

Human Factor Engineering strategies to solve hidden problems observed in modern trends in digitalization: Some examples from Sweden

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Date of reception:07/07/2024. acceptance:13/07/2024. publication:01/08/2024

Abstract:

Recent trends in digitalization techniques in ICs have revolutionized the day-to-day development process. At the same time, many people from IDCs have started to immigrate to ICs for education or employment. They are compelled to learn modern techniques in digitalization, in this process, hidden evils have been observed where IDC foreigners have become prey to these evils. This research aims to investigate the hidden problems of digitalization in DCs and offer insights into human factor engineering strategies that can be employed to address and control these problems.

This research adopts a case study methodology to gain an in-depth understanding of human factor challenges in the context of digitalization in Sweden. The selected cases represent diverse sectors such as healthcare, transport, and hospitality. Data was collected from interviews and questionnaire surveys. Thematic analysis was employed to identify recurring patterns and challenges in the human factors in each case. Goal-Directed Task Analysis (GDTA) was used to clarify the goals of the specific tasks of the users of the digital technologies. The three-level Situation Awareness Model was used to model the digital challenges of each case. The design of Situation Awareness strategies has been the foundation for the recommendations.

The application of the three-level Situation Awareness Model enabled the classification of the hidden problems arising from digitalization at different levels of the cognitive processes, the major effect was found on the comprehension. Most useful and applicable Situation Awareness interventions to address the problems discussed in the cases include mapping system functions to the users' goals and mental models.

Keywords: Digitalization, Industrially Developed Countries, Immigrants, Human Factor Challenges, Situation Awareness.

1. Introduction

The development of artificial intelligence in computer technology and modern trends in digitalization and hi-technology have revolutionized the rapidity and effectiveness of activities in Industrialized Countries (ICs). Digitalization refers to the adoption or increase in the use of digital or computer technology by an organization, industry, country, etc (Kreiss & Brennen, 2014). The tourists of Industrially Developing Countries (IDCs) while quickly adopting the high technology of the Westernized world have encountered many hidden problems in this process. Many authors have suggested effective solutions in the past to solve problems encountered by IDCs in adopting the hi-technology of the ICs (Myovella et al., 2020; Reis et al., 2020; Balogun & Adjei, 2019; Gebre-Mariam & Bygstad, 2019).

The departure of people from IDCs immigrating to ICs has been globally observed (Wiesbrock, 2011). Both the hi-technology development process and the movement process of IDC people to ICs have been rapid recently. Initially, they are compelled to learn modern techniques in digitalization.

Major expectations of digitalization are to have higher system reliability, a higher quality product and reduced risk for human error (Albus & Meystel, 2002). With the use of digitalized systems, the need for humans to observe and participate in the process has dramatically reduced. The Midttun, A. (2018). Challenges to the Nordic work model in the age of globalized digitalization. *Sustainable Modernity*, 139-159. Situation Awareness (Berberian et al., 2017). Situation Awareness (SA) is "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status shortly" (Endsley, 1995). There is a growing interest among the authors to explore the SA perspectives of digitalization (Tretten et al., 2021; Illankoon et al. 2019a; Illankoon et al. 2019b; Endsley, 2017).

The problems encountered by IDC people entering ICs using modern technology have yet to be adequately researched (Midttun, 2018; Chenat al. 2020). HFE is a modern science that originated in ICs and has helped IDCs in a variety of ways. Although ICs have advanced tremendously in HFE by adopting a step-by-step development process IDCs copied advanced technology following the leap-frogging process where many

mistakes occurred which the literature reveals (Matthess & Kunkel, 2020; Kurt et al. 2013).

Sweden is one of the high-ranking developed countries in Scandinavia. Sweden stands at the forefront of digital innovation. During the past 2-4 years Sweden has shown a remarkable development in modern technology (Bernhard, 2018). Sweden continues to accommodate immigrants from IDCs for education and employment (Gerdes & Wadensjö, 2013). Therefore, it is crucial to explore the hidden problems associated with the digital transition from the perspective of the immigrants who are compelled to use these digital technologies. This paper illustrates some examples of problems encountered by IDC nationals engaged in hi-tech activities in Sweden. Further, the paper aims to offer insights into human factor engineering strategies that can be employed to address and control these problems.

2. Objectives

This research aims to investigate the hidden problems of digitalization in ICs and offers insights into human factor engineering strategies that can be employed to address and control these problems. There are three objectives in this study.

- I. Identifying the hidden problems arising from digitalization in various sectors within Sweden,
- II. Modelling and evaluating the human factors challenges associated with these problems.
- III. And providing recommendations for enhancing human factor engineering strategies in the digitalization process.

3. Methodology

As the first data collection method, a questionnaire was distributed among a random sample of foreigners e.g. Sri Lankans, living in Sweden. Also, interviews were conducted with the foreigners from IDCs living in Sweden exploring the problems they encountered immediately after arriving in Sweden and from those who have settled down for a long period.

During the interviews and the questionnaire survey, the respondents were directed to reveal cases where they would have experienced human factor challenges in the context of digitalization in Sweden. The cases represent diverse sectors such as healthcare, transport, and hospitality, and those cases have relevance to digitalization challenges.

Goal-Directed Task Analysis (GDTA) was used to clarify the goals of the specific tasks of the users of the digital technologies of each case. GDTA enables analysis of the decisions that must be made to achieve the goals and to identify the associated information processing requirements (Crandall, et al., 2006; Sharma et al. 2019). Thematic analysis (Erlingsson & Brysiewicz, 2017) was employed to identify recurring patterns and challenges in the human factors from the cases that were analyzed using GDTA. The three-level SA Model was used to categorize the difficulties to three levels of SA: Perception, Comprehension, and Projection. In addition to the suggestions from the respondents, the design for Situation Awareness strategies (Endsley, 2001) was used to make recommendations for improvements.

4. Results and Discussion

We sent the questionnaire using Google Forms to 16 individuals, and 11 (70%) of them replied. From those responses to the questionnaire, three (27%) responded that they have never experienced difficulty in using the digitalized systems. All three respondents have lived in Sweden for more than two years, suggesting that they have gradually accustomed to the usage of the digital technologies that are in question. However, interestingly another three (27%) of the respondents who have lived in Sweden for more than two years replied that they have experienced difficulties with digital technologies very often. Furthermore, four (36%) who have lived in Sweden for longer than two years replied that they have faced some problems with digital technologies but, rarely. In the questionnaire, we allowed the respondent to describe the problem. For example, the description of the problem by one of the respondents is as follows "Once I was in the airport, there were no officers in the counters to issue me the boarding pass. I had to scan my passport, and air ticket, and get the boarding pass using a machine. The machine was not able to scan my passport, I think there was some error. The machine was just rejecting my passport, but no reason was given. I wanted to know why and what I am supposed to do if my passport is not scanned. I like to have some human assistance around the machine. I was very nervous about missing the flight. I had no clue of what was going to happen next".

The respondents to the interviews were different from those of the questionnaire, which allowed us to explore three different cases. One of the respondents of the interview had arrived in Sweden recently, whereas the other two have lived in

Sweden for longer than two years. Interviewing three individuals revealed three of the cases where they had difficulties with digital technologies. For example, one who arrived recently explained several difficulties he faced while trying to book an appointment with a doctor. Some of the highlights are as follows.

“Regarding a urine block, I obtained an emergency appointment with a doctor at the medical clinic where some disposable catheters were given, but no medicine was prescribed. As the problem remained, after a week I rang the medical clinic and was told medicines could not be prescribed until my medical journal arrived at the medical clinic from the clinic where I was living earlier. After 3 more weeks, the problem occurred even more frequently. I rang the clinic and was told telephone appointments were full for the day and to try again the next day. Ringing the next day, I was told that a prescription could be given only by a Urologist and an appointment would be made to meet a Urologist but I was told that it would take 2-3 weeks. After a week, as I was experiencing more severe pain, I made an emergency call to the medical unit, where I was advised to ring the hospital and request to speak with a urologist. No calls were possible that day and I was advised to ring the next day. I gave a call to the area medical clinic the next day and after explaining the predicament a telephone time was given to speak to a urologist the same day, however, the call did not come that day. The next day a telephone call was received by a nurse in the urology department who ultimately advised me about the correct steps to be taken about the problem. The nurse promised to fix another appointment with a hospital urologist to further help to solve the problem. However, no medicines were prescribed. The patient received another letter by post giving a telephone appointment with a hospital urologist after another week, which is almost 5 weeks since the first block occurred after arriving in Sweden. I also received six packets of catheters by post.

During another interview, the respondent went on commenting on rather a general view in connection with digitalization: “The high technology in ICs has become more or less make people's life mechanical. In the home country (IDCs) we had a relaxed life. After immigrating to Sweden (ICs) we suddenly become engaged in many digital activities that we are compelled to perform within certain timelines, and we gradually have no time for relaxation. So much so that we don't have the time to ring our families and relatives in IDCs or according to

their thinking be engaged in idle talk. Whatever we do is scheduled and planned. Gradually the workload becomes larger and larger but not unimportant. Hence there is hardly any time for relaxation, domestic communications, etc. Sometimes we realize the lifestyle we were accustomed to in IDCs has disappeared from our life”.

Close examination of the qualitative data obtained from interviews and the questionnaire helped us delineate the meaning units of those responses about the research objectives. Then, the meaning units were condensed to shorter versions by determining the underlying meanings. For example, the condensed meaning unit (the problem) of the first example presented above is as follows “The boarding pass machine was not able to scan my passport”. The condensed meaning unit of the second example was “Getting a consultation appointment took very long”.

Through an iterative process involving reading, reflection, and rereading of the condensed meaning units, we determined the categories. As per our research objectives, the categories are the problem faced by the respondent, the goal of the respondent, the information required, the affected SA level, and the interventions suggested by the respondent. For example, concerning the above case, the respondent’s most required information was what he/she is supposed to do if the passport is not being scanned. The most affected SA level was “Projection” because the respondent did not know what was going to happen once the passport was rejected by the boarding pass machine. However, the respondent also replied that coming to know of what is happening, and understanding what has happened was also moderately difficult. The respondent has proposed to have human assistance around the machine as an intervention. Table 1 and Table 2 show the results of the thematic analysis of the interviews and questionnaire respectively.

Table 1: Thematic analysis of the responses to the interviews

Goal	Condensed Meaning Unit (Problem)	Main information required	Mostly affected SA Level	Suggested HF intervention
To get medical treatment	Getting a consultation appointment took long.	How to get a faster appointment.	Perception	None

To obtain a bus ticket	Could not buy a ticket from the driver by paying cash.	Alternative ways of obtaining a bus ticket.	Comprehension	None
Accomplishing various prompted daily digital tasks	I am compelled to learn and accomplish many tasks digitally.	How to find some time to relax.	Perception	Better support for decision-making

Table 2: Thematic analysis of the responses for the questionnaire

Goal	Condensed Meaning Unit (Problem)	Main information required	Mostly affected SA Level	Suggested HF intervention
To meet a bank officer	Not aware that I should obtain a token	The requirement of a token	Perception	Clear instruction
Enter an archived library	Officers were inside, but the door was locked with a code.	Why can't I enter the facility	Comprehension	Clear instruction
To find a school for kids	Bank ID did not work, and I failed to apply.	Why is the bank ID not working	Comprehension	None
To obtain the boarding pass	The boarding pass machine did not scan my passport.	What am I supposed to do if my passport is not scanned?	Projection	Human assistance
To get a bus ticket	The telephone did not connect and could not get the ticket using Swish.	Why is my Swish not working	Comprehension	Human assistance
Log into online bank account	My personal desktop computer did not permit me to login, it did not show reason.	Why is my account not working	Comprehension	None
Using mobile ID	Repeated cycles asked me to scan the QR code before allowing me to log in.	Why is the scanning cycle repeated	Comprehension	Should match the mental model
To obtain a parking ticket	The parking ticket machine did not respond to my bank card.	Why is my bank card refused?	Comprehension	Human assistance

To meet our first objective of identifying the hidden problems arising from digitalization in various sectors within Sweden, the thematic analysis showed several difficulties in

various service sectors. According to the responses, the majority of the problems (four cases) were faced in the transport sector. Further classification was not easy through the thematic analysis due to the diverse types of problems reported by the respondents. While those problems have been brought to the surface, several respondents recognized and commented about the benefits they are getting from digital technologies. For example, the respondent who complained about the difficulty of getting a medical appointment, acknowledged "I understand that the procedure of getting a medical appointment over the phone and waiting for the medical data to transfer are error-free and systematic in medical methodology. But the time is so long that could be a disadvantage to the sick person".

Under the second objective, we classified the problems under the most affected level of SA. The majority of the cases (seven cases) relate to comprehension, suggesting that although the users can get a piece of information about what has happened, they are not able to understand why it happened. Three of the cases relate to the perception itself suggesting that the user did not have information about what was happening. In one of the cases, the major effect came with the inability to project what was going to happen.

In response to the suggestions for improvements, the majority (four cases) showed a preference to have human assistance with the digital solution. Respondents of the two cases have suggested having clearer instructions, while one suggested matching the system interface to the mental model of the user, which also is a formal recommendation found in the design for SA literature.

In summary, this study revealed that digitalization is reshaping how citizens interact and access essential services. As pointed out by the respondents, digital technology holds the promise of greater efficiency, accessibility, and transparency. Through online platforms and mobile applications, citizens can access a wide range of services from the comfort of their homes or on the go. As shown in many of the cases, digitalization has reduced paperwork, and automated routine tasks. This minimizes the potential for errors and delays in service delivery. By reducing the need for physical infrastructure and manual labor (e.g. bus conductor), digitalization can lead to significant cost savings. In the big picture, digital platforms enable citizens to access government datasets and participate in decision-making processes more easily.

However, as pointed out in this study digitalization also presents challenges that must be carefully navigated. A person with a lack of digital skills asking for casual assistance from another person raises concerns about data privacy. Despite the increasing prevalence of digital technologies and access to reliable internet connectivity, it appears that the necessary digital skills to navigate online services have not been addressed effectively. However, our focus in this study is on how to fit those "digital interactions" with the natural thinking and behaviours of humans.

5. Recommendations and Conclusions

What must be investigated is whether any HFE strategies can circumvent the obstacles encountered by IDC travellers. What must be borne in mind is that the mental capacities for digitalization are not developed among IDC personnel to the same level as IC personnel. Similarly, comprehension of high technology could be weaker among IDC personnel newly entering ICs.

Analysing the problems from a SA perspective offered a crucial advantage in defining the phases affected: perception, comprehension, and projection. Then, SA requirements guide us in identifying the true needs for perception, comprehension, and projection. Unlike the rather traditional "technology-oriented" approaches, the SA approach demands unique solutions aiming at the user's ability to follow what is happening. Over the last decade, research has honed an understanding of the essential mechanisms for SA and the corresponding design features (Endsley et al., 2003; Illankoon et al., 2019c; Illankoon & Tretten, 2020).

While the detailed design features are too extensive to delve into this article, three key approaches can be highlighted that can greatly influence the success of ensuring the user's ability to gain SA with the digitalized systems. The first is to incorporate a structured approach to consider the user's information requirements in the design process of digital services, using approaches such as GDTA. The second is to design for SA enhancement. Designing for situation awareness in complex systems (Endsley, 2001), offers a series of recommendations, and we look forward to contributing with specific Situation Awareness design recommendations in our future work. The third is to measure SA during the design evaluation of the digital services. SA measurement literature (Endsley, M. R. 2021) offers a series of tools and techniques

that can be used to measure situation awareness in individuals and teams. The insight from this article can aid designers of digital systems to create meaningful interfaces that can ease the interactions especially when the user is new to using digitalized systems.

While our study shed light on the challenges faced by the immigrants to get accustomed with the digitalised systems, our study carries some limitations. Our sample size is relatively small. However, we emphasize the fact that our intention is not to prove out points using statistical significance but to establish the issue of interest by using a few but very strong cases. We argue that the problems faced by the immigrants in using the digitalization can indirectly challenge the inclusion strategies and policies that the developed countries want to enforce.

In a broader view, what has to be realized is whether the people from IDCs lose any characteristics or attitudes and behavior patterns in their lives that perhaps thought essential for living. What about parental affection, love for their children, and the relationship with their in-laws and family members? How important are the above characteristics to their lives? Can we discard them saying 'When you go to Rome you must act like a Roman'?

6. References

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