Online-Journals.org

iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 18 No. 22 (2024) | OPEN ACCESS

https://doi.org/10.3991/ijim.v18i22.50697

PAPER

Integrating Escape Rooms and E-Learning Technologies for Smart Cities Development: A Simulation Study

Ragad M Tawafak(✉), Roy Mathew, Ghaliya Al Farsi, Abir AlSideiri, Sohail Iqbal Malik

Information Technology Department, Al Buraimi University College, Buraimi, Oman

raghad@buc.edu.om

ABSTRACT

The paper gives an intensive review of the current state of escape rooms and e-learning innovations within smart city instruction. It consolidates existing information, making it available to teachers, analysts, and policymakers. The paper bridges two distinct but complementary areas by combining insights from escape rooms and e-learning innovations. The paper distinguishes holes within the current investigation and hones, indicating ranges requiring assist examination. It also highlights openings for future advancement and development within the utilization of escape rooms and e-learning advances. This study examines 13 review papers related to each innovation. The strategy proposes a system that gives commonsense rules and contemplations for teachers and engineers. The paper outlines how escape rooms and e-learning advances have been effectively coordinated and utilized in keen city instruction in Oman. The paper finds and examines the potential effect of escape rooms and e-learning advances on learning results, emphasizing their part in improving engagement, inspiration, and critical thinking abilities among learners. The study reveals the center on innovative educational innovations; the paper contributes to forming more intelligent and feasible urban situations.

KEYWORDS

smart city entertainment, artificial intelligence (AI) technology, escape room technology, collaboration, economic impact

1 INTRODUCTION

There are many attempts to combine artificial intelligence (AI) technology with escape rooms to create a new form of edutainment in the smart city [1]. The use of escape room techniques has become a magnet for education in many cities, providing participants with an immersive and challenging experience. However, incorporating AI technology can further develop this concept. The paper outlines a review of the literature using AI and escape room technology in higher education, including

Tawafak, R.M., Mathew, R., Al Farsi, G., AlSideiri, A., Malik, S.I. (2024). Integrating Escape Rooms and E-Learning Technologies for Smart Cities Development: A Simulation Study. *International Journal of Interactive Mobile Technologies (iJIM)*, 18(22), pp. 130–142. https://doi.org/10.3991/ijim.v18i22.50697

Article submitted 2024-06-21. Revision uploaded 2024-08-31. Final acceptance 2024-08-31.

improving personalization and adaptability in education and entertainment as a form of smart city development [2].

Artificial intelligence is becoming imperative. In later decades due to its wide applications within the genuine world. Cases incorporate mechanical autonomy [3], Web applications [4], information mining [5], mechanical applications, instructive advancement apparatuses [6] [7], and so on. Even though distinctive subfields have verifiably worked within the classroom, analysts have done so ever since I found the amalgamation of distinctive zones of science leads to more inventive and viable arrangements more appropriate to the broader logical community [7] [8].

Smart cities represent the future of urban life, characterized by the integration of advanced technologies in all fields to improve and facilitate the quality of life, the efficiency of services, sustainability, and competition at the forefront of countries [9]. Education plays a crucial role in this transformation at the interactive and electronic levels because it prepares citizens to navigate and contribute in these technologically advanced environments. However, traditional educational approaches often fail to address smart cities' dynamic and interactive nature due to their systematic monotony and lack of receptivity to evolving technologies [10]. This paper proposes a new educational approach that combines student-driven e-learning and innovative escape rooms in educational development to enhance the learning experience and provide learners with the skills and knowledge needed for smart cities [11].

E-learning provides the ability to adapt and be open to learning sources, allowing learners to immerse themselves in the material at the speed they want and from any region, despite the differences and diversity of the learning mechanism [12]. Escape rooms, conversely, provide immersive encounters, test the student's intuition, and enhance their problem-solving abilities, collaboration, and basic consideration. By coordinating these two strategies, we point to creating a blended learning environment that takes advantage of the characteristics of both approaches to achieve a different leap in smart education. This paper examines the virtual institutions, the rationale for use, and the potential benefits of this half-breed educational offering [8].

The merging of e-learning and escape rooms as instructive apparatuses offers a novel approach to upgrading shrewd city instruction [19]. This orderly writing audit points to assessing existing investigations on integrating these techniques, recognizing their qualities and impediments, and proposing a system for their successful usage in smart city instruction [35]. The survey takes after an organized strategy to guarantee comprehensive scope and thorough investigation of significant things.

The aim of exploring the potential of this fusion to revolutionize smart city learning entertainment is objective and to emphasize the importance of collaboration between the technology of AI and learning entertainment industries to serve smart cities. The paper concludes that integrating AI and escape room technology can create a truly unique and unforgettable entertainment experience for residents and learners and could open up new avenues for smart city development [1] [3]. Figure 1 shows the fusion of AI and metaverse using an escape room technology tool [6].

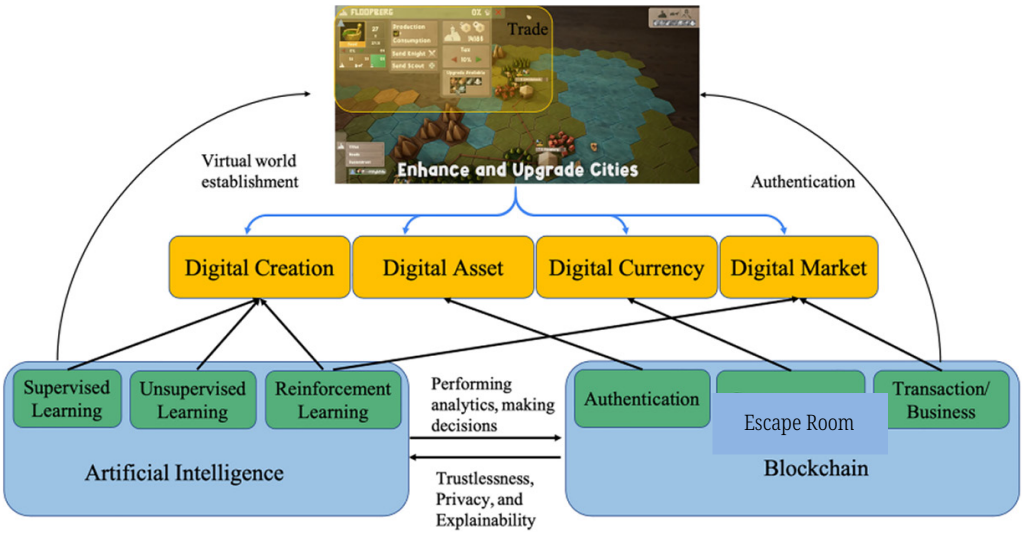

Fig. 1. Fusion of artificial intelligence and escape room in the metaverse [6]

However, this study has a research question: "How can the integration of escape rooms and e-learning platforms be designed and implemented to effectively enhance public understanding and engagement with smart city technologies and applications?".

This paper reviews a group of topics. The first axis examines the follow-up of literature related to explaining the mechanism of e-learning and escape room technology and its impact in providing effective guidance for achieving smart cities [10]. The second axis describes the theories and mechanisms that achieve efficient development of smart cities in the field of the educational sector for higher education students. The third axis explains the difficulties and limitations that hinder the integration of technology for escape rooms and e-learning. The last axis explains the conclusion and future outlook to enable smart cities to move forward in achieving and facilitating livelihoods and the joy of learning at the same time.

2 LITERATURE REVIEW

2.1 Conceptualizing the concept of educational escape rooms and digital escape rooms

Within the modern scene of instruction, there has been a resurgence of intrigue in energetic and all-encompassing learning approaches, with recreations rising as a progressively favored educational apparatus. Educational escape rooms (EERs) have materialized as an unmistakable shape of gamified learning, highlighting imaginative exercises custom-made for learners. Beginning in Japan in 2007, ERs have quickly picked up worldwide notoriety, rising above their beginning excitement roots to end up a necessary portion of instructive hones [15]. These immersive encounters include long-lasting challenges, entrusting groups with tackling confusions inside a set time allotment, making them versatile to different age bunches and instructive settings. Implanted with topical components and regularly driven by accounts, digital escape room (DERs) submerge members in locks in role-play scenarios.

The ability to scale the hybrid educational model to different educational contexts and environments is important for broader application. This factor involves examining the feasibility of implementing the model in various settings, such as schools, universities, and professional training programs, and adapting it to meet the specific needs of different learner groups. Understanding the impact of the hybrid approach on learner motivation and satisfaction is crucial. This involves assessing how the integration of e-learning and escape rooms influences learners' attitudes towards the subject matter, their enjoyment of the learning process, and their overall satisfaction with the educational experience [16].

[10] This review is credited to recognizing and covering inquiries about crevices since the current writing has centered on the academic perspectives of escape rooms (ERs) in instruction, but no ponders appear to have been conducted concerning the academic suggestions of computerized escape rooms (CERs) in instructive situations. The technology can be used in various settings, including entertainment, education, and team-building exercises. In programming learning, room escape technology has been adapted to create coding challenges that players must solve to escape the virtual room [10, 15].

Since 2017, the concept of ERs has expanded and spread around the scholastic world, joining mechanical devices and growing into zones past the amusement segment, such as instruction. [14] Even though this logical field is still in its earliest stages, the larger part of the articles has prioritized hypothetically mapping the current circumstance within the utilization of ERs in instruction [14], planning ERs for academic purposes, announcing the users' encounters in collaborative rooms—either genuine or virtual—or collecting and giving input information on learners' execution, the degree of substance understanding, and participants' recognitions of utilizing the ER diversions in post-activity tests [14]. By identifying crevices within the writing, this paper pointed to audit the methodological approaches and evaluation apparatuses utilized to gather the information determined from participants' reactions and tutors' points of view, to show common instruction and plan characteristics, and to look at their effect on particular learning accomplishments in cognitive, behavioral, and emotional segments [14].

2.2 Conceptualizing the concept of artificial intelligence in entertainment

The concept of smart cities has gained momentum in recent years, with cities worldwide exploring innovative technologies and solutions to improve their residents' quality of life. In recent years, there has been a growing interest in incorporating AI technology into entertainment experiences, including escape rooms. AI technology has the potential to enhance the personalization and immersion of escape rooms, providing an experience that caters to the specific needs and preferences of each participant. AI technology can analyze participant behavior and adjust the challenges and puzzles accordingly, creating a more personalized and adaptive experience [19]. Despite the developing intrigue in the coordination of AI into escape rooms to improve personalization and drenching, there's a restricted understanding of the moral contemplations and potential societal impacts related to the utilization of AI in this setting. Analyzing the moral suggestions, protection concerns, and the by and large societal effect of AI-driven personalized encounters in escape rooms may be a pivotal, however underexplored zone. This inquiry about points to fill this hole by examining the moral measurements of AI usage in escape rooms, exploring participant discernments, and proposing rules for mindful AI utilization within the excitement industry [14].

2.3 E-learning in smart cities education

E-learning has emerged as a powerful tool in education, providing flexibility, ease of access, and supporting the requirements of a wide range of interests. Studies have shown that e-learning can significantly enhance learning outcomes by providing personalized learning experiences and enabling learners to access information at their convenience [22]. E-learning provides everyone with a wide scope to diversify sources and methods for delivering content and evaluating different competencies [23]. In the context of smart cities, e-learning can spread knowledge about new technologies, sustainable practices, and civic engagement. However, the lack of reliable interactive and collaborative elements in e-learning platforms, as well as their flexibility to easily obtain abundant ready-made information, as an alternative to systematic traditional study, can limit their effectiveness in enhancing critical thinking and problem-solving skills [24].

Smart cities have become characterized by scientific progress and a wide range of methods for developing technology in all sciences. Recent studies have proven that smart cities are built based on a qualitative leap in science and teaching through the acquisition of high skills [19]. They also indicated that e-learning has taken a wide space in the development stage and is an effective task in enabling individuals to coexist in smart cities [17].

Ensuring that both e-learning content and escape room activities align with the educational objectives specific to smart city education is crucial. This involves identifying key topics such as technological innovations, sustainability practices, and urban planning principles and designing the educational materials and activities accordingly [18]. The integration of e-learning and escape rooms aims to enhance student engagement through interactive and immersive experiences. Factors to consider include the design of escape room challenges that require active participation, critical thinking, and collaboration, as well as e-learning modules that incorporate multimedia elements to maintain interest and engagement [30].

2.4 Escape rooms as educational tools

Escape rooms have gained popularity as educational tools due to their ability to create immersive, engaging, and interactive learning experiences [19]. Research indicates that escape rooms can open horizons for learners and scientific competition in the speed of unraveling puzzles and logical interpretation of algorithms using advanced visual applications [12]. With this in mind, it may not be surprising that escape rooms are starting to gain ground in the academic community and innovation in the ways of implementing escape room algorithms [33]. However, it is not possible to keep a subset of a lesson in a room and wait for them to come out. The idea is to distribute assignments that have an intellectual challenge to distinguish students' interaction and understanding through intellectual questions that move students between levels from easy to complex and complex ideas, through individual experiences or joint groups to solve challenging assignments [32]. Educational institutions and libraries have begun to coordinate this activity in their programs or to create their own EER. The educational escape room/game can be described as a 'directive strategy'.

In addition, it enhances teamwork, communication, and critical thinking skills by presenting learners with complex and realistic problems that require cooperation to solve [17]. The practical and experiential nature of escape rooms makes them

particularly effective in teaching practical skills and concepts, which are crucial in the context of smart cities [18]. Escape rooms have gained an advanced status in the development of smart devices, as they rely on integrating complex theories with advanced mathematical laws [19] [34].

Table 1 shows the summarized objectives, the field of interest in smart cities, and the limitations of the used studies in the literature review.

Table 1. Summary of the existing review papers

Ref	Study Objectives	Field of Smart City Development	Limitations
[12]	To speed up the logical interpretation of advanced algorithms	Factors, items, and challenges of smart cities	Limited student engagement and gained academic community
[14]	Examining the moral measurements of AI usage in escape rooms	Gamification in smart cities	Not enough rules for mindful of AI
[15]	DERs submerge members in locks in role-play scenarios.	Escape room in education	The Technology limited use.
[16]	The ability to scale the hybrid educational model to different educational contexts and environments	Game-based learning integrity	Local use of the methods for the educational part.
[17]	Enhance the critical thinking and skills of the learners	The dynamic infrastructure of ITS of smart cities	Miscommunication between teams
[18]	The practical and experiential nature of escape rooms makes them particularly effective in teaching practical skills and concepts	AI in transportation development	Escape room technology sill not used effectively
[19]	Escape rooms have gained an advanced status in the development of smart devices	Escape room for tourist development	The method required advanced mathematical professional use.
[22]	E-learning can significantly enhance learning outcomes	Revolution in smart cities	The learning techniques enhanced in higher education only
[23]	E-learning of smart city development using mechanical vehicle enhancement	Smart vehicles applications	The development requires time to be familiar with techniques
[24]	Identifying key topics such as technological innovations, sustainability practices	The nature of emotions in developing smart cities.	Alternative to systematic traditional study can limit their effectiveness in enhancing critical thinking
[31]	Using games to move from easy to complex ideas in education	Game-based education development	The method required advanced mathematical professional use.
[32]	Learning programming using new coding and compilers	Novelty of programming course for educational development	Escape rooms and AI technology still not used deeply in diploma levels
[33]	Using games to move from easy to complex ideas in education	Game development	Not benefits of waiting for possibility to collect all team results

3 RESEARCH OBJECTIVES

The general objective of "Revolutionizing Smart City Entertainment: The Fusion of AI and Escape Room Technology" is to explore the potential of integrating AI technology with escape room entertainment in smart cities to provide a highly interactive and engaging entertainment experience that caters to the specific needs and preferences of residents and tourists [14] [31]. The paper seeks to identify the benefits of using AI technology in escape rooms, such as personalization,

adaptability, and immersion, and to propose a conceptual framework for developing and implementing AI-enhanced escape rooms in smart cities [36].

4 METHODOLOGY

The literature review was conducted using a systematic approach, adhering to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. The databases searched included Google Scholar, PubMed, IEEE Xplore, and Web of Science. The search terms used were "e-learning," "escape rooms," "smart cities," "educational tools," and "hybrid learning." The inclusion criteria were peer-reviewed articles published between 2010 and 2023 that focused on the application of e-learning and escape rooms in educational contexts, with an emphasis on smart city education [37]. A total of 258 articles were identified, of which 68 met the inclusion criteria and were included in the final review. Figure 2 shows the method of extracting the analyzed articles.

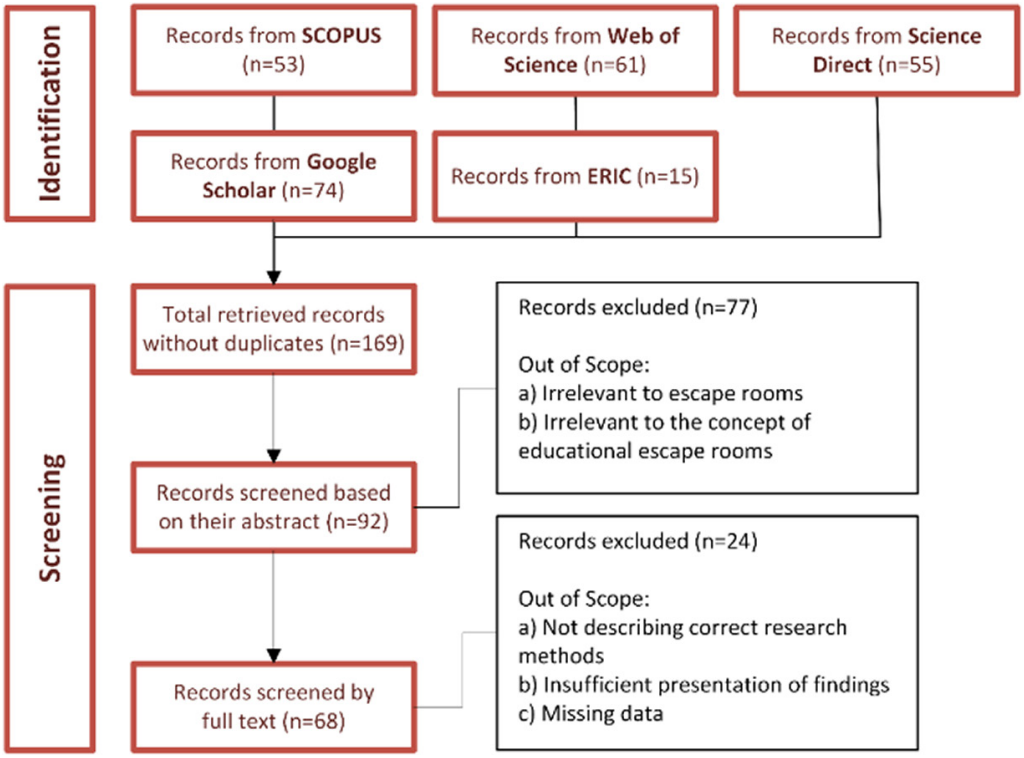

Fig. 2. Research methodology

The paper also discusses the potential economic impact of this fusion on smart cities, highlighting the importance of investing in innovative and engaging entertainment options to attract and retain residents and tourists [17] [19] [28].

The method proposed by [19] was adjusted for this orderly survey by utilizing the method after steps: planning; conducting the survey; and announcing the survey. The examination of the survey results that tested by using PLS-SEM, about and the dialogue of discoveries, patterns, and conclusions concerning the favored announcing things for orderly surveys and meta-analyses (PRISMA) articulation proposal [28].

5 IMPORTANT FACTORS OF SMART CITIES USING AI AND ESCAPE ROOMS

The concept of this study is an innovative approach that combines cutting-edge AI with the immersive and interactive experience of an escape room. The merger aims to improve the entertainment value, engagement, and educational aspects of urban leisure activities [21]. Several key factors play a key role in the successful implementation of this concept [37].

Advanced AI algorithms: AI is central to personalizing the participant experience.

Puzzles and challenges can be adapted in real-time based on player performance and preferences.

Immersive technology: Virtual reality (VR), augmented reality (AR), and mixed reality (MR) can be used to greatly enhance the immersive experience of escape rooms. This technology can create more engaging and interactive environments that are not possible in purely physical environments [32].

Internet of Things (IoT) integration: Integration of IoT devices enables a more interactive and responsive environment. Sensors and smart devices can adjust the environment, control puzzles, and track participants' movements and actions to provide a more holistic experience [25].

User experience design: The overall design of the escape room experience should be user-centered and focused on creating a compelling narrative and intuitive interactions. This includes a deep understanding of storytelling, game design, and user interface design.

Sustainability and accessibility: Design must consider environmental sustainability and be accessible to a wide range of participants, including people with disabilities [29].

Collaboration with city infrastructure: Integration with smart city infrastructure provides enhanced experiences, including examples include city-wide treasure hunts and puzzles tied to real-life locations and events [30].

Educational and cultural content: Incorporating educational or cultural elements increases the value of the experience and makes it not only fun but also informative.

Community Engagement: By working with local communities and stakeholders, we can tailor experiences to local culture and interests and encourage community participation.

6 RESULTS AND DISCUSSION

6.1 E-learning in smart cities education

E-learning has been included as a widely adopted and essential method in smart city development due to its flexibility and ease of access. E-learning is also distinguished by its ability to provide focused and specialized educational experiences that serve the needs of modern smart cities. Studies such as [23] highlight that e-learning can positively support learning outcomes by allowing learners and students to interact with content without committing to a specific place or time. The study also points to the benefit in the context of smart cities, where e-learning platforms can provide the necessary services and knowledge about new technologies to achieve sustainability [16, 20].

There remain some clear difficulties in this regard, as e-learning methods that are characterized by the traditional style and the modernity of use often lack interactive and modernizing elements, which are considered vital elements for developing

critical thinking, supportive team spirit, and problem-solving skills. [32] presented research that discusses the determinants and issues of conflict in e-learning and its negative role in enhancing developmental skills for sound architecture and smart cities that support scientific use. It emphasizes the need for more engaging and interactive educational experiences.

6.2 Escape rooms as educational tools

The educational aspect of developing uses for escape rooms includes a motivating aspect as educational tools. It also provides the ability to create modern educational experiences characterized by adventure, interaction, and motivation for future innovation. Research conducted by [17] and [31] shows that escape rooms can enhance teamwork skills and increase accuracy and real results. Educational technologies through escape rooms also stimulate communication and critical thinking, which increases the speed of development in smart cities. It also enables researchers to challenge these interactive environments in a way that serves learners to solve complex real-world problems effectively and from a developed scientific perspective.

Noting that the experimental nature of artificial intelligence technology in escape room technologies makes it well suited for the rapid growth that education in smart cities' needs. Learners' opportunities appear to be increased and refined when understanding and applying knowledge about technological innovations, sustainability, and urban planning [13, 24]. However, designing advanced technology such as escape rooms in the educational field for college students requires careful planning to ensure that the ideas, puzzles, and challenges are consistent with educational objectives and enhance the target knowledge and skills [31].

6.3 Integrating e-learning and escape rooms

Recent studies indicate that the integration of e-learning and escape rooms has a positive impact on creating an educational model synchronized with intellectual and technical modernity through comprehensive integration that enhances the strengths of both e-learning and advanced education with artificial intelligence technologies and escape rooms. E-learning provides flexibility in addition to individual confidence using basic learning mechanisms, while escape rooms provide mental and visual stimulation through interactive experiences and challenges of different stages to enhance this knowledge and apply it in real-world sectors and projects. [19] point out that this hybrid blended approach can address the limitations of each method and create a more engaging and effective learning environment.

On the other hand, many methods with a distinctive nature in AI have been explored through recent studies and what they represent in terms of providing an integrated approach to developing comprehensive educational methods for all different sciences and creating the infrastructure in smart cities. For example, [26] found that the feature of the collective link between e-learning and artificial intelligence software in escape room technologies enhances student participation, opens imaginative horizons for the comprehensive dimensions of the idea, and improves learning outcomes in higher education institutions [27, 33].

In conclusion, all the studies mentioned in this study indicate that combining e-learning with the uses of artificial intelligence based on shuffle rooms and its advanced methods provides an advanced educational methodology that is promising

for smart cities. Conclusions Through the creation of an effective, intuitive, innovative, and adaptable learning environment, this approach stands out and advances people in the way of open planning for the complexities of urban life, full of fluctuations and needs, in line with the demographic and educational development and the development of smart cities. Moreover, studying the diversity of this type of science, its needs, and its application in disparate settings can help understand new expectations and bring broad benefits [30, 33].

7 CONCLUSION

Combining e-learning and escape room technology is one of the methods that provide a promising educational strategy to renew and meet the requirements of smart cities. The idea of creating an attractive, interactive, stimulating, flexible learning environment, in addition to a renewed challenge, helped. This educational and systematic method can help better prepare individuals to deal with the complexities of development and the opportunities provided by smart urban life. The results of this manuscript, which is based on a systematic review of the literature, confirmed the important elements and available and potential theories of this hybrid educational model. It also highlights further scientific development in research to improve its implementation and evaluate its impact on the results of scientific research to develop smart cities.

8 LIMITATION

Tall improvement and usage costs: Making and keeping up elude rooms, both physical and virtual, can be costly and time-consuming. The advancement of advanced e-learning stages moreover requires critical ventures in innovation, substance creation, and continuous support. These costs can be restrictive for a few instructive teachers and may restrain the versatility of these learning devices. Not all understudies have risen to get to the vital innovation and web network required for e-learning. This advanced separation can compound existing instructive imbalances, especially for understudies from low-income foundations or those in inaccessible regions. Also, physical elude rooms may not be open to all understudies due to topographical or calculated limitations. Both ERs and e-learning stages can display specialized challenges that will ruin their successful utilization. Understudies and teachers may require prepared to be capable of utilizing these advances, and specialized issues such as program glitches or network issues can disturb the learning encounter.

9 ACKNOWLEDGMENT

This work was supported by the MOHREI/BFP/BUC/2023.

10 REFERENCES

[1] G. Al Farsi *et al.*, "A review of virtual reality applications in an educational domain," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 15, no. 22, pp. 99–110, 2021. https://doi.org/10.3991/ijim.v15i22.25003

[2] R. M. Tawafak, I. Y. Alyoussef, and W. M. Al-Rahmi, "Essential factors to improve student performance using an e-learning model: Review study," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 17, no. 3, pp. 160–176, 2023. https://doi.org/10.3991/ijim.v17i03.35727

[3] G. Al Farsi, R. M. Tawafak, S. I. Malik, and B. H. Khudayer, "Facilitation for undergraduate college students to learn java language using e-learning model," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 16, no. 8, pp. 4–17, 2022. https://doi.org/10.3991/ijim.v16i08.28689

[4] G. Alfarsi, H. Sulaiman, R. M. Tawafak, S. Malik, J. Jabbar, and A. Alsidiri, "A study of learning management system with e-learning," *International Journal of Advanced Science and Technology*, vol. 29, no. 3, pp. 4884–4890, 2020.

[5] K. Ahmad, M. Maabreh, M. Ghaly, K. Khan, J. Qadir, and A. Al-Fuqaha, "Developing future human-centered smart cities: Critical analysis of smart city security, data management, and ethical challenges," *Computer Science Review*, vol. 43, p. 100452, 2022. https://doi.org/10.1016/j.cosrev.2021.100452

[6] Z. Allam, A. Sharifi, S. E. Bibri, D. S. Jones, and J. Krogstie, "The metaverse as a virtual form of smart cities: Opportunities and challenges for environmental, economic, and social sustainability in urban futures," *Smart Cities*, vol. 5, no. 3, pp. 771–801, 2022. https://doi.org/10.3390/smartcities5030040

[7] S. E. Bibri, "The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart cities: A study in science, technology, and society," *Smart Cities*, vol. 5, no. 3, pp. 832–874, 2022. https://doi.org/10.3390/smartcities5030043

[8] V. Chang, "An ethical framework for big data and smart cities," *Technological Forecasting and Social Change*, vol. 165, p. 120559, 2021. https://doi.org/10.1016/j.techfore.2020.120559

[9] L. Chang *et al.*, "6G-enabled edge AI for metaverse: Challenges, methods, and future research directions," *Journal of Communications and Information Networks*, vol. 7, no. 2, pp. 107–121, 2022. https://doi.org/10.23919/JCIN.2022.9815195

[10] Q. Yang, Y. Zhao, H. Huang, Z. Xiong, J. Kang, and Z. Zheng, "Fusing blockchain and AI with metaverse: A survey," *IEEE Open Journal of the Computer Society*, vol. 3, pp. 122–136, 2022. https://doi.org/10.1109/OJCS.2022.3188249

[11] D. Chen and R. Zhang, "Exploring research trends of emerging technologies in health metaverse: A bibliometric analysis," *SSRN*, 2022. https://doi.org/10.2139/ssrn.3998068

[12] F. J. Agbo, "Co-designing a smart learning environment to facilitate computational thinking education in the Nigerian context," Doctoral dissertation, Itä-Suomen yliopisto, 2022.

[13] M. Dionisio and V. Nisi, "Leveraging transmedia storytelling to engage tourists in the understanding of the destination's local heritage," *Multimedia Tools and Applications*, vol. 80, pp. 34813–34841, 2021. https://doi.org/10.1007/s11042-021-10949-2

[14] A. Makri, D. Vlachopoulos, and R. A. Martina, "Digital escape rooms as innovative pedagogical tools in education: A systematic literature review," *Sustainability*, vol. 13, no. 8, p. 4587, 2021. https://doi.org/10.3390/su13084587

[15] A. R. Javed *et al.*, "Future smart cities requirements, emerging technologies, applications, challenges, and future aspects," *Cities*, vol. 129, p. 103794, 2022. https://doi.org/10.1016/j.cities.2022.103794

[16] T. Ji, J. H. Chen, H. H. Wei, and Y. C. Su, "Towards people-centric smart city development: Investigating the citizens' preferences and perceptions about smart-city services in Taiwan," *Sustainable Cities and Society*, vol. 67, p. 102691, 2021. https://doi.org/10.1016/j.scs.2020.102691

[17] G. R. Latifi, M. P. Monfared, and H. A. Khojasteh, "Gamification and citizen motivation and vitality in smart cities: A qualitative meta-analysis study," *GeoJournal*, vol. 87, pp. 1217–1230, 2022. https://doi.org/10.1007/s10708-020-10295-0

[18] A. Veldkamp, L. van de Grint, M. C. P. Knippels, and W. R. van Joolingen, "Escape education: A systematic review on escape rooms in education," *Educational Research Review*, vol. 31, p. 100364, 2020. https://doi.org/10.1016/j.edurev.2020.100364

[19] R. M. Tawafak, R. Mathew, G. Alfarsi, and S. I. Malik, "Games based learning: Method and integrity," in *Interdisciplinary Research in Technology and Management: Proceedings of the International Conference on Interdisciplinary Research in Technology and Management (IRTM, 2021)*, 2021, p. 410. https://doi.org/10.1201/9781003202240-64

[20] M. C. Lucic, O. Bouhamed, H. Ghazzai, A. Khanfor, and Y. Massoud, "Leveraging UAVs to enable dynamic and smart aerial infrastructure for ITS and smart cities: An overview," *Drones*, vol. 7, no. 2, p. 79, 2023. https://doi.org/10.3390/drones7020079

[21] A. Nikitas, K. Michalakopoulou, E. T. Njoya, and D. Karampatzakis, "Artificial intelligence, transport and the smart city: Definitions and dimensions of a new mobility era," *Sustainability*, vol. 12, no. 7, p. 2789, 2020. https://doi.org/10.3390/su12072789

[22] A. Pakhalov and N. Rozhkova, "Escape rooms as tourist attractions: Enhancing visitors' experience through new technologies," *Journal of Tourism, Heritage & Services Marketing (JTHSM)*, vol. 6, no. 2, pp. 55–60, 2020.

[23] U. B. Qushem, A. Christopoulos, S. S. Oyelere, H. Ogata, and M. J. Laakso, "Multimodal technologies in precision education: Providing new opportunities or adding more challenges?" *Education Sciences*, vol. 11, no. 7, p. 338, 2021. https://doi.org/10.3390/educsci11070338

[24] T. Senevirathna *et al.*, "A survey on XAI for beyond 5G security: Technical aspects, use cases, challenges and research directions," *arXiv preprint arXiv:2204.12822*, 2022.

[25] V. Sharma, A. K. Tripathi, and H. Mittal, "Technological revolutions in smart farming: Current trends, challenges & future directions," *Computers and Electronics in Agriculture*, vol. 201, p. 107217, 2022. https://doi.org/10.1016/j.compag.2022.107217

[26] F. Syed, S. K. Gupta, S. Hamood Alsamhi, M. Rashid, and X. Liu, "A survey on recent optimal techniques for securing unmanned aerial vehicles applications," *Transactions on Emerging Telecommunications Technologies*, vol. 32, no. 7, 2021. https://doi.org/10.1002/ett.4133

[27] G. N. Yannakakis, R. Cowie, and C. Busso, "The ordinal nature of emotions," in *2017 Seventh International Conference on Affective omputing and Intelligent Interaction (ACII)*, 2017, pp. 248–255. https://doi.org/10.1109/ACII.2017.8273608

[28] R. M. Tawafak, G. Alfarsi, A. Romli, J. Jabbar, S. I. Malik, and A. Alsideiri, "A review paper on student-graduate advisory expert system," in *2020 International Conference on Computing and Information Technology (ICCIT-1441)*, 2020, pp. 1–5. https://doi.org/10.1109/ICCIT-144147971.2020.9213794

[29] R. M. Tawafak, A. Romli, S. I. Malik, G. Alfarsi, and J. Jabbar, "Examining continuous integrating of technology acceptance model with task-technology fit," *IOP Conference Series: Materials Science and Engineering*, vol. 1088, no. 1, p. 012061, 2021. https://doi.org/10.1088/1757-899X/1088/1/012061

[30] G. Alfarsi *et al.*, "General view about an artificial intelligence technology in education domain," in *Proceedings of the International Conference on Culture Heritage, Education, Sustainable Tourism, and Innovation Technologies*, 2021, vol. 1, pp. 120–127. https://doi.org/10.5220/0010304501200127

[31] A. Tatnall, "Editorial for EAIT issue 2, 2020," *Education and Information Technologies*, vol. 25, pp. 647–657, 2020. https://doi.org/10.1007/s10639-020-10135-1

[32] A. Tatnall, "Correction to: Editorial for EAIT issue 2, 2020," *Education and Information Technologies*, vol. 25, pp. 5901–5910, 2020. https://doi.org/10.1007/s10639-020-10180-w

[33] S. Papadakis, A. M. Trampas, A. K. Barianos, M. Kalogiannakis, and N. Vidakis, "Evaluating the learning process: The 'ThimelEdu' educational game case study," in *Proceedings of the 12th International Conference on Computer Supported Education (CSEDU)*, 2020, vol. 2, pp. 290–298. https://doi.org/10.5220/0009379902900298

[34] N. Vidakis, A. K. Barianos, A. M. Trampas, S. Papadakis, M. Kalogiannakis, and K. Vassilakis, "Generating education in-game data: The case of an ancient theatre serious game," in *Proceedings of the 11th International Conference on Computer Supported Education (CSEDU)*, 2019, vol. 1, pp. 36–43. https://doi.org/10.5220/0007810800360043

[35] R. Tawafak, A. Romli, S. Malik, and M. Shakir, "IT governance impact on academic performance development," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, no. 18, pp. 73–85, 2020. https://doi.org/10.3991/ijet.v15i18.15367

[36] R. M. Tawafak, A. Romli, S. I. Malik, M. Shakir, and G. M. Alfarsi, "A systematic review of personalized learning: Comparison between e-learning and learning by coursework program in Oman," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 14, no. 9, pp. 93–104, 2019. https://doi.org/10.3991/ijet.v14i09.10421

[37] G. Al Farsi, R. M. Tawafak, I. Y. Alyoussef, and W. M. Al-Rahmi, "Systematic literature review for smart mobile learning in programming courses," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 18, no. 12, 2024. https://doi.org/10.3991/ijim.v18i12.46299

11 AUTHORS

Ragad M Tawafak is with the Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman (E-mail: raghad@buc.edu.om).

Roy Mathew is with the Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman.

Ghaliya Al Farsi is with the Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman.

Abir AlSideiri is with the Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman.

Sohail Iqbal Malik is with the Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman.