of constraints (A–D) are consistent. Values of $CR \leq 0,08$ were obtained for the matrix of main criteria, economic constraints (A), and constraints at the level of competence and organisational culture, thereby meeting the requirements for a 4×4 matrix. In the remaining matrixes concerning institutional constraints (B) and technological and infrastructural constraints (C), the condition $CR \leq 0,05$ was met for the smaller-sized matrixes.

Discussion

The resulting hierarchy of main categories indicates that the technological transformation of theatres is primarily an economic and identity-related issue, rather than a technological or systemic one. This is evidenced by the dominance of economic constraints (A; 0,5232) and constraints relating to competence and organisational culture (D; 0,2777) over technological and infrastructural constraints (C; 0,1411) and institutional constraints (B; 0,0580).

The dominance of the financial factor (A1; 28,27%); globally, this is consistent with the literature on economics and management in the cultural sector (Throsby, 2001), which highlights the underfunding of the cultural sector and its heavy reliance on grant funding (Galecka and Smolny, 2017; Towse, 2019). From this perspective, investment in next-generation technologies is viewed as a burden on the budget rather than an opportunity for development. Furthermore, the high ranking of constraints related to habits and the specificity of the audience (A4; 14,36%); this suggests a strong link between investment decisions and demand risk, which will affect the potential return on investment. This fits with the narrative of the divergence between the artistic and economic objectives of theatres (Kleppe, 2017) and confirms the traditional nature of theatre audiences (Walmsley, 2011).

In light of the findings, it is also possible to speak of the strategic importance of the identity of theatre institutions in the context of the implementation of next-generation technologies. This is confirmed by the high ranking of the definition of theatre (D4; 15,44%) in the global ranking. From the perspective of decision-makers' beliefs, next-generation technologies may be perceived as interfering too radically with the traditional way of perceiving theatre and as a threat to artistic autonomy. It may therefore turn out that effective implementation processes will first require a redefinition of the theatre's mission and artistic vision, and only subsequently the transformation of other organisational factors. The significant role of factors related to the identity of theatres is consistent with the findings of institutional theory (Bourdieu, 1993; DiMaggio, 1987).

The low score for the entire category of technological and infrastructural constraints, along with its internal structure, suggests that the market already offers a wide range of technological solutions and that their availability is not a major issue; rather, the implementation processes themselves depend on other factors, particularly financial and cultural ones. It can therefore be concluded that technology is ceasing to be a barrier in itself, and that the organisational capabilities of the theatre and effective change management by theatre managers are beginning to play an increasingly significant role.

The limited role of institutional factors (B; 0,0580) is also worth noting. These results should be considered in the context of the set of constraints included in the AHP model. It is easy to conclude that the model does not cover the full range of factors. Legal barriers, for instance, are missing. This can be explained by the period in which the research was conducted – in most countries, regulations significantly governing the use of next-generation technologies were not yet in place. One need only refer to regulations concerning artificial intelligence. There are still countries where even the development of this technology is not regulated, let alone its application in the cultural sector. It is therefore to be expected that as new regulations emerge, the role of institutional constraints will grow; however, at this stage, their significance in comparison with financial and cultural factors appears to be marginal. Furthermore, certain institutional factors may be assessed within the framework of other constraints, such as the uncertainty of market development. In view of the above, it can be concluded that the main barriers are internal rather than systemic in nature, with the exception of financial aspects. In this context, responsibility for technological transformation lies primarily with the institution itself.

With regard to the limitations of the study, it is important to highlight the limitations of the expert-based nature of the AHP, which is associated with a relatively small number of experts. Consequently, the established preferences are not entirely unaffected by the subjectivity of the respondents. Furthermore, the previously mentioned limited representation of institutional factors is significant. As a result, great caution must be exercised when attempting to generalise the obtained results to other cultural institutions.

With regard to the contribution of the research, it should be emphasised that the research method employed has complemented the qualitative studies conducted on the implementation constraints of next-generation technologies in theatres, lending them greater significance. It has been demonstrated that the technological transformation of theatres is primarily of an economic and identity-related nature, rather than technological, infrastructural or institutional. From a management practice perspective, the results obtained have broad applicability at the level of innovation management and the management of technological transformation in the theatre. The findings provide theatre managers with a useful tool for better planning of implementation processes, particularly in the context of minimising potential risks and assessing the feasibility of investment plans.

In the context of further research, it is important to take into account emerging new institutional factors. It is necessary to compare these with existing findings. Furthermore, an unexplored area requiring in-depth investigation is the issue of identity in the implementation processes of next-generation technologies. The results suggest its key role in the context of the effectiveness of these processes.

Conclusion

The aim of the study was to determine the importance of factors limiting the implementation of next-generation technologies in theatres. To achieve this objective, the AHP method was employed, which enabled the research questions to be answered. The results obtained complement the qualitative research that identified these factors. At the same time, they group them into four categories and allow for their prioritisation and comparison.

In relation to the first research question, it was established that the constraints on the implementation of next-generation technologies in theatres are primarily linked to economic factors, as well as staff competence levels and organisational culture. Technological, infrastructural and institutional barriers are of secondary importance.

With regard to the second research question, financial constraints, the definition of theatre, and the habits and specificity of the audience proved to be the most significant factors overall. The first and third of these also dominated the group of economic constraints. Conversely, the definition of theatre proved to be the most significant factor within the group of constraints at the level of competence and organisational culture. In this category, resistance of theatre staff was also of great significance. In turn, within the group of technological and infrastructural constraints, deficiencies in the technical infrastructure of the theatre proved to be the most significant. Institutional constraints, on the other hand, were dominated by resistance from the advisory bodies of theatres. This suggests that the technological transformation of theatres is primarily an economic and identity-related process, and to a lesser extent a technological and systemic one, which answers the third of the research questions posed.

The research findings may be useful both to researchers in the cultural sector particularly those specialising in arts management and to researchers exploring the subject of technological transformation in the modern world. Furthermore, the research findings have broad practical implications, particularly for theatre managers, theatre organisers and next-generation technology providers for the cultural sector. Moreover, they may be useful to other arts organisations for benchmarking purposes.

From a theoretical perspective, the findings complement previous qualitative research into the constraints on the implementation of next-generation technologies in theatres. In practical terms, the findings may be useful for innovation management in theatres and for managing technological transformation within the theatre sector. In particular, they enable the planning of implementation processes in a way that minimises the impact of key barriers, thereby reducing implementation risk.

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