Puzzle away the Puzzledness: Action-Design Study of an Educational Escape Room for Intervention in SMEs' Perception towards ICT Adoption

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Abstract

Digital transformation initiatives in small and medium-sized enterprises (SME) are often hampered by individual practitioners' perceptions of information and communication technology (ICT). This research employs an educational escape room (ER) game for an intervention towards informed decision-making on ICT adoption in SMEs. ER design and implementation are elaborated and consequently tested with SME practitioners, all embedded in an action-design study based on a qualitative research methodology. The result highlights a trade-off between creating immersive game experiences and achieving learning objectives. Still, the outcome implies an impact on players' perception of ICT integrated in the ER. The findings contribute to the emerging field of serious games for learning and shed light on the potential of game-based interventions for SMEs.

Keywords: SME, ICT adoption, serious games, escape room, digital transformation

1. Introduction and Background

Digital transformation (DT) of small and medium-sized enterprises (SME) yields a variety of challenges centered around the rapid development of digitalization and disruption of traditional industries worldwide (OECD, 2021). Thus, it is a frequently discussed topic in information systems (IS) research (ISR). Exemplary research directions concern SMEs' business models (Bouwman et al., 2019; Heikkilä & Bouwman, 2018; Pucihar et al., 2019), innovative (Eikebrokk & Olsen, 2007; Weigel et al., 2020) and strategic capabilities (Grant & Wunder, 2021; Heikkilä et al., 2017; Rehm & Goel, 2017; Wang et al., 2007). Another emphasis is put on digital leadership, human factors and biased decision-making in regards of DT initiatives (Canhoto et al., 2021; Fitz et al., 2022; Franco & Matos, 2015). In consequence, IS scholars recently advocate for studying SMEs' DT separately from larger organizations (Drechsler et al., 2022; Hönigsberg et al., 2021).

What is more, DT involves the adoption and use of information and communication technology (ICT) which is particularly challenging for smaller businesses (Wolcott et al., 2008). Earlier on, Culkin and Smith (2000) identified "technophobes" and a "watching brief" (indecisive) category of overwhelmed SME leaders in the context of digital technology. Even two decades later, Mandviwalla and Flanagan (2021) observe similar issues, calling it the "cannot see the trees in the forest problem" (p. 367). In essence, the variety of options for ICT adoption has become so large that informed decision-making is significantly hampered for SME decision-makers with lacking ICT expertise (Arendt, 2008). Implicitly, they tend to follow intuitive logic and motivations, shaped by individual perceptions (Wang et al., 2007).

To counter this, game-based learning can be a solution to facilitate corporate training (Larson, 2020). Moreover, advantages of utilizing serious games and the propensity of enterprises to deploy them for goal attainment have been observed (Azadegan et al., 2012). In this context, Veldkamp et al. (2020) suggest that Escape Room (ER) games are especially suitable to experience new phenomena. Fotaris and Mastoras (2019) show that ERs for learning form an emerging research topic – though, ICT education in particular only accounted for 14,7% of the studies analyzed in their paper. According to the authors, there also remains a lack of empirical substantiation regarding the influence of ERs within educational environments. Pan et al. (2017) especially commend studying questions of ER design around the use of networked objects and devices such as ICT.

Taking these related works into consideration, the present study employs an interventional design-based approach. It involves development, gameplay and evaluation of an educational ER targeting SME practitioners' perception of ICT, hypothetically leading to better informed decision-making in the

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context of adoption. We manifest our research scope with a research question (RQ): *How does an educational ICT-based ER game experience influence SME practitioners' perception towards ICT adoption?*

2. Research model

A common approach to study decision-making processes towards technology adoption is utilizing the Technology-Organization-Environment framework (TOE), initially developed by Tornatzky and Fleischer (1990). It is frequently involved in research revolving around business and technology (Oliveira & Martins, 2011). Looking at our RQ, we find that technological factors, provided by the ICT context, organizational factors, provided by the SME context, and environmental factors, provided by the context of global DT trends, play a decisive role, hence, promote TOE as a suitable framework for this research. Therefore, to streamline our approach, we develop an adapted TOE framework with ICT adoption in SMEs as a dependent variable, but, building upon similar approaches (e.g. Mikalef et al., 2022) and in consistence with our research motivation, primarily investigating influence on perceptions towards ICT.

TOE-related perception factors in the specific context of SMEs and ICT demanded for a systematic derivation. Through a systematic keyword search for ["TOE" OR "T-O-E" OR "Technology Organization Environment"] AND ["ICT"] in Scopus with 148 hits, which were filtered for completed journal articles in English, published since 2013 in the areas of Computer Science or Business/Management, and sorted by relevance. 50 hits remained and were screened for extraction. A noteworthy finding at this stage was that all papers were already contextualized with either SMEs or emerging economies. In the extraction process, papers qualified if title or abstract pointed at TOE analyses of ICT or IS adoption, in order to provide a knowledge-based foundation from other TOE studies for our framework. However, studies dealing with specific technology, such as cloud computing, IoT or social media, were excluded, as they were less concerned with ICT adoption as such but rather dealt with the acceptance of technology-specific characteristics. Twelve papers remained, out of which four did not contain any perception factors and two had adopted another TOE framework, thus Yoon and George (2013) and Kuan and Chau (2001) were included after backward searching. Finally ICT perception factors were elicited from the extracted papers. Table 1 presents a comprehensive synthesis of these findings with references that clarify the nature and origin of each perception factor.

Finalizing the adapted TOE framework, we consciously omit indications of positive or negative direction or weight of impacts, as it is our goal to study the mere impactfulness of an educational ER experience on ICT perceptions in SMEs, that is, regardless of the subsequent effects, which we consider to be subject of another discussion. Moreover, factors E1 and E2 (Table 1) are not considered, since our study is geographically limited to Germany, which we consider to make these specific environmental factors minorly relevant. Consequently, we formulate three hypotheses:

H_T: *Educational ICT-based ER game experience influences SME practitioners' perceptions of technological aspects of ICT adoption; in particular perceived advantages/benefits (H_{T1}), perceived convenience/ease of use (H_{T2}), perceiced affordability (H_{T3}), perceived compatibility (H_{T4}) and perceived triability (H_{T5}).* ***H_{Org}:*** *Educational ICT-based ER game experience influences SME practitioners' perceptions of organizational aspects of ICT adoption; in particular labor force perceived as an obstacle (H_{Org1}), perceived technical competence (H_{Org2}), perceived internal barriers (H_{Org3}) and perceived financial cost (H_{Org4}).* ***H_E:*** *Educational ICT-based ER game experience influences SME practitioners' perceptions of environmental aspects of ICT adoption; in particular perceived industry pressure (H_{E3}), perceived customer/supplier pressure (H_{E4}), and perceived government pressure (H_{E5}).*

Table 1. ICT perception factors from literature.

TOE	Perception factor	References
Tech-nology	Perceived advantages / benefits (T1)	(Chen et al.; Kuan & Chau, 2001; Munikrishnan et al., 2018; Yoon & George, 2013)
	Perceived convenience / ease of use (T2)	(Wahyuningtihas et al., 2021; Yoon & George, 2013)
	Perceived affordability (benefits of adopting over cost of acquiring) (T3)	(Eze et al., 2018; Eze et al., 2019)
	Perceived compatibility (T4)	(Munikrishnan et al., 2018; Yoon & George, 2013)
	Perceived triability (T5)	(Munikrishnan et al., 2018)
Organi-zation	Labor force perceived as an obstacle (Org1)	(Arslan et al., 2019)
	Perceived technical competence (Org2)	(Kuan & Chau, 2001)
	Perceived internal barriers (Org3)	(Munikrishnan et al., 2018)
	Perceived financial cost (Org4)	(Kuan & Chau, 2001)
Environ-ment	Perceived instability, corruption, crime (E1)	(Arslan et al., 2019)
	Perceived telecom infrastructure (E2)	(Arslan et al., 2019)
	Perceived industry pressure (E3)	(Kuan & Chau, 2001; Yoon & George, 2013)
	Perceived customer / supplier pressure (E4)	(Yoon & George, 2013)
	Perceived government pressure (E5)	(Kuan & Chau, 2001)

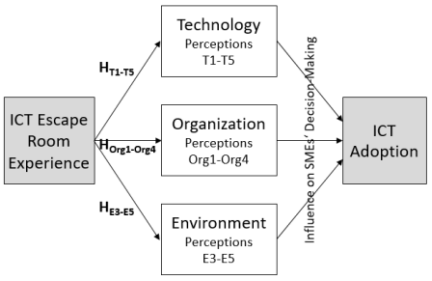

Figure 1. Extended TOE research model.

3. Methodology

A suitable method to address our RQ and study the hypotheses should enable insights on both intervention design and interventional effects on SMEs. Considering the educational ICT-based ER game experience as a design artifact, we chose an Action Design Research (ADR) approach for this study. ADR was introduced by Sein et al. (2011) and is a methodology that involves the active engagement of stakeholders, promoting collaboration and co-creation throughout the research. Especially in ISR, it complements the Design Science Research methodology (e.g. Hevner et al. (2004); Peffers et al. (2007)), which is rather centered around the design and demonstration of IS artifacts (Peffers et al., 2018). Within an ADR cycle, researchers explicate a practical problem, build an artifact and put it into action for an intervention. The outcome is finally evaluated to derive both design knowledge and utility for end-users (Sein et al., 2011). Thus, every ADR cycle contributes to general knowledge on the given problem and leads to better generalizability of insights. To complement our methodology, the methods used for Building, Intervention and Evaluation (BIE) stages are described in the following.

3.1. Building

A systematic literature review (SLR) method is used to derive existing design knowledge and guidelines. The goal is to gather design requirements (DR) for building an educational ER. We follow common guidelines for conducting a systematic search (Vom Brocke et al., 2015) and analysis (Webster & Watson, 2002) in ISR to document the procedure transparently and present the outcome in a structured and visual manner. Thereafter, an abridged documentation of the artifact implementation is presented. It follows suggestions on how to sketch and build a design artifact (Johannesson & Perjons, 2014) and combines stakeholder characterizations and descriptions of each game component as well as the gameplay process.

3.2. Intervention

After the ER's technical functionality has been thoroughly tested by developers, the next stage comprises initial gameplay sessions with practitioners. The sessions resemble user experience (UX) tests, which follow the definition of free flow and blind testing sessions (McAllister & White, 2015). In such a scenario, the testers are to experience a game for the first time and without any intermediate instructions other than intentionally built-in hints. However, the experience ends with a moderated reflection session. Descriptive data on game performance and user demographics are collected from each session.

3.3. Evaluation

The test observations are complemented by qualitative semi-structured focus groups (Powell & Single, 1996), which are textually transcribed and thematically analyzed (Braun & Clarke, 2021). We argue for this approach based on three major considerations. First, recent IS research advocated for SMEs to be studied with a separate scope (Drechsler et al., 2022), due to the large impact of individuality, human factors and biased leadership on decision-making (Culkin & Smith, 2000; Franco & Matos, 2015; Wang et al., 2007). Therefore, we apply semi-structured interview techniques that provoke storytelling and subjective statements; a common method in human-centered requirement engineering (Hehn et al., 2019). The focus groups are expected to yield insights on both design requirements and utility for SMEs, while the questions will be designed to ask for perceptions of both gameplay and ICT. Secondly, heuristic findings tell us that the large majority of usability problems can already be found by a low number of testers (Nielsen, 1992; Nielsen & Molich, 1990), even though they may miss out on some issues. Hence, we prioritize depth over quantity and accept the implicit limitations in this first ADR cycle, but already prepare and aim for a quantitative approach at a later stage. Third, borrowing the words of Powell and Single (1996), we claim that "the subject under investigation is complex and comprises a number of variables. A focus group enables the researcher to concentrate time and resources on the study's most pertinent variables" (p.500).

4. Design requirements

Enquiring DRs through an SLR, our literature search was conducted in WoS using the keywords ["Escape" AND ["Game" or "Room"]] AND ["Learn*" OR "Aware*" OR "Educat*"]. A general observation is that most articles in this field revolve around target stakeholders from universities, schools, and classrooms. Given our organizational context of research, we added [NOT "School"] to the search string. The outcome, counting 400 papers, was sorted in descending order of relevance and filtered for full research articles published since the year 2005, encompassing the domains of business and economics, computer science, education, social science, and

behavioral science. In addition, we widely excluded topics related exclusively to nursing, pharmacy, and other health care or hospital settings, because most ER studies in these areas appeared to be centered around learning cases in the respective medical area and were hardly insightful in terms of artifact design. Additionally, online or virtual ERs were excluded from the review, as these games merely imitate physical ERs, but yield less comparability in terms of experience (Pan et al., 2017). Finally, 14 papers were selected for further analysis. Following a thematic analysis of the collected studies, we propose five conceptual dimensions of ER design, summarized in Table 2. Based on that, we formulate five major DRs, one based on each of the identified concepts from literature.

DR1: Learning objectives. Learning objectives should be predefined in order to address the goals to be achieved by the ER intervention (Clarke et al., 2017). Moreover, the objectives need to align with the pedagogical approach, if applicable (Veldkamp et al., 2020). In essence, the ER should be designed to enable the immersion of the real world goals into the game world (Veldkamp et al., 2022). It should be noted that participating in an ER game can leverage collaborative learning effects (Veldkamp et al., 2022; Warmelink et al., 2017).

DR2: Frame story. Several papers refer to gamification techniques and serious gaming concepts behind ER (Bakhsheshi, 2019; Friedrich et al., 2019; Musil et al., 2019; Veldkamp et al., 2020). All authors resonate that the whole experience around the ER game should be themed and the narrative must be made tangible for players (Clarke et al., 2017; Järveläinen & Paavilainen-Mäntymäki), enabling full immersion into the game world (Löffler et al., 2021).

DR3: Equipment. The framework for ER design proposed by Clarke et al. (2017) suggests designing and placing the physical equipment in a way that supports the immersive game experience. Several studies also emphasize the importance of tailoring such equipment to individual needs of participants, such as level of complexity, cultural or language specificities. (Bakhsheshi, 2019; Clarke et al., 2017; Friedrich et al., 2019; Warmelink et al., 2017).

DR4: Guidance. Recommendations on assisting guidance throughout the ER experience were most frequently mentioned by the authors, since a well-balanced supervision during the game is considered essential (Bakhsheshi, 2019; Beguin et al., 2019; Löffler et al., 2021; Veldkamp et al., 2020). The researchers recommend providing players with a clear task sequence, instructions and hint-based guidance (Buchner et al., 2022; Clarke et al., 2017; Järveläinen & Paavilainen-Mäntymäki; Musil et al., 2019). Hints, however, need to be delivered carefully, as they may disrupt the players' immersion in the game or discourage them from solving puzzles on their own. The authors also emphasize the value of debriefing and reflection after the game sessions (Clarke et al., 2017; Löffler et al., 2021; Schneider & Zanwar, 2020; Veldkamp et al., 2022; Veldkamp et al., 2020).

DR5: Test/Evaluation. ER design and operation should be entangled with frequent testing and evaluation. Clarke et al. (2017) suggest to test and evaluate the ER experience before, during and after the game to measure the gameplay efficiency, knowledge transfer accomplishment and contribution to further development steps. Schneider and Zanwar (2020) emphasize the special importance of evaluating long-term learning effects in SMEs after an ER game experience. In accordance, Löffler et al. (2021) suggest to conduct additional evaluation of ER prototypes to enrich the understanding of such games in an SME context.

Table 2. Concepts of ER design from literature.

References	Learning objectives	Frame story	Equip-ment	Gui-dance	Test/ Eval.
(Bakhsheshi, 2019)		x	x	x	
(Beguin et al., 2019)				x	
(Buchner et al., 2022)				x	
(Clarke et al., 2017)	x	x	x	x	x
(Friedrich et al., 2019)		x	x		
(Järveläinen & Paavilainen-M, 2019)		x		x	
(Kuo et al., 2022)			x		
(Löffler et al., 2021)	x	x	x	x	x
(Musil et al., 2019)		x		x	
(Pickern & Costakis, 2023)	x	x	x	x	
(Schneider & Zanwar, 2020)	x	x	x	x	x
(Veldkamp et al., 2020)	x	x		x	
(Veldkamp et al., 2022)	x			x	
(Warmelink et al., 2017)	x		x		

5. Implementation

The implemented artifact is a physical ER located in Germany. It is sponsored and hosted by a public development program for SME DT initiatives. The ER specifically targets incumbent firms with less than 250 employees and low digital maturity or ICT affinity. Figure 2 showcases major parts of the physical artifact implementation, guided by the DRs.

5.1. Story

The frame story revolves around an ordinary group visit to a technological laboratory [DR2]. At the start of a fictional guided tour through the lab, the visitors (team of 3-5 players) are "accidently" locked into the facility while waiting for their host to fetch some documents and return. By another mistake, the group is suddenly exposed to an automatic and allegedly hazardous decontamination program that they need to deactivate within 60 minutes. Several puzzles, all involving ICT use, need to be solved to

reach the tool that stops the decontamination program. If the players manage to complete all puzzles, or if time is up, the game is over and the lab host returns.

Figure 2. ER Rooms 1, 2.2 and 3 (top to bottom).

5.2. Actors

A **player** can be anybody who never played the game before [DR1], who is not part of any other actor category, who plays the ER in a group of three to five players, and who is at least 16 years old. A player can have any level of ICT handling experience, although the complexity level is adapted to beginners or intermediates [DR3].

The **game master** (GM) is an individual person who knows each step necessary to finish the puzzles and has fundamental expertise with the ERs gameplay and its control panel. Hence, the GM fully ensures the fit to DR4. Tasks include the active supervision of gameplay, active guidance by delivering hints and assistance, taking care of the players' wellbeing, preparation of the ER and communication of any technical errors and difficulties to developers [DR5]. Moreover, the GM acts as a tour guide in the frame story [DR1] and facilitates debriefing and reflection.

A **developer** is anybody who participates in the development, deployment, or maintenance of the ERs technical infrastructure during, before or after the operation. Furthermore, fundamental knowledge of the systems in use for both front- and backend are required. Developers are primarily responsible to meet DR3 and DR5.

5.3. Components, puzzles and gameplay

Figure 3 shows a floor plan with room, puzzle and door labels for auxiliary orientation. The space totals 363 ft². Door 00-02 and door 01-01 refer to the same physical door, but faced from different directions. The GM room serves as an operation control station that includes several video screens, a computer terminal for playing pre-recorded audio-hints and a microphone [DR4]. Players and GM enter the ER through the staircase and anteroom.

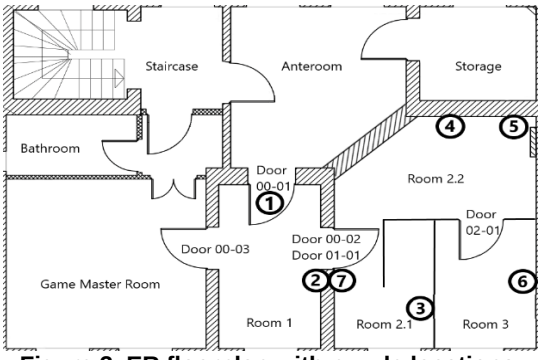

Figure 3. ER floorplan with puzzle locations.

Puzzle 1 involves object detection [DR1] using a TV screen and webcam connected to a computer running object detection software. The players need to clear the camera's field of view to start the decontamination process [DR2] and retrieve an NFC card [DR1] from a robotic vacuum cleaner to unlock a cupboard containing a staff folder and ID cards [DR2].

Puzzle 2 focuses on pattern detection [DR1]. Lab coats [DR2] in Room 1 have emblems sewn onto them, and players must match ID cards with the corresponding lab coat emblems using the staff folder. By positioning the correct combination of lab coat and ID card in front of a tablet's camera, the door mechanism unlocks, allowing access to Room 2.1. To continue, they must close the door again, which subsequently blocks the access back to Room 1.

Puzzle 3 involves an electronic cash register (ECR) in Room 2.1. Players find an article number and photo in a document folder that matches a colored cube in a lockbox. They must input this data into the ECR software to generate a receipt with a net price [DR1], which serves as the code to open the lockbox.

Puzzle 4 centers around a filter machine in room 2.2. Players need to arrange nine colored cubes, one of which they obtained from Puzzle 3, in a specific pattern on a grid tray based on hints hidden between pseudo-scientific formulae on posters in the room [DR2, DR3, DR4]. A laptop connected to the filter machine checks the cube positions and colors [DR1], revealing a PIN code on a TV screen. This code unlocks a digital combination lock, granting access to a compartment door and a key for door 02-01.

Puzzle 5 requires color detection [DR1]. Players use the PIN code from Puzzle 4 to identify specific areas in the escape room through gray-scaled live

recordings [DR2] on a TV screen in Room 2.2. Colorful squares are augmented onto the live recordings. Players must place corresponding items, such as green gloves, an orange tray, and yellow folders, in the designated areas to progress.

Puzzle 6 features an HR planning software running on a laptop in Room 3. Players use a password, retrieved upon successful completion of Puzzle 5, to unlock the laptop and delete the scheduled decontamination process from an electronic calendar [DR1, DR2]. However, a 2-factor authentication [DR1] is required from another device in Room 1.

Puzzle 7 utilizes a sentiment analyzer and voice recorder on a tablet and an intercom system. Players must say "friendly" phrases through the intercom to increase the friendliness sentiment score and reopen the door to Room 1 [DR1, DR3]. Once inside, they press a button on a tablet to confirm the 2-factor authentication and successfully complete the game [DR2].

5.4. Guidance and reflection

The GM is involved throughout the whole experience. To begin with, thorough preparation is crucial for reconstructable and equal research settings [DR3]. Most of the preparations consist of activating technical devices such as tablets, laptops and cameras. In addition, the operation control tools in the GM room need to be up and running. During the game, the control terminal allows the GM to play audio hints via loudspeaker [DR4]. There are two different types of hints. Pre-recorded hints focus on specific puzzles and aim at directing the attention of the players onto a certain object that helps to continue with the game. Individual hints are delivered over the microphone and are only used if a group is stuck on a specific step for which no hint was prepared, or if the group is stuck even though all prepared hints have been given. The decision on delivering hints is up to the GM, however, the minimum play time before giving the first hint for a puzzle is 10 minutes. Once the game is completed, or if time is up, the GM must unlock the entrance door. After a short break in the anteroom, a debriefing and reflection session begins. It involves a re-visit to the ER with explanations of all ICT components integrated in the puzzles [DR1]. Once the reflection is complete, the players are farewelled, session data are stored [DR5] and the ER is reset.

6. User tests and evaluation

Sixteen test sessions with SME practitioners were conducted between January and June 2023, one of which was cancelled during gameplay due to time constraints. The participant sourcing was conducted through e-mail invitations via the ER sponsor's network of SME practitioners in the region of Berlin-Brandenburg. Users qualified as SME practitioners if they were currently employed in or leading a company with less than 250 employees, or if they were delegates of strongly SME-related institutions, such as specialized chambers of commerce or SME associations. Descriptive details of the fifteen analyzed sessions are listed in Table 3.

Table 3. Overview of test sessions.

Team	ICT use experience*	Industry	Group size	Time (min.)	Players' characteristics
T-1	3/5	Finance / graphic design / manufacturing	3	59	Entrepreneurs with micro businesses (<5 employees), did not know each other before gameplay
T-2	3/5	Textile	3	55	Representatives of an SME innovation cluster for the textile industry
T-3	4/5	(various)	4	50	Representatives of a regional SME innovation cluster
T-4	3/5	(various)	4	56	Representatives of a regional SME innovation cluster
T-5	4/5	(various)	3	38	Two representatives of a regional SME innovation cluster and one financial SME employee
T-6	3/5	Consulting	3	> 60 (failed)	Interns
T-7	3/5	Media	5	41	Employees
T-8	3/5	(various)	4	54	Representatives of a regional chamber of commerce
T-9	2/5	Administration Services / Manufacturing	3	49	Employees, did not know each other before gameplay
T-10	2/5	Health / Optometry / Public Services	4	58	Employees, did not know each other before gameplay
T-11	2/5	Waste recycling	5	57	Employees
T-12	3/5	Marketing	4	> 60 (failed)	Interns
T-13	3/5	IT Services	4	50	Representatives of a public-private partnership network for AI development in SMEs
T-14	3/5	IT Services	4	53	Representatives of a public-private partnership network for AI development in SMEs
T-15	4/5	Consulting	4	58	Representatives of an SME innovation cluster
*self-assessment prior to gameplay;1=none, 2=beginner, 3=intermediate, 4=advanced, 5=expert					

Table 4. Key questions for focus groups.

ID	Question
Ice-breaker	Which part of the game was most fun for you? (Follow-up: Which was your favorite tool?)
KQ1	How did the story feel for you? (Follow-up: How realistic did the challenge appear to you?)
KQ2	What issues did you come across during the game?
KQ3	What was your biggest insight / "wow" moment during the game? (Follow-up: Did you encounter any surprises?)
KQ4	How did you experience guidance during the game?
KQ5	In what sense did the game influence your perception of the technology integrated in the ER? (Follow-up: What was new for you in the game situation?)
KQ6	What can you take away from this experience about using ICT in companies? (Follow-up: Can you specify any use cases?)
KQ7	To whom would you most likely recommend this ER game experience?

After each reflection session, players were asked to participate in a feedback focus group held in the anteroom. The focus group sessions started with an "ice-breaker" question. Then, participants were involved in an open talk guided by several key questions (KQ) listed in Table 4. The KQs were

hypotheses designed to build rapport with the interviewees and evoke storytelling. The talk concerned gameplay itself, targeting feedback on artifact design (Ice breaker, KQ1, KQ2, KQ4), ICT perceptions in alignment with our hypotheses (Ice breaker, KQ2, KQ3, KQ5, KQ6, KQ7) and overall feedback, pointing at both design and ICT perceptions (Ice breaker, KQ1, KQ2, KQ7). Following a semi-structured approach, the interviewer could optionally follow up on certain aspects to increase the depth of players' responses. All focus groups were audio-recorded based on written agreements. In preparation of this study, the recordings were manually transcribed to text. Next, thematic analyses were conducted by three authors independently, through which transcribed statements were coded into four main categories: feedback on ER game design, feedback on technology-related ICT perception, feedback on organization-related ICT perception, and feedback on environment-related ICT perception. The three coding results were finally synthesized in a spreadsheet to provide a common basis for writing down key insights. The focus group talks had an average length of 25:16 minutes. 7:09 hours of audio recordings and 155 pages of textual transcripts (in German) were stored.

7. Results

7.1. Findings on ER game design

Several teams found the puzzles' cognitive mix of searching, thinking, and transfer elements enjoyable. The visual design of the ER was also positively perceived. One participant (T-5) explicitly mentioned that exploring the entire ER and interacting with the equipment was stimulating the game situation. Some participants highlighted certain ER equipment adding up to the immersive experience (T-3, T-5, T-6, T-13, T-14): "*What I liked the most is that it [ER] seemed so real"* (T-5)*; "At the beginning, having to wear the coats was actually pretty cool because we were wearing them the whole time. That also added a bit of a feeling"* (T-6)*; "[...] when you work in the labs […] with the lab coats, that's cool, it comes very close to reality"* (T-13). In addition, acoustic support and guidance in the ER allegedly supported the frame story well. Three groups (T-1, T-5, T-11) expressed an initial uncertainty about the game's objective, as the introduction part was not well understood: *"We understood, of course, that at some point we have to get out, because otherwise we would be poisoned or something like that. [...] It just takes a while to get into this narrative, but at some point we had the hang of it, I guess"* (T-1). In contrast, three other groups (T-2, T-6, T-7) found the theme and objective clear enough: *"What I also really liked was the narrative transition from the beginning [...] it was a bit like in an old movie, we got introduced and then everything flows together smoothly"* (T-7). Another outcome concerning learning objectives was that several groups perceived the ER experience as an impetus to learn (T-2, T-3, T-5, T-14). Although they did not report on any immediate learning effects after the game, they felt the motivation to learn more about the technologies: "*[…] I hadn't even thought about it [application areas of ICT]. […] I would have to think about it*" (T-5); *"I need the evening to reflect again"* (T-2).

7.2. Findings on influence on ICT perception

The demonstrated ICT use cases in the ER were considered beneficial (T-7, T-9, T-10, T-11, T-14, T-15). In particular, participants found it valuable to have the opportunity to experiment with the technology, emphasizing the importance of hands-on interaction for better understanding, acceptance and losing the fear of contact with technology (T-1, T-3, T-6, T-10, T-11, T-12): "*I thought it was quite good that you just kind of get in touch with objects, with things and surroundings that you don't normally get in touch with. […] To lose the fear of contact and just try out. Theoretically, you can't break much […]"* (T-1). Some players envisioned concrete use cases such as construction site safety, drawing upon the experience with puzzles 2 and 5: *"The machines may stop when someone doesn't wear yellow gloves or doesn't wear a helmet… that's where it can also be used effectively. Or in the field of accessibility, [...] for example, a door automatically opens and recognizes the face." (T-1)*. Further considerations included error detection (e.g., identifying discoloration in product packaging – T-6), quality control and production safety (e.g., assessing the ripeness of vegetables in agriculture – T-7; detecting anomalies in fabric or tissue for quality control purposes – T-2), laboratory settings (e.g., identifying different types of waste materials – T-11), security (e.g. personal ID detection – T-6), event management (e.g. counting visitors, face mask detection, crowd control – T-14). Another value potential for incorporating ICT in small businesses was recognized in the context of perceived benefits and cost-effectiveness (T-1, T-2, T-5, T-7): "*I definitely see potentials in the future to integrate [ICT into] SMEs, [...] from IT department itself to expansions upwards, so that you can work more efficiently and better with each other that way. Also, for many SMEs it might be more cost-effective. Technology is always implementable*" (T5). Even though the experience did not lead to immediate investment decisions, it provided grounds for further

inquiry regarding ICT usefulness and cost-effectiveness: *"[…] for me, it was just a game. I would take it as an opportunity to look into the subject further and then see which departments it could be useful for"* (T-2). Regarding potential employee-related barriers for adoption, the importance of intuitive interfaces and user-friendliness of ICT was highlighted: *"[…] That really depends on an intuitive interface. Just recently, I saw a software where I thought it simply wasn't intuitive."* (T-8). *"This should address SMEs, [...] and really dive into it, to experience the things, [...] and to really bridge the gap between the real-life situations of SMEs, a bit in a playful approach. [...] Then you really come to the question: 'Can I imagine implementing tools, instruments, or whatever, in any way in an application within my company?'"* (T-1).

8. Limitations, conclusion and outlook

In sum, the evaluation revealed two main centers of attention directly after the ER experience: game design / play and technology-related perceptions. The game-based experience framed by a challenge with limited time and a realistic scenario seems to have dominated the players' perception. Drawing upon the DRs elicited from literature, this indicates a successful ER implementation regarding frame story, equipment and guidance. However, it also shows a coherence with Cheng et al. (2017) who revealed that "high gaming performance/high immersion" and "high science learning/low immersion" may be common performance patterns in serious games. This clearly raises the question if a highly immersive frame story is actually a suitable design requirement for ERs in the given context. Nevertheless, some insights on ICT perception could be obtained. Within the semi-structured focus group format, the players overly preferred to talk about technology-related perception matters, even though these were occasionally linked to organizational or environmental aspects such as financial considerations, barriers or practical use cases. Essentially, the feedback indicates a recognition of the value and potential of ICT in SMEs, as well as the importance of hands-on interaction and intuitive interfaces for successful adoption. Participants also discussed various application scenarios of ICT, highlighting both relevance and versatility of the topic as well as revealing concrete considerations for decision-making in individual business domains. Hence, based on our findings, we argue that the evaluation partly validated H_T, with a special emphasis on H_{T1}, H_{T4} and H_{T5}, which provides a limited answer to the RQ. We assume that H_{Org} and H_E should be re-assessed with more distance to the experience and be contextualized with long-term effects, as the players in our study wished for more time to process the input.

Our findings have several limitations. First, because AI features are implemented in game, the ER host and sponsor decided to name it "AI Escape Room". We have to object the possibility that this label pre-framed the players' perceptions in a subliminal manner. Nevertheless, in favor of higher rigor, we decided that our research should not employ the ER for a study on AI adoption specifically, because (1) not all ICT involved had AI components integrated and (2) the players only interacted with so-called "weak AI". Moreover, although a first ADR cycle is concluded by now, this study does not make a claim for final completeness. It provides a case with several starting points to continue from. Apart from possibilities to apply alternative, for instance quantitative, research methods, or to re-organize study design to serve a different research focus, we especially highlight the opportunity for interdisciplinary research. During the literature searches and background research conducted for this paper, we found various links to psychological, sociological or cultural aspects which have already been touched in the context of ER games, but which may yield new potential in conjunction with ICT and corporate teams such as SME practitioners. For instance, eight out of fifteen of our focus groups indicated that the ER experience led to better communication and collaborative effort within teams.

The merit of human-centered research methods is underlined by the insightful user feedback that goes beyond validating predetermined assumptions. On the other hand, the method is naturally prone to individual bias and, what is more, failed to address some of the elaborated hypotheses, leaving unexplained whether these untouched dimensions are indeed irrelevant to the players' overall game experience and learning, or if more structured questioning would have led to further insights in these regards. Though and after all, learning from case to case is a fundamental process in serious games research. This research domain is inclined to provide new and experimental approaches to real-world challenges, one example being DT in SMEs. Therefore, we would like to encourage the ISR and game-based learning community to continue and enhance this practice.

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