Digital Innovation based on Digital Signage: Method, Categories and Examples

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Abstract. Delivery of demand-oriented and accurate information for a person's interest has been subject of research since many years. In the last years, focus of attention shifted from just-in-time provision of information to context-oriented personalized information supply. Digital signage is one way of context-oriented information supply and summarizes information presentation to a wide audience on large screens. Work presented in this paper brings together technology-oriented work in digital signage and application-oriented work in the housing industry. More concrete, we developed new digital signage solutions connected to elevators and investigate their potential for providing innovative services to tenants in apartment buildings, i.e. in the housing industry. The main contribution of this work is (1) an overview to innovative digital signage solutions connected to elevators, (2) the categorization of assistance services in the context of digital signage, and (3) application example from housing industry.

Keywords: digital signage, digital innovation, assistance service, housing industry, elevator.

1 Introduction

Delivery of demand-oriented and accurate information for a person's interest has been subject of research since many years in various areas in the field of business information systems research, such as decision support systems [1, 2], ubiquitous computing or information logistics [13]. In recent years, the focus of attention shifted from just-in-time provision of information to context-oriented personalized information supply, i.e. to capture and interpret the context of a person and refine the information supply accordingly. However, what context-orientation is and how it can be implemented depends on the application field and the technical means of information supply.

The information presentation to a wide audience on large screens (Digital Signage [3, 4]) is one way of information supply and quite popular both in publicly accessible places (fairs, shopping centres) and places available to a clearly defined and limited

group of persons (industrial facilities, office buildings). Digital signage can be used for different kinds of information, like, e.g., commercials, general information about the location for orientation purposes, safety-related information or information directed to individuals or groups of people. In the case of providing targeted information not to one particular person, but to a group, several problems arise. Information might be confidential and cannot be displayed without exactly knowing the audience, it might be difficult to identify the joint interest of a group of persons, or the presentation of certain information might require authentication of persons – to name only some examples.

From a technical perspective, there are no solutions for personalized contextual information supply with digital signage available, although the market potential of such "targeted" digital signage is promising, which is illustrated in an industrial case in this paper. From a research perspective, more work is needed both on technical aspects and on methodical issues regarding business models and contributions to digital innovation.

Work presented in this paper brings together technology-oriented work in digital signage and application-oriented work in the housing industry. More concrete, we developed new digital signage solutions connected to elevators and investigate their potential for providing innovative services to tenants in apartment buildings, i.e. in the housing industry. Due to this combination, we are able to study the process of both, technology development and digital innovation and business model development. From a methodology perspective, the digital innovation process is performed in accordance to the Digital Innovation and Transformation Process (DITP), a method proposal proposed in previous work [14].

The research focus of the paper is on categorizing digital signage solutions and on evaluating and improving DITP. The main contribution of this work is (1) an overview to innovative digital signage solutions connected to elevators, (2) the categorization of assistance services in the context of digital signage, and (3) application example from housing industry.

The paper is structured as follows: Section 2 describes the background for our work from digital signage and digital transformation and innovation. Section 3 briefly summarizes the research method used for the work. In Section 4, the industrial case and the digital signage solutions for elevators are presented. Section 5 describes the categorization and discusses lessons learned. Section 6 summarizes the paper and presents future work.

2 Background

2.1 Digital Signage

The term digital signage (DS) denotes "a system that transmits information using electronic display devices connected to the network at all places, such as outdoor, shop front, public space, transportation facilities" [6]. Related terms used with similar meaning are pervasive display or digital-out-of-home (DOOH). Taniguchi [7]

provides a comprehensive survey of literature in the field of DS. Important work streams in this area include:

- Application fields of DS and their characteristics, such as corporate communication [8],
- Technology developments and technology applications, such as touchless tactile display [9]
- The effects on user attention and behaviour [10],
- Back-end services and their architectures [11], or
- The impact of digital signage use in different application fields, such as retail [12].

The analysis of existing work in the field shows that technologies such as large screens or touch monitors are frequently used in DS solutions but – with exception of [5] – there is no published work on DS solutions connected to elevator infrastructures, which encourages our work in such devices and solutions presented in section 4. Furthermore, the specific situation of individuals or groups waiting in front of an elevator door and the applications resulting from this situation so far have not been investigated in research from the perspective of innovation potential.

2.2 Digital Innovation and Transformation Process

In previous work, we proposed a digital innovation and transformation process (DITP) in combination with the qualification profile of "digital business architect" (DBA) as an acknowledgement of the importance to integrate business model innovations into the established enterprise architecture of the company under consideration [14]. In this paper, the DITP will be applied and briefly introduced in the following, whereas the DBA is not discussed.

The DITP is supposed to support enterprises in digital transformation and innovation processes. DITP can typically be applied in the following scenarios:

1. An existing enterprise is facing new product-related, customer-related and/or competitive challenges caused by digitalization and needs to react promptly.
2. A start-up company aims to implement a new business concept.
3. An established company has no urgent need of action regarding a digital transformation but is interested in exploiting its digital potentials and thus in improving or expanding business accordingly.

The overall DITP process triggered by these scenarios is illustrated in Figure 1 and aims at tackling business-model and architecture-related problems. In the following description of DITP, we will focus on scenario 3 only, as this is the most adequate for the industrial case considered in section 4.

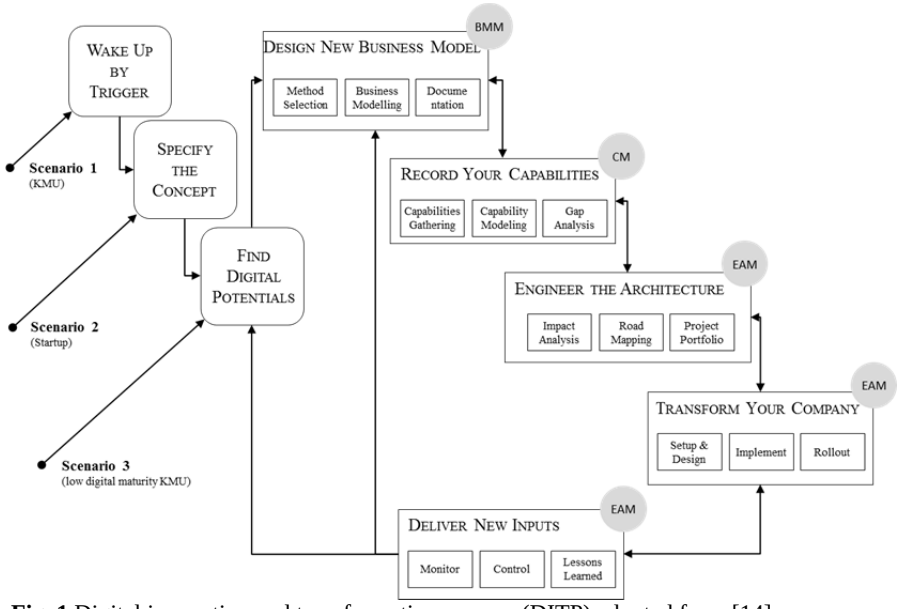

Fig. 1 Digital innovation and transformation process (DITP) adopted from [14].

The phase ***„Find Digital Potentials“*** focusses on the analysis of digital trends and potential building blocks for implementing innovations and transformations in the business. This phase is divided into the activities *DITP2.1 Research of digital trends/building blocks (for example by using Gartner Hype Cycle* [18] or *Technology Radar* [19]) and *DITP2.2 Evaluation of digital trends/building blocks.* Examples for building blocks are *automation, digital accesses* (social networks, apps, etc.), *interconnectivity and exchange* (broadband, IoT, Cloud), *artificial intelligence or data* (big data, blockchain).

The next phase includes the modelling of the business model ***„Design New Business Model“***. Different approaches can be used for modelling according to personal preferences or the requirements of the project [16, 17, 23, 24]. In general, three activities have to be performed: *DITP3.1 Choice of business modelling approach, DITP3.2 Modelling of the business model, DITP3.3 Visualization of the business model & documentation*.

The phase of ***„Record Your Capabilities“*** has to focus on the question *“What capabilities are needed by the company to implement the developed business model?”*. Capabilities [22] are considered as missing link between business units and IT and therefore support the business IT alignment. The Capability Management Guide supports the identification, the structuring and the management of capabilities [15]. Three activities have to be carried out: *DITP4.1 Collection of required and existing capabilities, DITP4.2 Capability modeling, DITP4.3 Gap analysis and adaptations*.

In the phase **„Engineer the Architecture“**, the future enterprise architecture model is defined by means of the detected capabilities and the present architecture. The aim of this phase is to draft an enterprise architecture model (EA) including the required architecture objects and their dependencies. In this context, we propose the

following activities: *DITP5.1 Choice of an approach for the impact analysis, DITP5.2 Development of the enterprise architecture including roadmap for integration, DITP5.3 Project portfolio for the implementation*.

The phase ***„Transform Your Company“*** focusses the activities *DITP6.1 Project set up, DITP6.2 Implementation and DITP6.3 Roll out* of the EA in the enterprise. The planning of strategic initiatives and/or single projects provides the framework for the following change measures and the implementation of the planned EA.

One of the most important functions of the final phase ***„Deliver New Inputs“*** is to safeguard the digitalization objectives. In order to monitor the implementation of digitalization objectives within the entire enterprise and the changes related to it, enterprises have to determine suitable indicators to be sustained by a corresponding data base [24].

3 Research Method

The primary research method used in our work is qualitative case study research. Qualitative case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources. This ensures that the subject under consideration is not explored from only one perspective, but rather from a variety of perspectives which allows for multiple facets of the phenomenon to be revealed and understood. Yin differentiates various kinds of case studies [25]: explanatory, exploratory and descriptive. The case study presented and discussed in section 4 can be classified as exploratory, i.e. we explore digital transformation process in its organizational context. As focus of the case study, we decided to address the innovation potential of digital signage solutions and the DITP use. More concrete, the case study explores the following questions addressing the perspectives:

RQ1: What digital innovation potential in housing industry exists from the perspective of data-driven services for tenants?

The primary focus of the case study is on understanding the innovation potential. In this context, the term “data-driven” services denotes in our work that the value proposition offered to a target group is to a substantial part based on collecting, analyzing and applying data.

RQ2: How can digital signage support this innovation potential?

The focus on digital signage is based on the intention of the case study company to evaluate the options created by this technology.

RQ3: How can the DITP support the digital innovation in the industrial case and what implications does the have for the DITP?

The secondary focus of the case study is on evaluating the DITP.

In the case study, we so far analyzed documents of the case study company, formed a focus group and performed interviews. More details are given in section 4 when introducing the case study company and discussing the results.

4 Industrial Cases

4.1 Housing Industry: EDS solutions “Doorshow” and Black-board

The industrial case is a housing company owning and operating more than 200 residential buildings with 36.000 flats. Although many technological innovations were proposed for housing industries, a lot of innovation potential remains in this area. Smart buildings, ambient assisted living and smart living are only some of many examples connected to introducing digital technology and IT into apartment buildings and flats. The area not yet sufficiently explored by research and industry is the possibility to integrate the business processes of housing companies with the processes of their suppliers and partners (e.g., for maintenance of buildings or facilities) and to offer additional services for the tenants as part of the buildings’ infrastructure (e.g., individual assistance services or logistics services). Such services are part of the digital innovation in housing industries and subject of research in our project.

The current focus of the project is to explore and specify what services will be of value for the tenants and at the same be promising for the housing company. For selected services, we build prototypes and conduct acceptance tests. The main objective of the company is to improve comfort for the tenants and attractiveness of the buildings without charging extra for the services. Digital signage solutions, such as the elevator related products presented in the following, are a potential technical basis for the new services.

The technical solutions used in the industrial case resulted from cooperation with one of the market leaders in producing and operating elevators and escalators. This company with more than 100 years of history opened a new “digital” business line including elevator digital signage (EDS) solutions. The EDS builds upon a technical infrastructure available in all modern elevators which is independent of EDS: in the elevator shaft there is a data communication facility connecting every elevator cabin with a communication device on top of the shaft to the maintenance unit in the back-office. The data transmitted to the back office includes real-time sensor information and statistical data which are used for preventive maintenance and fault diagnosis purposes.

With this communication facility installed, also the EDS can be connected to the back office. The elevator manufacturer has detailed knowledge who operates the elevators and what kinds of users (i.e., target groups) are frequently using the elevator. This makes the EDS an interesting option for marketing campaigns or presenting information relevant for the organizations or individuals in the building. From a technical perspective, there are three main EDS devices:

- The “doorshow”, a short-distance data projector mounted above the elevator door from the outside. For an individual or a group waiting for the elevator, this projector can display content on the elevator door.
- The interactive doorshow, which adds gesture recognition to the conventional doorshow. Persons waiting for the elevator can navigate through the displayed content by using gestures (see fig. 2).

- The black-board which is a shock-proof touch screen mounted on the side of the elevator door (again from the outside) (see fig. 3). The black-board is equipped with various sensors (RFID, NFC, camera, etc.) which potentially could be used to identify the person waiting or to collect context information.

Fig. 2. EDS device “interactive doorshow” in use: advertisements on elevator doors

Fig. 2 shows the EDS in use providing the digital service of advertisements on elevator doors (demonstrated on Hanover Industrial Fair in April 2017). The elevator with the advertisement is visible on the right of the Figure with the short distance projector mounted above the door. The person in the centre of the picture (arm raised above his head) demonstrated the gesture recognition possibilities of the service to the visitors on the stand.

Fig. 3 shows a snapshot of the black-board EDS solution. The blackboard software so far primarily supports two “roles” meant to represent stakeholder groups: tenant and facility manager. For supporting individual processes and demands of tenants, in the first step an import of the tenant’s profile information is foreseen.

4.2 Personalized information on in-company screen

Another solution independent from the actual elevator digital signage case is based on the usage of information screen installed in company offices and aimed at utilizing possibilities related to presence of multiple people next to a digital signage screen to provide for personalized information based on the interests and preferences of these people. The complete developed framework can be split into three major components:

viewer detection system, annotated content storage and content management system (fig. 4).

Fig. 3. The black-board as demonstrated at Hanover Industrial Fair in 2018.

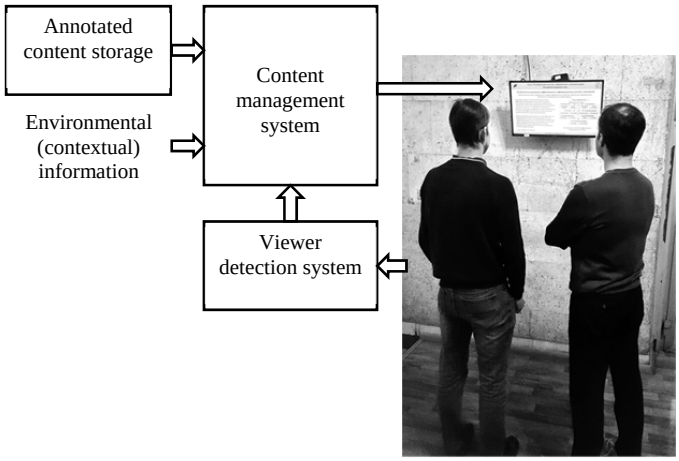

Fig. 4. The framework of the targeted digital signage system.

The viewer detection is based on the application of the WiFi technology. It is currently integrated into most of portable electronic devices. Though technologies of in-door positioning via WiFi are not precise enough without usage of additional complementing technologies, it is still possible to identify if the signal source is really close (in the range of couple of meters) to the receiver what meets the requirements of the research. Unlike WiFi, Bluetooth can only be used if it is either switched on in a discoverable mode (which is unlikely), or the personal device is paired with the scanning device (also not very likely due). Identification of viewers via face recognition through a camera photographing the space in front of the digital signage is

a complex task that requires additional research and it was not considered in the frame of the presented work.

The annotated content storage is a database storing the information pieces to be shown with tags that relate it to particular persons (e.g., Nikolay Shilov is asked to visit the HR department), positions at the company (e.g., an announcement to all product managers), and environmental conditions (e.g., announcements related to upcoming week).

The content management system is responsible for integration of the environmental information (the context) including time, day of the week, weather, etc., the information about digital signage viewers and available content from the content storage.

When information is presented to a group of people the confidentiality issues become important. However, since we consider a limited community (company employees), some shared information related to the company or department can be distributed. An example of such information can be an upcoming meetings with their times and locations, exhibitions, success stories or new software tools used.

5 Case Work and Results

In the industrial case presented in section 4.1, we studied the work on identifying digital innovation potential using EDS. This section first describes the DITP use for this purpose and afterwards investigates lessons learned regarding the research questions defined in section 3.

5.1 DITP use and categorization of services

In the housing company a focus group with managers of residential buildings and service process owners was established. This was the starting point for the “find digital potential” phase of DITP. Topic of the focus group was the digitization and innovation potential of tenant services. The focus group started by developing a list of stakeholder groups of relevance for digitization and of potential relevance for implementing innovations. Examples for stakeholder groups identified by the focus group are tenants (grouped according to different phases of their work life, e.g., students, works in shifts, retired, …), the housing company (again in different groups, like facility managers, administration, …), logistic service providers (mail, transport, delivery), personal service providers (hair dresser, medical personnel, …), relatives and friends to tenants.

With the stakeholder groups defined, an interaction matrix was created showing all stakeholder groups on one axis as potential recipient of value offerings and on the other axis as providers of value creation. In the cells of this matrix, potential value exchange was positioned. Example: the housing company might offer an additional service to tenants to allow logistics partners to deliver parcels to the tenants at a safe facility in the building. This service could be supported using the EDS by displaying the information to the tenant as soon as he/she returns to the building that a parcel arrived and how the access is possible.

More rewarding than the interaction matrix was the discussion of individual processes for the stakeholder groups and how they could be supported, i.e., individual process assistance. A simple example would be a tenant on his/her way to work could receive an information while waiting for the elevator which bus line close to the building would arrive next and to what bus stop to go. This information is only possible if it is known that the "process" of the tenant is "go to work", where the work is and that riding the elevator is part of the way to work.

The next phase of DITP is on designing the new business model. As a starting point, based on the interaction matrix and the individual process analysis, a list of potentially interesting services, required information and expected user functionality was derived. Furthermore, one of the results of the focus group work was the differentiation of services for tenants regarding (a) information or process assistance and (b) individual or organizational assistance. As a precondition for describing these assistance categories, we have to define the terms process, context and situation:

- A process is a sequence of activities aiming at achieving a defined purpose.
- Context consists of context elements; each context element captures information about defined aspects or factors required for providing assistance.
- Situation is the status of all context elements at a certain point in time.

The assistance function categories are as follows:

- Individual assistance is directing to providing information relevant for the situation of an individual,
- Organizational assistance is directed to providing information to an individual relevant for the situation of an organization,
- Process assistance is providing information in time for supporting the activity at hand.
- Information assistance is providing information relevant for the actual situation (of an individual or an organisation)

Table 1 shows examples for individual/organizational and information/process assistance.

Table 1: Categories of EDS services with examples

	Information Assistance	**Process Assistance**
Organisational Assistance	Information to employees about the closest restaurant with free capacity for lunch	Guiding technicians to the next device defined in a maintenance process
Individual Assistance	Information to person about the fastest public transport option to the target location	Guiding a person to the office in the building where the next step in applying for a permit can be done

From a research perspective, our conclusion is that the value propositions originating from the analysis of individual and organisational processes are of particular interest for business service design.

Another part of the "design new business model" phase is to evaluate the identified technical building blocks for implementing innovative services. In the case

study, the EDS devices presented in section 4 are of particular interest. For individual assistance, both information and process assistance, an identification of the individual tenant is required. Without such an identification, the information for an individual's process or demand profile cannot be provided. Only the black-board and the in-company screen offer the technical means for identification, for example by an RFID in the key ring of the tenant/employee or by face recognition and comparison to the personal profile in the back-office of the (housing) company (if the tenant/employee agrees to these methods).

Organisational assistance could be implemented by all three devices, if we assume that the situation to be supported is identified by evaluating context information from information systems in the organisation or by installed sensors. The interactive doorshow can be expected to have advantages over the conventional doorshow as the person to be supported at least could acknowledge that she/he received the information by using a defined gesture. With the black-board the highest level of organizational support can be expected, as the identification of individual employees would allow for documentation possibilities and for refining organizational assistance.

5.2 Discussion of Conclusions for Research Questions and Experiences

The experiences from the blackboard development and the previous EDS and interactive EDS development are discussed in this section from the perspective of the research questions defined in section 3. Furthermore, the experiences can be used to derive lessons learned for future work.

RQ1: What digital innovation potential in housing industry exists from the perspective of data-driven services for tenants?

The focus group work in the industrial case returned a long list of potential innovations (see section 5.1 for examples). The most promising ones are in the field of information and process assistance for individuals and organizations as illustrated in table 1. User acceptance and economic viability of the services will have to be shown in future work by implementation of the services. The phases of DITP which were not yet performed in the industrial case describe a way for achieving this implementation.

RQ2: How can digital signage support this innovation potential?

The different EDS devices (see section 4) offer significant support for implementing innovative services, in particular for individual assistance of tenants and for organizational assistance. Most valuable seems to be the blackboard due to its suitability for all identified services. The interactive doorshow and the black-board both were part of our earlier work where we produced proof-of-concept (PoC) implementations. This work is covered in other publications [5].

RQ3: How can the DITP support the digital innovation in the industrial case and what implications does the case have for the DITP?

The DITP proved to be a useful guide through the first phases of identifying digital innovation potential. In the phase "find digital potential", the activity of analyzing stakeholder demands proved to be not only useful but a mandatory and valuable step

in combination with analyzing trends and digital building blocks, i.e. this activity might be useful to integrate into the DITP. The "develop business model" phase of DITP was not performed completely, but only regarding the value creation process and the identification of target groups. Here, the close inter-relation to the previous phase "find digital potential" and the next phase "integration into the enterprise architecture (EA) became clear. Regarding the EA, the necessity of an analysis of the existing EA was confirmed. This will be part of the future work.

The importance of the different dimensions of the DITP approach (i.e. business model, enterprise architecture, user experience, service design) was analysed based on the time consumed working on the dimensions and based on the perceived importance from the perspective of the engineers involved. Table 2 shows the result of this investigation for the PoC of the interactive elevator door solution compared to the blackboard solution. "1" indicates the highest and "4" the lowest perceived importance. The time consumption is presented in terms of the share of the overall development efforts for the PoC. The table clearly illustrates the greater weight of user experiences in the interactive elevator door show, which is not providing personalized information, (i.e., no "targeted digital signage") as compared to the blackboard which can be classified as targeted digital signage.

Table 2: Comparison of time consumption and perceived importance

	Interactive elevator door solution		**Blackboard**	
	Time consumption	**Perceived importance**	**Time consumption**	**Perceived importance**
User Experience	32%	1	22%	3
Business Model	22%	2	16%	1
Architecture	18%	4	33%	2
Service Design	28%	3	29%	4

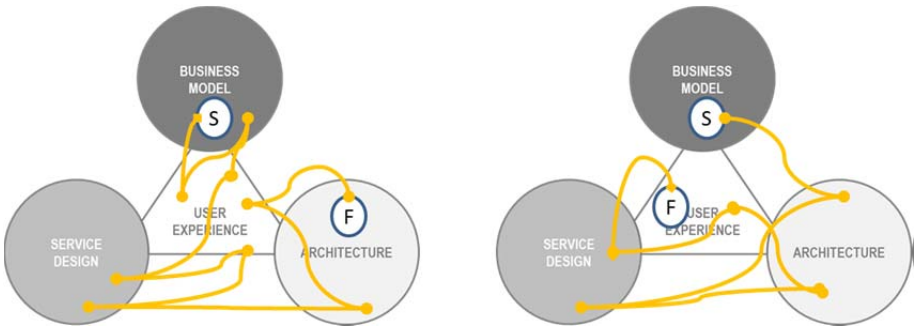

Fig. 5. Development paths for elevator door signage (left) and blackboard (right).

The comparison of the development processes, as illustrated in figure 5, confirms this impression. The figure shows in what sequence the different dimensions were tackled, beginning from the “S” (start) and finishing with the “F” (finish).

6 Summary and Future Work

This paper focuses on the field of elevator digital signage motivated application needs from housing industry. We identified categories of assistance service in digital signage as individual or organizational process or information assistance.

Future work will have to focus on technical and method aspects. The ideal digital signage solution would be able to provide individualized content for the audience consuming the information at any time: if only one person is present, the content would be personalized for this person, if a group of persons is present the demand of all should be met. This would require continuous recognition and identification of the current audience for the digital signage, their preferences and the matching content, which requires more work in developing our approach for intersecting preferences and integration with content aggregation, filtering and matching as well as user identification and profiling techniques.

The initial EDS solution developed in our previous work improved due to the new business requirements from the industrial partner from housing industry. The demonstration at the fair in Hanover created the impression that gesture recognition and display on elevator doors were more attractive for audiences seeking entertainment and leisure than for target groups with a certain personal plan or purpose on their minds. However, this impression was not seriously investigated at the fair. Thus, the third DSR cycle at the same time was supposed to address a differentiation of digital signage solution in door show, interactive door show and classical blackboards.

From method perspective, the technical work described above will contribute to completing the ongoing DITP application. Furthermore, the implementation of EDS solutions in housing industry will have to be integrated into the EA.

The biggest limitation of our work so far obviously is that we conducted only one case study in one application field. More case study work or experiments tackling usability, user acceptance, benefits and improvement potential are needed to reach generalizable conclusions. However, the focus of the work presented in this paper was on improving the understanding about potentials and limitations of EDS and digital signage. To this aim the paper provided a number of contributions.

Acknowledgements. The research was supported partly by projects funded by grants # 18-07-01201and 18-07-01272 of the Russian Foundation for Basic Research, by the State Research no. 0073-2018-0002, and by Government of Russian Federation, Grant 08-08.

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