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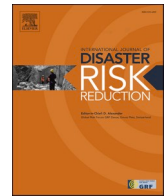
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Determinants for the acceptance of emergency response information systems: Ethnographical insights into the digitalization of a voluntary fire department

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ABSTRACT

Fire departments are one of the most versatile and widespread emergency management organizations. To support their digitalization, innovative firefighter information technologies such as emergency response information systems (ERIS) are suggested. Despite theoretical potentials like raised situation awareness, however, these technologies seem to disseminate only slowly in practice. As existing acceptance models cannot sufficiently explain the acceptance of novel technologies in this special domain, literature calls for increased contextualization. To get insights into the domain-specific acceptance factors, we conducted an ethnography and observed a voluntary fire department's multi-year project to introduce an ERIS. We identified seven factors, like revealing events and error management culture, which acted as triggers for different adoption stages. From overarching characteristics of a voluntary fire department, we derived six additional acceptance factors, like situational adaptability and self-determination. The identified factors can help firefighters in conducting successful digitalization projects, and policy makers in supporting voluntary emergency management organizations. Moreover, the results provide numerous avenues for future research, can be linked to various research fields and contextualize existing acceptance models. Beyond fire departments, the results may be transferred to similar high-reliability organizations.

1. Introduction

To better cope with increasingly occurring human-made and natural disasters, significant efforts are made to improve emergency response processes and to provide a better infrastructure for first responders such as firefighters [1]. Digitalization, that is the use of digital technologies to provide new efficacy-increasing opportunities, seems to have a particularly promising potential since the success of emergency responses considerably depends on the ability of first responders to understand and adapt to the encountered situation with context-dependent decisions. In such circumstances, information technologies and systems can help firefighters to improve their *situation awareness*. This comprises the perception of relevant environmental elements, the comprehension of their meaning, and the projection of their future status [2]. To improve the situation awareness, several innovative technologies for firefighters have been suggested, including digital maps, smart protective equipment, unmanned vehicles, and emergency response information systems (ERIS). While most of these technologies are meant to provide a rather specific support, ERIS introduce a generic platform that supports the gathering, analysis, and communication of mission-critical information in incident command processes.

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They hence appear to be particularly suited to enhance the overall situation awareness on site.

Despite the potential to improve the situation awareness, however, the digitalization of firefighter processes and the dissemination of the proposed information technologies in particular appear to be progressing only slowly [3]. As one reason for this observation, literature emphasizes that digitalization approaches and technologies have been suggested mainly based on their theoretical potential. Such technology-driven approaches ignore that information technologies are delicate artifacts for emergency responders because several tight usage constraints exist during emergency responses. To explore the factors that impact the acceptance of information technologies and systems in the emergency response domain, research has only recently begun to develop specific acceptance models that reflect domain-specific requirements such as reliability, mobility, or simplicity [4]. While these models explain the intention to use better than generic acceptance models, they still seem to miss relevant factors. Especially actual usage remains poorly predicted and appears to be contingent on other, so far unexplored factors.

To provide insights into the conditions that facilitate digitalization approaches and the acceptance of information technologies in the firefighter domain, we present the findings of an ethnography, in which we closely observed a multi-year project to introduce digital support for the command processes in a typical voluntary fire department in Germany. A core element of this project was the introduction of an ERIS, which allowed us to examine the following research questions: “Which determinants guide the digitalization of a voluntary fire department? Which factors determine the acceptance of ERIS by firefighters?” During our observation, we identified several triggers for different stages of technology acceptance. Beyond that, we found characteristics of voluntary fire departments that influence digitalization projects. While the results are closely related to the observed fire department, we deem them to be transferrable to other fire departments in Germany and around the globe, because they are often organized as voluntary service units with comparable structures and constraints.

To put our results into perspective, we integrate the identified factors into an acceptance model that is based on the Unified Theory of Acceptance and Use of Technology (UTAUT) as well as the User Satisfaction literature [5,6]. The model was developed to describe the usage constraints of ERIS and was hence felt appropriate as a theoretical framework to classify our results. With the identified acceptance factors, we also answer a call to contextualize the UTAUT [7]. We hence complement existing acceptance theories such as the UTAUT with a domain-specific perspective that might also be able to explain the usage of other firefighter information technologies as well as technologies in other high reliability organizations with similar structures and constraints. From a practical perspective, our insights can help firefighters in conducting successful digitalization projects, vendors in designing suitable technologies, and policy makers in strengthening voluntary emergency response organizations.

We proceed as follows: next, we describe the concept of ERIS, existing acceptance theories, and related works in detail. In section 3, we discuss the chosen ethnographic research approach and describe the study object. The key insights are presented and discussed in section 4. In section 5, we link the identified factors to existing acceptance models, discuss implications and limitations. Section 6 concludes the paper.

2. Background and related work

2.1. Firefighter information technologies

All over the world and for centuries, fire departments have been assembled as highly available emergency response organizations. According to the widely applied disaster management cycle, firefighters are typically engaged in the phases of preparation and response [1]. Preparation comprises all activities to establish, equip, and train a fire department. Firefighter responses typically include firefighting, technical rescue, and hazardous material operations [8]. Beyond that, fire departments often play a key role in dealing with large-scale disasters [1,9]. To ensure positive outcomes, both phases must go hand in hand. Amongst others, departments should prepare concrete, local processes to guide their responses. For the most important topics, such processes can build upon general regulations that provide basic guidelines. One of these topics is incident command and command support, which is crucial for the outcome of the whole operation [9,10].

A quite unique feature of fire departments are their mostly voluntary structures in many countries, which fundamentally distinguish them from other agencies like police or emergency medical service. Some examples include China with 98 %, the United States with 65 %, and Germany with 97 % volunteers [8]. Such structures appear necessary to achieve a sufficient density of departments and ensure quick response times especially outside major cities. In contrast to career firefighters, volunteers receive no or only minimal payment for their service. They are firefighters as a hobby besides their regular jobs. In case of an emergency response, they must first rush to their stations to gear up and staff the needed vehicles. Apart from this evident difference, voluntary firefighters typically have the same rights and duties as their paid colleagues [11]. They undergo similar trainings, use the same equipment, and respond to the same types of emergencies.

To stay safe and make correct decisions within an operation, firefighters must gain situation awareness [2]. As a means to achieve this, literature proposes several firefighter information technologies. A recent review gives an overview of the different technology types and remaining literature gaps [12]. The technologies range from data-driven approaches for forecasting and detection, over unmanned aerial and ground vehicles, to personal firefighter augmentation with smart protective equipment and augmented reality. Remaining gaps in the domain include the support beyond the reconnaissance phase and merely firefighting missions as well as user-centered aspects like technology acceptance.

Among the firefighter information technologies, ERIS appear especially promising. They are designed to holistically support the incident command process across all phases and for all operation types, which addresses two major literature gaps [12]. ERIS provide a platform to gather, process, and share relevant information about an emergency operation. As displayed in Fig. 1, typical elements of an ERIS include an operation log, an overview of responding units, a representation of the command structure, and a situation map.

ERIS can be further divided into three evolutionary stages regarding their degree of automation. Most currently available systems require the manual input of data [13,14]. Advanced systems, which are so far mostly discussed in research, can capture automatic sensor inputs for unit positions, water tank capacities, and others [15,16]. ERIS of the highest stage can use the available data to derive suggestions for commands and actions, which categorizes them as decision support system [17,18].

2.2. Digitalization of fire departments

Digitalization and the acceptance of novel technologies has been extensively researched in the past. Amongst others, the UTAUT and its predecessors (Technology Acceptance Model, Diffusion of Innovations Theory, etc.) have been successfully applied in several contexts [5]. Recent contributions, however, indicated numerous potentials for further development [7]. Amongst them are the need for new conceptions of technology use and the identification of new endogenous, exogenous, or moderating mechanisms. The proposed areas of research are summarized in Fig. 2. Most prominently, Venkatesh et al. [7] call for an increased contextualization of UTAUT, considering context-specific factors. Following this call for research, our study examines digitalization and technology acceptance in the special context of firefighters.

Technology acceptance by firefighters is not well understood by now, as the previously mentioned review shows [12]. For most technologies, including ERIS, the study found a clear focus on technology-driven works. Only few works take a user-driven perspective or specifically examine technology acceptance in this domain. A couple of papers analyzed command processes to derive appropriate interfaces and integrate them in a system architecture [17,19]. Another study identified general capabilities a fire department must have to be able to adopt information technologies [20]. The review found only one study that explicitly took the identification of acceptance factors for firefighter information technologies into focus [21].

A subsequent study integrated such factors into a model explaining the acceptance of ERIS, which is summarized in Fig. 2 [4]. Based on the ideas of Wixom and Todd [6], the authors interpreted information and system satisfaction as antecedents of the core UTAUT constructs. Regarding the contextualization call of Venkatesh et al. [7], they resemble *technology attributes*. The resulting model revealed important information and system characteristics. With a coefficient of determination (R^2) above 0.75, it could reasonably well predict a firefighter's intention to use an ERIS [4]. The predictive power for actual usage, however, remained weak ($R^2 < 0.5$). To fill the remaining blind spots, an increased contextual understanding appears necessary.

2.3. Ethnographic research about firefighters

Despite initial insights, the digitalization of fire departments remains a rather unexplored phenomenon. To explain such phenomena in special organizational contexts, literature suggests conducting ethnographic research to gain deep insights [22]. For the emergency responder domain, ethnographic studies can especially be found in the field of sociology. The seminal work of Van Maanen [23], for example, exhibits insights into the routine of police officers. With the specific focus on firefighters, multiple studies examined wildland firefighting [24,25] and the role of gender [26,27]. Other recent works focused on learning in fire departments [28], the coping with temporal boundaries [29], and the impact of life-death decisions [30].

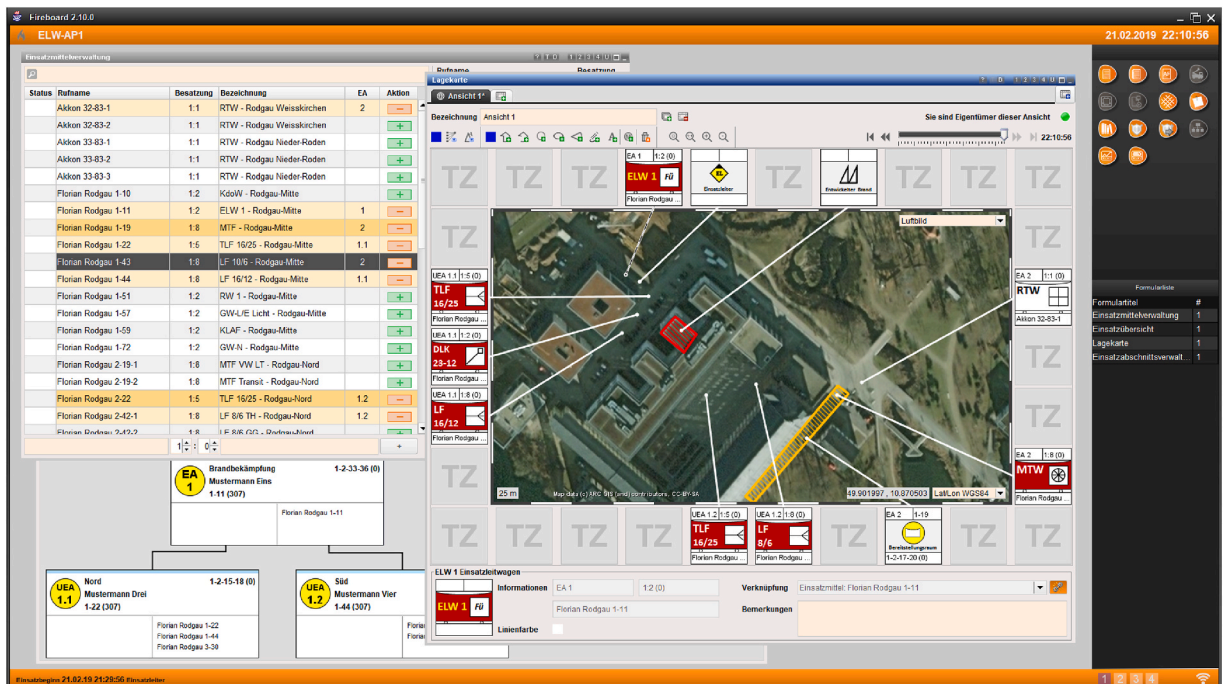


Fig. 1. Exemplary ERIS "Fireboard".

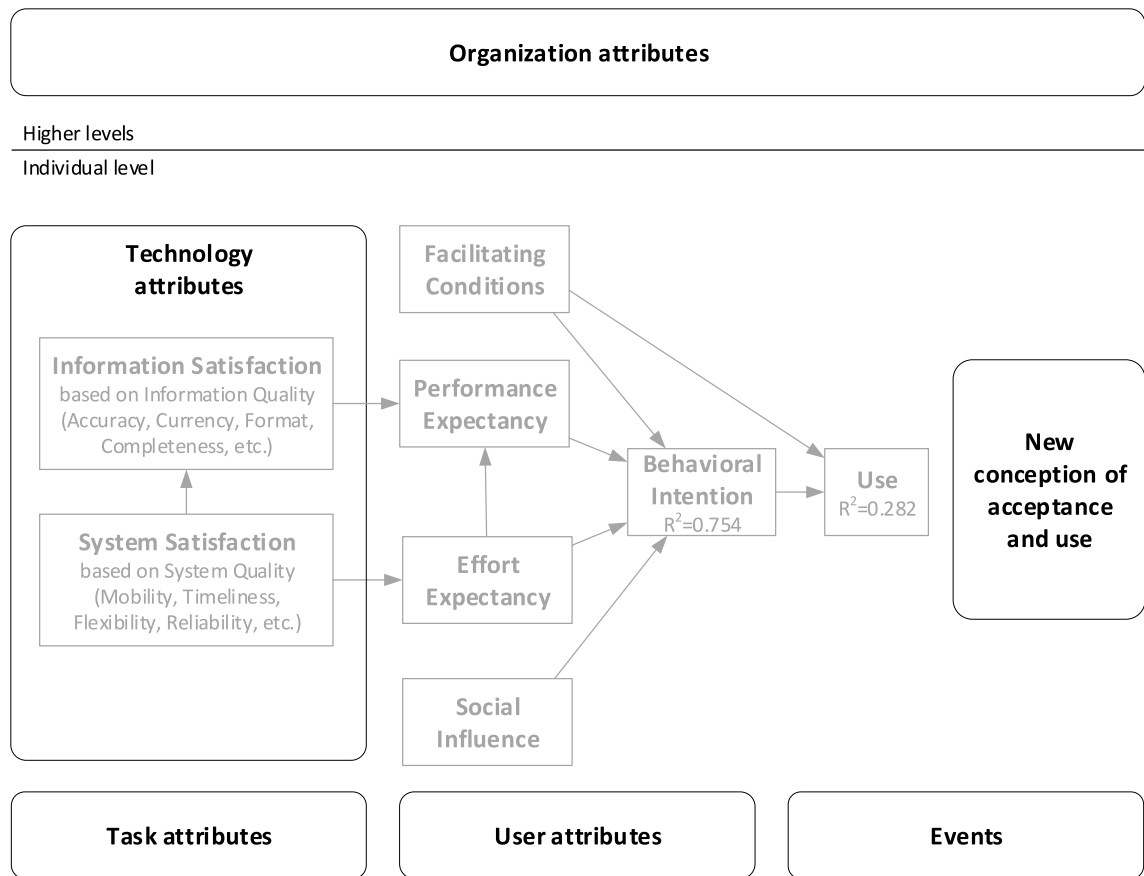


Fig. 2. UTAUT-based acceptance model for ERIS based on Weidinger et al. [4] in faded grey with calls for contextualization based on Venkatesh et al. [7] in solid black.

There are examples of ethnographic research in the fields of information systems and computer science research, as well. Most prominently, it was employed to derive design implications from firefighter interactions during structure fires [31,32]. Other studies concentrated on the preparation phase. They examined the interrelations of emergency planning and emergency response [33] and the projection of structure fires to enable proactive responses [34]. We also identified two studies in the command context. One illuminated the interaction of first responders with information technology on the multi-agency level [35] and the other examined technological challenges of digital plans in Swedish fire departments [36]. Overall, ethnography seems to be an established research method in the firefighter domain. However, we could not identify any study examining digitalization of the incident command processes in fire departments. It hence remains unclear under which specific circumstances novel technologies like ERIS can be integrated in the command processes of firefighters.

3. Methodology

To bring light into the dark, we aimed to directly observe and experience the adoption of an ERIS in a fire department. We had the chance to ethnographically accompany a voluntary fire department over multiple years to gain in-depth insights [23,37]. In the following, we describe the observation site, the observed project, the data collection, and analysis of our study.

3.1. The Haßfurt Fire Department

Our observation site was the Haßfurt Voluntary Fire Department, which provides emergency services for the 13,500 inhabitants of Haßfurt in Bavaria, Germany. While this pure number might seem small, there are several characteristics that make the city a quite interesting area of firefighter operation. As the largest municipality and administrative seat of the county, it is home to several facilities with regional catchment areas. Among them are schools, dormitories, authorities, retirement homes, and a hospital. The historic city center with its narrow alleys includes numerous churches and other culturally significant buildings. It is contrasted by large commercial areas, industrial plants, and several buildings near the high-rise threshold. The nine separate city districts distributed over 53 km² complete the highly diverse picture with extensive forests and agricultural areas. Regarding traffic infrastructure, Haßfurt is linked to a federal freeway and other busy roads. The city's regional airport processes 10,000 aircraft movements per year. The river Main flowing through the city is a federal waterway and used for passenger and freight traffic. Summing up, the city combines a variety of

special characteristics packed into a quite small area. For a firefighter this means an interesting and challenging mix of potential dangers. They range from structure, industrial, and wildland fires, over car, aircraft, and ship accidents, up to floodings and many other scenarios.

To cope with these dangers, the city of Haßfurt maintains a highly trained and well-equipped fire department. Like 97 % of German firefighters, the 328 members are volunteers who work in regular full-day jobs as well. Therefore, predictable activities like trainings are typically held in the evenings or on weekends. For the unpredictable emergency operations, the firefighters get alerted via pagers or sirens. They rush to their fire station, equip themselves and staff the needed vehicles. On average, the department responds to about 200 emergencies per year. To support the volunteers in maintenance and administrative issues, the department has two fulltime employees. Nevertheless, most work including the observed command processes are done fully by volunteers. Of the nine fire stations, eight smaller ones are distributed across the city districts. Several workshops and specialized equipment are centralized in the headquarters. Overall, the department has 24 vehicles as well as several trailers and roll-off containers. Among them are engines, an aerial ladder, a water tender, a heavy rescue vehicle, and boats.

3.2. Command support facilities

Our observation focused the digitalization of the department's two major command support facilities and the surrounding processes. The command center in the department headquarters (see Fig. 3) gets staffed only in large-scale or long-lasting disasters like thunderstorms, floodings, or blackouts. On such occasions, the regional control and dispatch center will just forward all incident data to the municipal fire departments where the further coordination is managed. Besides that, citizens will also directly contact the fire departments. During the observed digitalization project, the command center got equipped with five PC workstations and the ERIS Fireboard. More importantly, a command support process including pre-defined functions was established. As displayed in Fig. 4, it is based on the three-phase command circle [10]. For reconnaissance, two functions answer incoming emergency calls and transfer them into prioritized tasks. For planning, the incident commander and the command assistant evaluate these tasks and decide which units to dispatch. Finally, the transmission of information gets managed by two functions for incoming and outgoing communications via radio, telephone, and email. To staff the newly established functions, a command support unit (CSU) was founded. This special task force recruits its members from ordinary firefighters which frequently train the new command support processes.

The other major facility is a newly procured command vehicle for mobile operations and command support on the operation site (see Fig. 5). It carries three PC workstations, the identical ERIS as the command center, extensive office equipment, and many more accessories. Like the command center, it is staffed by the CSU. The standard crew comprises three functions. The incident commander leads the department's response. The command assistant supports him/her in the field. As an officer at special disposal, the assistant may, for example, take command of an operation sector. One CSU member operates the vehicle and establishes a command post with it. This includes information gathering, holding radio contact to the regional control and dispatch center, and documenting important events in the operation log. On special occasions, like large-scale operations, the standard crew can be extended up to six functions. Fig. 6 displays this highest expansion level and summarizes the task areas covered by the command vehicle.

3.3. Data collection

The observed digitalization project extended over a period of multiple years. Its official beginning is marked by the foundation of the CSU in September 2018. From then on, we consciously observed and documented the developments. Significant events from previous years have already been witnessed but not explicitly observed. Major milestones were the command center digitalization in December 2018, the command vehicle test operation from March 2020, and its active operation from September 2020 on. These marked usage decisions in terms of technology acceptance and the completion of the digitalization project from the fire department perspective. However, we continued the still ongoing observation to cover long-term aspects. This paper describes the insights up to the year 2024.

The extensive observation was conducted by the first author, who is a trained firefighter and has been a member of the Haßfurt Fire Department since 2004. Besides rich firefighter experience, he also has a background in the IT sector and holds a master's degree in information systems. The observation took place in the context of his PhD studies about the acceptance of firefighter information technologies. At the observation beginning in 2018, he had the position of a squad leader and signed up for the newly founded CSU. In May 2021, he was elected assistant chief of the department. From then on, he could not only experience the perspective of a firefighter



Fig. 3. Command center impressions.

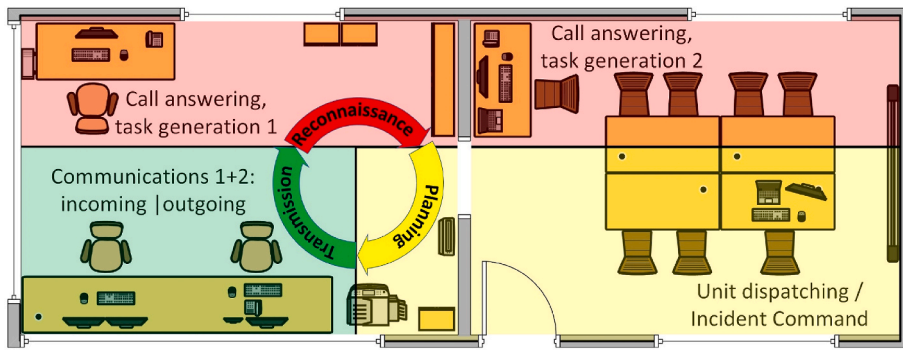


Fig. 4. Current command center setup (excerpt, translated from original resource).



Fig. 5. Command vehicle impressions.

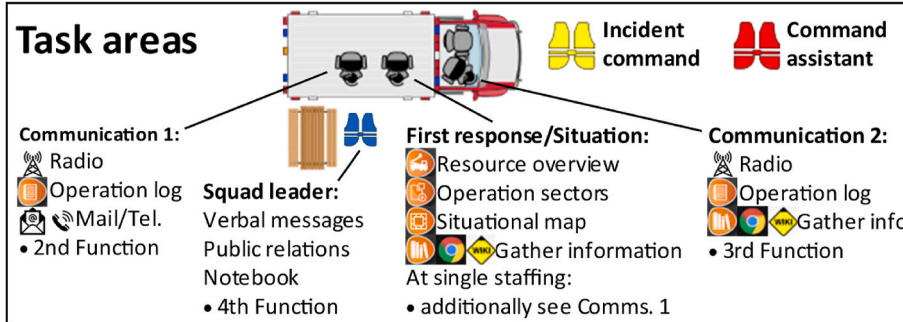


Fig. 6. Current command vehicle setup (excerpt, translated from original resource).

and CSU member, but also of a command assistant and incident commander as described in the section before. The decisions of digitalization itself, the use of an ERIS, the software selection, and the command support processes have been made prior to this. Therefore, these new perspectives mainly account for the long-term usage observation and the better interpretation of prior events.

The observation itself as well as the later data analysis were informed by the established principles of Klein and Myers [22], which are italicized in the following paragraphs. The *interaction between the researcher and the subjects* can be described as companionable [22]. The first author actively engaged in form of a participant observation [38]. Since 2018, he participated in several trainings (17 explicitly for the CSU), more than 400 emergency responses, countless surrounding talks, and social activities of the department. Such deep involvement might be the only realistic way to capture *multiple interpretations* and gain a holistic insight from a voluntary fire department [22]. Their emergency operations occur extremely spontaneously, and planned activities typically happen outside normal working hours of a researcher. The observation focus was on the digitalization project including related problems, solutions, opinions, facilities, processes, etc. Despite theoretical knowledge of extant acceptance models, we did not aim to verify certain factors or adoption phases. Instead, we aimed for an unprejudiced observation to identify novel aspects and enable *dialogical reasoning* based on our data [22].

Our observations were documented in multiple ways. The observer frequently took fieldnotes of project-related and otherwise relevant events, observations, talk impressions, etc. and collected them in a diary [38]. Due to the nature of a voluntary fire department

with spontaneous responses and sporadic “office hours” in the evenings, notes could not be taken daily but on a rather scattered timeline. Besides his own notes, the observer had access to all training and organizational resources of the department. These included, for example, the intended command setups displayed in Figs. 4 and 6 as well as official reports of trainings and responses. Finally, we also collected audio-visual resources in form of pictures and videos.

3.4. Data analysis

The goal of our research was to identify aspects influencing the digitalization of a voluntary fire department and, more precisely, the introduction of a new technology. For this, we aimed to tell a *Realist Tale* as categorized by Van Maanen [23]. To inductively derive insights from our data, we applied open coding techniques [39]. Related observations and resources were grouped to common concepts and labeled with speaking names. For example, the concept *revealing events* in section 4.1 combines multiple aspects. First, the observer personally witnessed the hectic situations and stressed impression of the involved firefighters in the referred events. Second, the decision-makers themselves told that these events “*made problems evident*” and “*opened our eyes*”. Third, official reports of the operations state the experienced problems and later training resources name them as the motivators for change. Like this, the identified concepts are based on combinations of the different resources and inductively identified.

To rule out possible biases resulting from the observer’s deep involvement (*suspicion*), the observations and derived concepts were frequently discussed with the non-firefighter co-authors [22]. In our analysis and the insights described in section 4, we focused on novel concepts that have not yet been described in related research. For example, the significance of *information format* and *system reliability* in the acceptance of ERIS have already been proven and were omitted [4]. The identified concepts could be further organized in the two overarching themes of *stages and triggers for technology acceptance* (section 4.1) and *characteristics of voluntary fire departments* (section 4.2).

To interpret the identified concepts, we built on several *contextualization* information [22]. Section 2.1 described the firefighter domain and firefighter information technologies in general. Sections 3.1 and 3.2 explained the observed department and its command support facilities in particular. For *abstraction and generalization* purposes, we tried to link our identified concepts to existing theory where possible [22]. To explain them, we integrated findings of various research disciplines. They illustrate the generalizability beyond the observed project and fire department. For the overall interpretation presented in section 5, we integrated the identified concept into an extant acceptance model [4]. The causal relationships between the newly added concepts and the existing constructs were derived via axial coding [39]. This procedure illustrates how the inductively identified concepts uncovered gaps in or contradictions to existing theory, which is in line with the principle of *dialogical reasoning* [22].

4. Key insights

During our observation of the Haßfurt Fire Department, we drew several insights from the command support digitalization project. On the one hand, they can explain certain stages and triggers of technology acceptance within a fire department. On the other hand, they comprise general characteristics of voluntary fire departments that may have an overall influence on their digitalization potentials. In the following, we describe our observations and discuss them in relation to existing literature.

4.1. Stages and triggers of technology acceptance

The adoption of information technologies can be seen as a process of multiple stages. Technology acceptance literature refers to the intention to use and the decision of actual usage as the main stages. Beyond this, the long-term use can be seen as the final stage of adoption. For all three stages, we observed specific triggers that were needed to reach the respective stage in the Haßfurt Fire Department. These are summarized in Fig. 7 and described in the following sections.

4.1.1. Revealing events

To trigger a fire department’s intention to use an ERIS, many incidences must convene. Typically, firefighters feel a rather strong resistance to change. They work in hectic, sometimes life-threatening situations and demand reliable technologies to support them. Therefore, many firefighters resemble true incarnations of the term *never change a running system* – unless it appears necessary. To illustrate such necessity, the personal experience of revealing events can serve as a major trigger. In the Haßfurt Fire Department, two such revealing events occurred. The first one took place on July 5th, 2015, when a heavy thunderstorm hit the city. Within an hour, the fire department got confronted with 107 simultaneous incidents. Without any dedicated command support structures and using paper

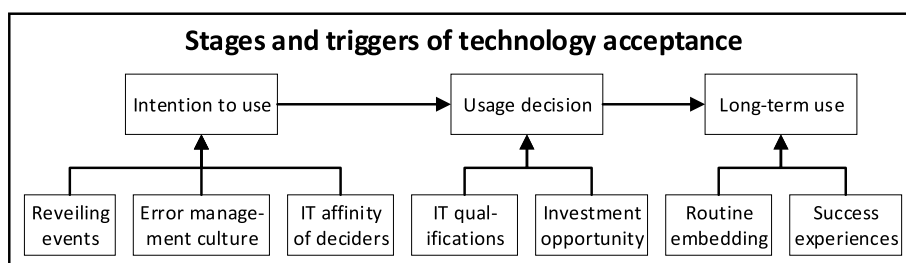


Fig. 7. Stages and triggers of technology acceptance.

or excel sheets, the department was completely overwhelmed by the situation. The second revealing event occurred on October 14th, 2017, at an apartment fire with two fatalities. During the operation, the incident commander had communication problems with his handheld radio. Without any on-site command support, he had to run from the incident area to his command vehicle several times to communicate important information with the control center.

These observations can add to a more holistic view of the intention to use technologies. The trigger of revealing events implies that firefighters learn best from their own experiences. This is in line with the educational theory of experimental learning [40]. Especially in safety critical domains like firefighting or police, extreme events revealing a need for change could be systematically provoked in trainings. On the one hand, this could trigger intentions in more departments and help disseminate innovative technologies. On the other hand, this could avoid revealing events during real operations where affected people could be harmed. We know of practical approaches to deliberately stress command staff during trainings. However, its interpretation as a trigger of intention to use technologies might add a valuable perspective. In terms of Venkatesh et al. [7], it would resemble an *event*.

4.1.2. Error management culture

To trigger the intention to use an ERIS, such revealing events must at the same time fall on the fertile ground of an existing error management culture. This is not given in every department, by far. Most departments are quite considerate about maintaining a nimbus of infallibility, especially in the eyes of the public. Therefore, mistakes will rarely be discussed or even mentioned in any public context. This appears insofar comprehensible that civilians must be able to blindly trust the firefighters in life-threatening situations of an emergency. However, many firefighters confuse this nimbus of infallibility with actual infallibility. They believe their own tale of doing all that is humanly possible to avert harm from the community and of negative developments always resulting from the situation itself – never from their own mistakes or misjudgments. This perceived infallibility is not only unrealistic. It is often an impediment to a working error management culture where mistakes can be admitted, analyzed, and conclusions can be drawn. In this respect, the Haßfurt Fire Department was a pleasant example. Those responsible did acknowledge own mistakes revealed by the before-mentioned events. They analyzed them and tried to bring about improvements.

A lack of error management culture can be an explanation for the frequently reported resistance to change in fire departments [21, 41]. In psychology, error management culture stands in contrast to error aversion culture and is supposed to improve overall performance [42]. Also, error management culture on organizational level will promote innovativeness on organizational as well as individual level [43]. In the firefighter domain, error management culture was shown to be related to lower accident occurrence rates while error aversion culture relates to a higher one [44]. Despite this evidence from psychology and safety science, we could not identify any study that examined error management culture in the context of technology acceptance. It may be integrated as an *organization attribute* and, due to the generalizable nature, enrich acceptance models in many different contexts [7].

4.1.3. IT affinity of deciders

The fact that the improvements of command support in Haßfurt included the intention to use an ERIS required a third trigger: a certain IT affinity of the deciders. Fire departments typically follow a rather strict hierarchy. Therefore, strategic decisions largely depend on the opinions of the respective chief and perhaps his/her assistants. Besides that, fire departments are organized at the communal level in many countries, which provides the individual chiefs with a certain freedom in decision-making for their respective municipality. In that sense, the organizational level and the individual level of technology acceptance will often become blurred in a fire department. In the observed case, the chief was used to working with IT from his job and aware of its potentials. Therefore, his intention was not only to modernize command support and assemble them as a task force. He also wanted to digitalize command support with a modern ERIS at the same time.

Such IT affinity of deciders appears to be closely related to the already established construct of computer self-efficacy [45]. The more interesting point here is the blurring of individual and organizational level effects. Due to the hierarchical structure of a fire department, many aspects heavily depend on few individuals. One could argue that this also applies to the before-mentioned error management culture, which is an organizational characteristic. Such culture must be wanted and exemplified by the command staff individuals to introduce and maintain it. While a fire department with its strict hierarchy may be an extreme case, mitigated forms of the described aspects can be found in business and other contexts, as well. As a construct, IT affinity resembles a *user attribute* but points toward the importance of cross-level effects [7].

4.1.4. IT qualifications

Once the fire department committed to the intention of using an ERIS, additional triggers seem necessary for the decision to actually use it. The department's team must have certain IT qualifications for the introduction of such a system. On the one hand, IT experts are needed to enable full-fledged operation. Luckily, the observed department does have such experts. They administrate all the necessary hard- and software in the command facilities and realized custom solutions like a VPN for remote data exchange. On the other hand, the prospective users of the ERIS should bring at least basic IT skills. With the typical firefighter rather being a craftsman than a theorist, this is anything but self-evident. In Haßfurt, most CSU members are familiar with computers from their everyday jobs. Only with these two team qualifications fulfilled, the observed fire department could decide to realistically integrate an ERIS into its command support.

The above observations can help understand firefighters' actual technology usage, which is rather unclear by now [4]. The necessity of certain IT qualifications includes multiple facets. First, a firefighter's confidence in using an ERIS may be described by established constructs like computer anxiety [46], computer literacy [47], and computer self-efficacy [45]. These might introduce factors that go beyond *effort expectation* or *ease of use*, which are typically considered in technology acceptance literature and precede usage intention. From our observation, they could rather be interpreted as specific *facilitating conditions* in terms of the UTAUT [5] or

user attributes [7]. Second, needed team qualifications constitute a special challenge for volunteer organizations. They are typically not free to choose their personnel or retrain them from scratch. The overall voluntariness aspect will be explained in detail in sections 4.2.5. and 4.2.6.

4.1.5. Investment opportunity

Another potential trigger for the usage decision typically lies outside the departments. In most countries, fire departments are financed by public means. Investments therefore require the approval of the relevant bodies. An ERIS comes with significant one-time and running costs. That alone was not a problem in Haßfurt. In the command center, it was only the ERIS itself and two computers that had to be added to the existing infrastructure. These manageable investments could be quickly implemented. However, in mobile operations, the ERIS could not straightforwardly be integrated in the existing infrastructure. The command vehicle at that time was an SUV without sufficient space for a computer workstation. The necessary procurement of a larger command vehicle could not be spontaneously implemented. In Germany, like most other countries, emergency vehicles are normally replaced at regular intervals. In Haßfurt this interval is between 15 and 25 years. Consequently, the integration of the ERIS into mobile operations was on hold until the end of the replacement interval. Only the investment opportunity for a new command vehicle enabled the usage of the ERIS here.

An investment opportunity as a usage trigger is another aspect that may complement existing literature. There are several approaches to integrate monetary views into acceptance models. They range from actual *cost* [48] to perceived constructs like *price value* [49]. However, we observed investment opportunities to go way beyond a mere amount of money. It can rather be interpreted as an external trigger that is a basic prerequisite for the technology usage. As such, it constitutes an *event* according to Venkatesh et al. [7]. Besides fire departments, this trigger may also be relevant for other public institutions and business contexts, where innovation must wait for predefined replacement intervals.

4.1.6. Routine embedding

Even if a fire department has purchased an ERIS, it is not yet a given that it will keep using it in the long-term. Two triggers may have enabled this in the Haßfurt Fire Department. Long-term use typically needs the technology's integration into user activities. However, users in a voluntary fire department have way less opportunities to use a new technology than typical fulltime employees. To still provide as many points of contact, it seems important to embed the technology in as many routines as possible. For this reason, in Haßfurt the ERIS is supposed to get used in every single emergency operation – even smaller ones where command support is not necessarily needed. Only this way and with frequent trainings, the CSU staff could get used to the system and gain experience with it. Over time, several process adjustments and change requests toward the vendor were identified by the team. Meanwhile, the team, the technology, and the process have quite well adjusted to each other.

While the factors leading to the punctual decision of technology adoption are well understood, the long-term interaction between users and technology has been researched far less extensively. One existing concept that could represent our observations is technology appropriation. It can be interpreted as part of a multilevel cycle. Following the adoption, a newly designed technology may be *explored*, *evaluated*, and *adapted* by its users. This appropriation can, in turn, deliver input for another design process [50]. By now, the decision if and how a technology gets appropriated, has mainly been addressed in a philosophical way. For example, the appropriation decision itself may be explained by Marx's dichotomy of human nature and his concepts of *perception*, *orientation*, and *appropriation* [51]. Technology appropriation strategies may be derived from cultural appropriation in the new world, including *baroquization*, *creolization*, and *cannibalism* [52]. The above-described, deliberate embedding of the ERIS into working routines may indeed be a factor fostering its appropriation. As such, it can be interpreted as an *organization attribute* and may be transferable to other contexts of technology usage, as well [7].

4.1.7. Success experiences

Besides routine embedding, a certain sense of achievement may be another potential trigger. Best suited seem personal success experiences. They can be interpreted as counterparts to the before mentioned revealing events. While the ones trigger the initial intention to use an ERIS, the others are needed to confirm the usage decision and motivate long-term use. In Haßfurt, several such success experiences occurred over time. One was a thunderstorm on June 22nd, 2019. The newly introduced ERIS and the adapted processes led to a much calmer and more structured working style compared to the revealing thunderstorm in 2015. For mobile command support, larger operations impressively demonstrated improvements, as well. A gas leakage in an industrial plant and a compartment fire in a hospital in 2020, fires in a dormitory and a production hall in 2021, and a barn fire in 2022 are just some examples. In all these cases, command support as well as command staff could experience the positive effects of the digitalization project first hand. This way, they stayed convinced and motivated to keep using the introduced ERIS on the long-term.

The observed success experiences can be interpreted as the demonstration of digitalization results. Such *result demonstrability* has been observed as an acceptance factor for other technologies or innovations, as well [53]. Even if expectations from the adoption get negatively disconfirmed over time, success experiences may still facilitate technology appropriation. The basic prerequisite seems to be that identified benefits must exceed experienced restrictions [54]. Despite some obstacles during the integration of the ERIS in Haßfurt, the success experiences frequently demonstrated the benefits. It was somewhat fortunate that there were emergency scenarios suitable to demonstrate the ERIS's benefits. As a compensation, success experiences could also be intentionally provoked in training situations. Nevertheless, experiences from real operations will be much more impressive for a firefighter. This might imply that larger fire departments with more frequent operations have a larger chance of result demonstration and can more easily appropriate new technologies. Success experiences can be interpreted as *events* [7].

4.2. Characteristics of a voluntary fire department

Besides the stages and triggers of technology acceptance, we observed some general characteristics of a voluntary fire department. These fundamental aspects significantly influenced the whole adoption process as well as the way the Haßfurt Fire Department uses the newly introduced ERIS. As summarized in Fig. 8, they include specialties of the emergency context, necessary cooperation scenarios, and aspects of voluntary structures. The factors resulting from these three are explained in the following sections.

4.2.1. Process flexibility

The context of emergency management comes with fundamental implications for the way fire departments can employ information technologies. It is important to understand that firefighters can rarely follow rigid processes. As many of them put it, no operation is like the other and deviations from the plan are the standard. Like the operation itself, the scope and type of command support can vary heavily and change spontaneously. Therefore, the Haßfurt Fire Department rather relies on flexible guidelines and checklists to integrate the ERIS in their operations. There are predefined positions in the command center and command vehicle, each initially assigned to one or more approximate task areas. Exemplary areas are *operation log documentation*, *resource overview*, *situational map*, *radio communications*, and *information gathering*. Depending on the operational situation, the task areas can be added, prioritized, skipped, or transferred between the positions. This enables the incident commanders to flexibly compile the command support they need and the CSU to flexibly react to the requests. The same applies to command structures that will be flexibly adapted to the respective operation by dividing it in sectors, assigning sector commanders and units to them.

Observing this flexible approach toward command support, we noticed analogies between emergency management and agile project management. As for example, emergency management follows an iterative approach. The command cycle of reconnaissance, planning, and issue of orders can be interpreted as a sprint known from scrum [55]. Each officer will repeat this cycle until the end of the operation. Frequent situation reports among commanding officers resemble daily meetings or sprint retrospectives. Moreover, an incremental approach can be seen in the prioritizing of tasks and the division of large operations in different sectors [55]. Another example are the visualization techniques that are comparable to a kanban board [56]. All commanding officers will detect, prioritize, and combat dangers using their assigned units. An ERIS can provide a visual overview of such dangers, their status, and assigned units. Given all these similarities, it is surprising that we could not identify studies that systematically compare the aspects of emergency management and agile project management. Such comparisons might potentially unveil new beneficial patterns that could be introduced into emergency response processes. As for example, Scrum Retrospectives typically encompass the questions „What went well? What could be improved? What did we learn? How should the next iteration look like?“. Adding such a structure might not only target potential threats such as perceived infallibility, but it would also help structuring and harmonizing meetings. Additionally, existing templates and/or tools from the agile project management domain could be introduced to document, visualize, and summarize the results of meetings. Following Venkatesh et al. [7], process flexibility resembles a *task attribute*.

4.2.2. Situational adaptability

Besides the usage behavior, the technologies themselves must provide a certain adaptability for emergency management. An old saying among firefighter is that *technology must follow tactics – not the other way around*. The ERIS employed by the Haßfurt Fire Department indeed offers many degrees of freedom. All functions are grouped in independent modules that can be used in any order and combination. Default values for units etc. can be pre-set but also overwritten at runtime. An important factor we could witness was the system’s ability to situationally adapt with growing up operation structures. Even large-scale operations, of which some were mentioned in section 4.1.7., typically started with few units on site and evolved from this initial state. On the one hand, the scope of command support will grow. Therefore, the ERIS must support the transition from single-user to multi-user operation. On the other hand, the number of responding units will grow and they will get organized in sectors and subsectors. The ERIS must be able to digitally map this actual command structure. In both aspects, only minor optimization potentials were identified in Haßfurt.

The described requirements can be interpreted as direct consequences of the established situation awareness theory [2]. Incident commanders must comprehend the situation and act according to it. Therefore, ERIS supporting them must be adaptable to the situation, as well. Modern ERIS can indeed follow tactics in the sense that highly diverse situations can be mapped in them. Strictly following tactics, however, they cannot prevent tactical fails. For instance, we observed that the transition between different levels of command is a special challenge. The incident commander must recognize the right moment to expand the command support while simultaneously commanding an escalating operation itself. An ERIS automatically suggesting a higher command level or the distribution in sectors based on parameters like the number of responding units might effectively increase situation awareness. Thereby, it

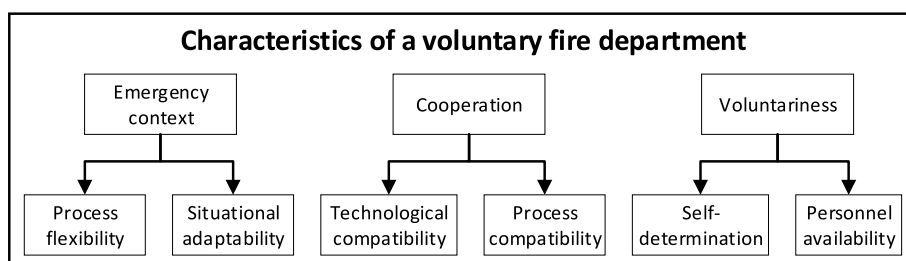


Fig. 8. Characteristics of a voluntary fire department.

would not only follow tactics but support it. Such decision support systems have already been proposed by literature [17,18]. While the practitioners seem to be more and more open toward such approaches, they still fear too excessive interference in their work. Therefore, automation in incident command remains a delicate subject. As a system characteristic, situational adaptability resembles a *technology attribute* [7].

4.2.3. Technological compatibility

Firefighting is always teamwork. In smaller operations, the team is limited to a single fire department. In larger operations, multiple departments, as well as other emergency organizations, must cooperate to ensure overall success. Despite that, state or federal standards ensure the compatibility of tactics and technologies only in certain areas. Regarding means of command support, the German service regulation on incident command merely lists exemplary solutions. Since fire departments are organized at the communal level, each municipality can decide for itself, if and which ERIS gets used. Due to missing interface definitions, no data can be exchanged between the ERIS of different providers. This particularly affects the creation of situation awareness at a higher level. In Haßfurt, the CSU of the county luckily uses the same ERIS as the Haßfurt Fire Department. This at least enables data exchange between these two levels. However, to pass it on toward the state level, data must be manually transferred into another software. Also, data exchange with the regional control and dispatch center takes place almost exclusively via e-mail. Around Haßfurt, most other municipalities employ paper-based solutions for command support, which excludes data exchange from the start. Summing up, fire departments only occasionally benefit from easy data exchange and aggregation as major advantages of IT solutions like ERIS.

There are various aspects to be drawn from these observations. First, emergency organizations must be able to employ information technologies, at all. To assess their maturity in this area, literature defined several metrics [20]. Second, being able to adopt an ERIS, the departments must actually do so. Factors deciding usage intention and actual use have been described in section 4.1 and in related work [4]. Among them, easy data exchange can be interpreted as a significant advantage compared to paper-based solutions. Finally, interfaces and exchange formats must ensure compatibility of the used systems. Even for this, there are already some suggestions in the literature [57,58]. Exemplary studies demonstrate the potentials of compatible systems in emergency organizations [15]. Overall, most problems and solutions regarding technical compatibility appear theoretically well understood. What is still largely missing is the practical implementation of existing knowledge. As a construct, it resembles a *technology attribute* [7].

4.2.4. Process compatibility

Even assuming technological compatibility, there remain cooperation obstacles. To effectively work together, a common process or at least understanding of the ERIS usage should exist among all stakeholders. As pointed out, the Haßfurt Fire Department defined and frequently trains a basic framework of task areas. While such guidelines are far less structured than a fully defined process, they still ensure a common understanding. As a contrast, a neighboring department's CSU works without any guidelines and solely relies on the ERIS's intuitive operability. This works well with single users. In multi-user scenarios, especially when cooperating with users from other departments, the individual intuitions will collide. The common understanding must then be established at runtime during the emergency operation. Beyond that, the before-mentioned data exchange is not only a technological but also an organizational challenge. For example, remote data exchange in the ERIS used in Haßfurt only works offline or within a VPN. The technologically possible exchange between different departments would require the organizational measure of introducing a unified VPN on county or even state level. Without it, the current form of exchange is to punctually export the incident data in one command vehicle to a USB drive and import it in the other command vehicle.

Regarding the process compatibility of different departments and organizations, we already elaborated on the analogies between emergency management and agile project management in section 4.2.1. Like in agile projects, contents develop iteratively and incrementally, but every team member must know and acknowledge the employed frameworks. However, frameworks in emergency management are often abstract and only briefly mention the use of modern IT [10]. More detailed organizational standards for information processing and sharing would be needed to achieve process compatibility. Additional enablers of interorganizational data exchange proposed in related work include incentive mechanisms, fair benefit distribution, understanding of the other organizations, ease of use, and the integration in daily routines [59]. Overall, the interoperability of ERIS is seen as a mainly organizational rather than a technological challenge [60]. This organizational challenge should be tackled at the highest possible instance to achieve state-wide or even federal compatibility. A starting point could be to identify the needed scope and quality of information from and for each involved organization [61]. Our German example showed highly diverse organization levels (fire departments on communal, emergency medical service on county, police on state level). This alone appears to be a huge problem, resembling an *organization attribute* [7].

4.2.5. Self-determination

Among the different emergency services, fire departments have an even more special position in many countries due to their voluntary structures. This significantly influences if and how a fire department can adopt technologies like an ERIS. On the one hand, voluntariness holds the great opportunity to gain expert knowledge of various domains at zero cost. For example, the Haßfurt Fire Department has several IT and electronics graduates in its ranks. With their help, parts of the ERIS, the surrounding infrastructure and processes could be customized according to the department's needs. On the other hand, it is all the more important to awaken and maintain the firefighters' motivation. In a voluntary fire department, opposed to business contexts, extrinsic regulations like money or sanction threats are unsuitable for motivation purposes. The firefighters do their service as a hobby and typically seek fun, team spirit, and self-realization with it. These are consequently the much better motivators in this domain. The Haßfurt Fire Department tries a playful approach by emphasizing the analogies between using an ERIS and playing a video game. Furthermore, it tries to promote a feeling of perceived importance regarding the newly shaped command support. The CSU is referred to as a special task force and the

achievements of the new processes get frequently presented to the entire team.

An established psychological concept to explain different forms of motivations can be found in Self-Determination Theory [62]. Following its taxonomy, voluntary fire departments constitute prime examples for the need of intrinsic motivation. This accounts to the described aspects of fun and joy. The aspects of perceived importance and team-spirit can be interpreted as extrinsic motivators. However, in contrast to salary, Ryan and Deci [62] still see the source of these motivators as internal. The resulting high degree of self-determination can foster engaged use of technologies [63]. Of course, a fire department with entirely voluntary structures may be an extreme case. But to a certain degree, the aspects of motivation and self-determination are transferable to any other domain, also in business contexts. According to DeLone and McLean [64], “no system use is totally mandatory.” Users will typically be able to find workarounds or, in sectors with labor shortage, simply refuse or quit. Therefore, paid users should also get motivated and not forced to use the intended technologies. Regarding ways of motivation, all kinds of organizations can draw inspiration from our exemplary voluntary fire department. We interpret self-determination as an *organizational attribute* according to Venkatesh et al. [7].

4.2.6. Personnel availability

Voluntary structures typically come with a set of natural limitations like limited personnel availability. With the firefighter service being a hobby, the firefighters will be engaged with their main occupations during the office hours. Plannable activities like trainings or the before-mentioned ERIS-customizations must be done during free time in the evenings or weekends. This alone limits available times in a voluntary department compared to professional departments or any ordinary business context. Even for emergency operations, it is anything but certain that every needed firefighter can leave their workplace to respond to the call. Especially the above-mentioned experts often commute to neighboring cities or are engaged in management obligations. Consequently, employed technologies and processes must be manageable for ordinary firefighters, or in this case any CSU member, with limited time of training. The Haßfurt Fire Department considered this in two ways. First, intuitive handling was an important selection criterion when purchasing the ERIS. Second, the guideline-based usage with prioritizable task areas can help keeping complexity low. Certain task areas are defined as necessary, and any CSU-member must be able to manage them on their own. Others are defined as optional and can be omitted if necessary.

Several studies examined the voluntary use of technologies on the individual level. Technology acceptance in wholly voluntary organizations, however, has seen little research. Existing literature emphasizes the special characteristics of voluntary organizations [65,66] and describes reasons for their failure in technology appropriation [67]. The researched organizations (churches, historical societies, etc.) have certain aspects in common, like limited time or heterogeneity of volunteers. What distinguishes a voluntary fire department from other voluntary organizations is the spontaneity of emergency operations. This circumstance intensifies certain issues like personnel availability. However, we could not identify any study researching the specific aspects of a voluntary emergency organization in technology acceptance. The observed focus on technologies’ ease of use in fire departments is in line with existing literature [4]. The before-mentioned agility in the command process can be seen as another measure to ensure ability to act even with limited personnel availability. Several other limitations and solutions of voluntary organizations combined with the emergency context could be identified by specialized studies in the future. Like personnel availability, they will resemble *organization attributes* [7].

5. Interpretation of results

The paper at hand raised the question which determinants guide the digitalization of a voluntary fire department and which factors determine the acceptance of ERIS by firefighters. We described several observations gained during an extensive ethnography and discussed each of them in the context of existing literature. In this section, we interpret the contribution of our results to answering the initial research questions. We also elaborate on their implications and describe remaining limitations.

5.1. Determinants guiding the digitalization of a voluntary fire department

Our study took the digitalization of command support in the Haßfurt Voluntary Fire Department as an example. This project’s key element was the adoption of an ERIS as a novel technology and its integration into the command process. We identified three stages of adoption. For each stage, we found specific triggers of which some appear completely unexplored in the context of technology acceptance. We observed that usage intention may be triggered by revealing events as firefighters’ personal experiences. At the same time, there should be an organizational error management culture and individual IT affinity of few deciders in place. The decision to actually use an ERIS seems dependent on appropriate IT qualifications among the department members and the external event of an investment opportunity. Finally, the long-term use of an ERIS may be consciously facilitated by organizationally embedding it in routines and affirmed by occurring success experience events.

Beyond the mere adoption triggers, we identified overarching characteristics of a fire department that must be considered in their digitalization. First, fire departments work in the context of emergency management. The task calls for highly flexible or agile processes and employed technologies must be able to situationally adapt to these processes. Second, firefighters frequently cooperate with other fire departments or emergency organizations. Therefore, the used technologies themselves, as well as the organizational process of how to use them, should be compatible among departments. Third, fire departments are a special case even within the emergency domain, due to their mostly voluntary structures on the organizational level. This calls for a high degree of self-determination as a key motivator but also comes with specific limitations, especially regarding personnel availability.

Overall, our study identified 13 novel aspects that can complement extant literature. As pointed out in section 2.2, one of the few related works tried to explain technology acceptance by firefighters with an UTAUT-based acceptance model [4]. The model integrated

several technology attributes as antecedents of the UTAUT constructs, based on the ideas of Wixom and Todd [6]. It could reasonably well predict a firefighter’s intention to use an ERIS. However, actual usage was measured as a punctual decision and could be predicted only weakly. Beyond technological antecedents, there is a call to complement the UTAUT with new conceptions of technology use and a higher degree of contextualization [7]. This state of the literature has been summarized in Fig. 2 before. Based on this, Fig. 9 adds our insights in the different areas of contextualization. Following the interpretations of section 4, they added several contextual factors regarding events, organization, technology, task, and user attributes. As a new conception of acceptance and use, we identified determinants for appropriation.

Besides ERIS as a specific technology, many of our insights may also be transferred to other technologies that are intended for the use in emergency operations, like unmanned aerial vehicles or smart protective equipment. Especially the overarching characteristics of a voluntary fire department have a generalizable nature and may be transferred to virtually any kind of digitalization in this specific domain. Taken together, the discovered aspects provide a comprehensive overall picture. They cover several perspectives of technology, process, and personnel.

5.2. Implications for practice, policy, and academia

This study holds direct implications for several practical areas. For the fire departments, the implications can be described in the context of their old saying that *tactics without technology are helpless, technology without tactics is pointless*. On the one hand, digitalization provides fire departments with new technologies that support them in their tactics. We described how an exemplary department adopted a novel ERIS to improve their command support. The observed and explained practices can act as an inspiration for other departments facing similar challenges. On the other hand, novel technologies can only be effective, if they get suitably integrated into

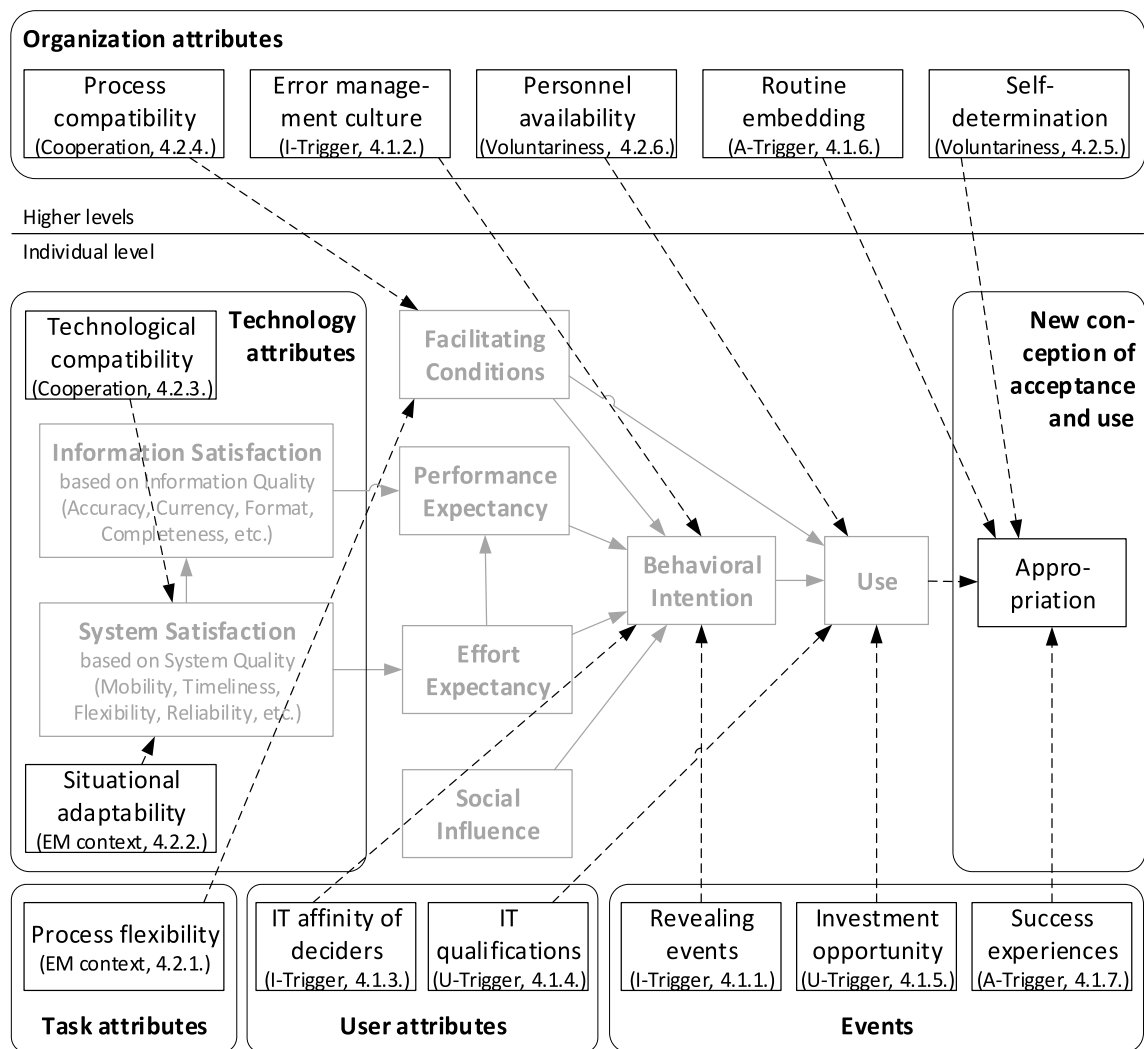


Fig. 9. Allocation of results in extant literature (I-Trigger = Intention trigger; U-Trigger = Use trigger; A-Trigger = Appropriation trigger; EM context = Emergency context).

an organization and its processes. Therefore, we derived several triggers of technology adoption as well as general characteristics of a voluntary fire department. Both must be considered if a novel technology like an ERIS is supposed to be used in a voluntary fire department. Besides fire departments, the provided insights can also be relevant for the vendors of digital technologies. They can use our study to better understand the firefighter domain and its special characteristics to provide better-matching technologies. Beyond voluntary fire departments, the findings may, to varying degrees, also be transferred to professional fire departments, other emergency organizations, and institutions of critical infrastructure. Several aspects, like situational adaptability, error management culture, and routine embedding appear applicable to a wide range of high reliability organizations.

Politically, our study can provide implications for the digitalization and overall strengthening of voluntary fire departments. Decision-makers can consciously pull the triggers of technology acceptance that our study identified. For example, they can install training programs to actively provoke revealing events and awaken intentions to use novel technologies. To accelerate their diffusion, they can promote acquisitions apart of anyway existing investment opportunities. Such measures may foster the digitalization of fire departments. We also identified starting points to increase the efficacy of used technologies. Amongst them is the necessity to define universal interfaces for technologies like ERIS on the state, federal, or international level. This would ensure interoperability of different systems and allow data aggregation for situation awareness on higher command levels. While all these aspects account for all kinds of fire departments, our study also provides insights specific for voluntary ones. Policy may use them to help mitigate the natural limitations of voluntary emergency structures. They especially call for improved personnel availability and increased research of the topic. Again, many of these implications can be partly transferred to other emergency organizations and voluntary associations.

As academical implications, we complemented existing research on digitalization, technology acceptance, and firefighter information technologies. Up to now, there remained many uncertainties regarding the usage of novel technologies in fire departments [4]. The study at hand addressed this literature gap by conducting an extensive ethnography within this special domain. We could exploratively identify several additional determinants of digitalization and provide rich insights into their respective backgrounds and roots. In the interdisciplinary tradition of information systems research, we could explain many of our observations using knowledge from other disciplines. Among them were educational theory (experimental learning), safety science (error management), sociology (appropriation), project management (agile methods), and psychology (self-determination). However, despite their prominence in other fields of research, many of the identified aspects have not yet been considered in the context of digitalization and technology acceptance. On the one hand, these newly gained insights may complement existing acceptance theories and raise the understanding about why firefighter do or do not employ novel technologies [4]. This also answers existing calls for research regarding the increased contextualization of UTAUT and the identification of novel acceptance factors [7]. Despite context-specificity, some of the discovered factors may also be transferred to other domains. Examples include public institutions (investment opportunities), voluntary organizations (personnel availability), high reliability organizations (situational adaptability), and arbitrary business contexts (revealing events). On the other hand, our results provide several starting points for future research. Within the firefighter domain, the similarities between agile project management and emergency management call for more detailed research to identify interdisciplinary insights. Outside the examined domain, error management culture may be examined as an acceptance factor in virtually any other context. These are but two of the many literature gaps identified by this study and waiting to be filled.

5.3. Limitations

Despite valuable insights, the results of our study should be considered in the light of certain limitations. Our observation covered multiple years but was mostly focused on a singular voluntary fire department in Germany. This can be seen as a natural drawback of ethnography as a methodology, which is especially suited to derive in-depth insights but lacks breadth [38]. While we also had limited insights in neighboring departments, the study cannot account for international variations. While many other countries like the United States and China at least have comparable voluntary firefighting structures, our insights might be less transferrable to countries that build primarily on career structures. Additional insights are needed to verify our results in such contexts. As another limitation, we took command support and ERIS as an exemplary process and technology. Our results might not be straightforwardly transferrable to arbitrary processes or technologies within a fire department. Finally, one of the authors was deeply involved in the observed department and its processes. This was the only realistic way to enable in-depth observations but held the dangers of subjectivity and influencing. We tried to ensure objectivity by following established rules of ethnographical research.

6. Conclusion

Digitalization and technology acceptance in the firefighter domain remains a rather unexplored, yet relevant field. The ethnographic insight provided by the paper at hand can help illuminate it and establish an increased contextualization of existing acceptance theories. With 13 novel aspects, we identified approaches to explain under which circumstances firefighters will adopt an ERIS and which determinants will guide digitalization in the domain. The results hold several theoretical and practical implications and can serve as starting points for various future research endeavors.

CRediT authorship contribution statement

Julian Weidinger: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Sebastian Schlauderer:** Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization. **Sven Overhage:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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