Visualization in Digital Occupation

Project case: Stereotype-free representation of “IT Security Administrator”

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ABSTRACT

Representations of digital occupations nowadays often deal with hidden stereotyping. Stereotype in Information Technology (IT) careers appear to be affecting the competitiveness of companies globally. Manju Ahuja offered a framework of three distinct stages of career choices, persistence and advancement [1,2]. Such patterns on career development are especially augmented as stereotype concern from the point of view Catherine Ashcraft [3] and Susan Fiske [6].

In the context of our study project, we will present a model, which faces aspects of stereotypes in the IT field. We will highlight visualization techniques, as digital visualizations combining pictures, texts, video and audio materials offer the opportunity to communicate more accurate day to day work practices and build stereotype free representations of work.

This work starts with an introduction about digitalization, occupation, stereotyping and visualization methods. In the core part, we elaborate on the development of our project ideas including choosing our digital occupation “IT Security Administrator”, using visualization methods and creating several different design concepts, subsequently narrowing them down to one final concept. As a following step, an interview process was conducted and a usability study to evaluate results and the impact of our concept. The last part sums up key findings, takeaways and recommendations for the future.

The goal of this project is to build visual representations of occupations - in our case “IT Security Administrator” - emerging due to digitalization processes without illustrating features of stereotypes and prejudices. To reach this goal, digital visualization methodologies as well as tools will be used.

CCS CONCEPTS

• Human-centered computing → **Visualization design and evaluation methods**;

KEYWORDS

Career, Digitalisation; IT Security; Occupations; Stereotype; Visualization; Work; Workforce;

INTRODUCTION

In the following, we will introduce to you the overall topic contents including digitalization and occupation, stereotyping in the workforce, as well as visualization and representation.

Digitalization and Occupation

Nowadays, there is a huge hype around digital transformation and the terms “digitalization” and “digitization”. We refer to [5] digitalization as “the material process of converting individual analogue streams of information into the digital bits”. Digitalization is a way, in which many domains of social life are restructured around digital communication and media infrastructures. One of the first research approach on the term “digitalization” in conjunction with the computerization era appeared in 1971 by R. Wachal (in [5]), where he discussed the social implications of the “digitalization of society” in the context of computer-assisted humanities research [5]. At that time, Edgar Schein [15] introduces a career framework that developed the idea of matching careers to talents, skills and personality, considering a clear understanding of yourself, a knowledge of the requirements of work and the true reasoning on the relations of these two groups.

We followed the approach to choose a professional area, which is in our case “IT Security”, and an occupation within this area, which we decide to be “IT Security Administrator”. Mitre [4] defined “Security Administrator” as an individual responsible for defending organizational mission, systems, networks and devices by

detecting, administering, analyzing and responding to cyber-attacks and practices to ensure authorized users to access information that is protected in terms of confidentiality, integrity and availability. ISACA [8] explains this term as "a person responsible for implementing, monitoring and enforcing security rules established and authorized by management".

Mark Muro et al. have reported [11] that the "digitalization of everything" is changing the skills needed to access economic opportunity, while creating new race and gender-based access challenges. Many individuals have appreciated the value and understood the need for minority representation within an organization. For others, organizational diversity, openness, and inclusion has not yet been registered as a shift in corporate culture.

Stereotyping in the Workforce

Stereotyping has been common in the workforce [6]. It is a belief that characterizes people based merely on their group membership. It is a fixed and oversimplified belief or expectation [6]. Fiske claimed that a community or groups of people are often subjective against others outside of their own social group, showing prejudice, stereotypes, and discrimination. When it comes to digitalization, it became less socially acceptable to exhibit bias, which leads to prejudice, stereotypes, and discrimination became more subtle [6]. A variety of stereotype come from an educational background, recruitment process and, cultural factors which prevent all of us from recognizing highly qualified talent even when it is right in front of our eyes.

Previous studies [1,2,3,6] have suggested that gender stereotyping and organizational factors may contribute to discrimination. Yet it is not well understood how these elements connect to foster gender discrimination in everyday workplaces. We hope this study project contributes to the understanding of these relationships by analyzing stereotype content constructed from our closed group interview and validated using mature framework.

Visualization and Representation

As digitalization takes place, we are surrounded by various ways of visual technology, namely photography, film, video, digital graphics or television. According to Gillian Rose on Visual Methodologies [13], all these different sorts of technologies and images offer views of the world and they render the world in visual terms. Vision is what the human eye is capable of seeing (Crary in [13]). Visuality, on the opposite side, refers to the way in which vision is constructed [13]. Rose recommends how we should interpret the meaning of visual image, using "the site of production, the site of the image itself, and the site of its audience". Regarding the interpretation of visual images, the participant or the viewer should take each image seriously, think about the social conditions and effects of visual objects, and reflect own way of looking at images [13].

We also refer to "Visual Thinking" from R. McKim [12] in terms of cognitive structure. According to recent psychological theories, mental pictures are not stored at all, but instead the "process", by which each image was initially perceived. In line with G. Rose, R. McKim offers methods that enable participants to recall more colorful and complete memory images. For example, to visualize a landscape, participants can visualize all the details inside the landscape: the trees, the gardens, the lake, the shadows, the grazing cattle and the fragrant flowers.

Additionally, we use the approach from Stuart Hall [7] to illustration and documentation of work, workplaces and work processes using visual representation. Eventually, Hall explained a culture that is concerned with the production and exchange of meanings, between the members of a society or group.

In Stuart Hall´s work called "The Work of Representation" [7], the author discusses the concept of Representation, which is a production of meaning through language. Representation connects meaning and language to culture. It is then no surprise that in general, culture has become crucial. Many social scientists understand this complex concept of culture as social processes, social identities, and social change and conflict [7]. Hall describes two related 'systems of representation'. The first enables us to give meaning to the world by constructing a set of correspondences like people, objects, events, abstract ideas, and our conceptual maps. The second one depends on constructing a set of correspondences between our conceptual map and a set of signs, organized into different languages. Furthermore, the author explains three different approaches to Representation: the "Reflective Approach", which basically states that things themselves fix the meaning of language, the "Intentional Approach", that describes individual users of language to fix the meaning of the language, and the "Constructionist Approach", where meaning is constructed through language, where words and things function as signs e.g. traffic lights. The "Constructionist Approach" is subdivided in the Discursive Approach, which is about the control contributions of less powerful participants, and in

the Semiotic Approach, including Saussure´s legacy and its focus on Langue and Parole. Hall differentiates between the Semiotic analysis, which is the art of describing and interpreting the meaning of sign, versus the Syntagmatic analysis, which is studying the structures and relationships within a text. The author also discusses the concept of Codes, which would produce meaning through encoding and decoding of the content. Codes are more like social conventions, instead of fixed rules.

METHODOLOGY

We followed the qualitative research approach. For that, we set up and conducted interviews with our target group. The development of the interview guideline involved several interview questions, separated in two categories. We asked our interviewee general and in-depth questions, in order to describe, interpret, evaluate, understand and gain more in-depth insights into our topic and our overall project goals to build a stereotype free representation of work and to visualize IT occupation in a more appealing way. Additionally, we leverage an online form survey in order to gather some demographic data about our participants.

We compared the results from our seven interviews with the previous findings from literature and research journals and papers. Not only did we analyze the relationship between the concepts, but we also wanted to figure out which statements from literature can be confirmed by our interview conductions, which information is new and can be provided by our interviews. We want to understand and give answers to our goals within the context of our study project.

Regarding the collection of data, papers, scientific journals, publications, company websites, research sites and our interviews as sources were used. We analyzed and examined the information, as well as did observations to identify patterns within the content, in order to interpret the data. Furthermore, we used the qualitative data-analysis and research software ATLAS.ti to analyze all manually transcript interviews in terms of coding and grouping distinct key words from the interview contents [14]. Then, a research model was created to get an understanding of the relations between the coded key words and group members. For the evaluation part, key information was highlighted.

PROJECT CASE

In the following, we will elaborate on the development process of our visualization product, from first ideas generation to the final achieved visualization results. Each stage of the idea generation, which in our terms included “project ideas”, “pictures of an occupation”, “evaluation method” and “evaluation of self-elaborated pictures”, was delivered as a group presentation.

Project Ideas

Out of four occupation fields related to Information and Communications and Technology (ICT) given by the study project instructors, we decided to choose “IT Security”. The National Institute of Standards and Technology (NIST) describes “IT Security” as the “protection of information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide confidentiality, integrity, and availability”. Other descriptions of IT security include technologies, processes and practices designed to protect organizational networks, programs and data from attack.

At the beginning of our project, we came up with the occupation “IT Security Consultant”. We created story boards to visualize and portray our chosen occupation. We aimed at illustrating the profession in a stereotype-free way. Story board ideas include infographics about “IT Security Consultant” and its relationship to IT Governance and GDPR. Additionally, we had ideas to illustrate a daily life of an IT Security Consultant, as well as a network architecture and its crucial role in security life-cycle, as graphics. Other ideas incorporate creating comic sketches in the field of business social networks, where an “IT Security Consultant” would consult company employees about the importance of IT security measures e.g. having a strong password and firewall settings. Initially, we had the idea to combine all illustrations in forms of graphics, infographic, comic sketches and pictures, to a video.

Soon came the realization that “IT Security Consultant“ is an occupation, which is multifaceted. It is not easy to visualize its “typical” tasks, which is why we decided to change our profession to “IT Security Administrator”. This is a vocation, which is not only relevant in today´s professional world, but has specific tasks, which would be interesting and clear to visualize.

Pictures of an Occupation

The goal for this stage is to introduce the first visualization results, which is a video in .mp4 format and the content would be “A daily life of an IT Security Administrator”.

We did research on regular and daily tasks of an "IT Security Administrator", as well as those unexpected ad-hoc tasks and risks. Daily tasks include to secure data of company and clients, define and implement secure systems and policies e.g. COBIT, GDPR, detect and prevent malware, as well as research related to the cyber-security trends. Unexpected ad-hoc tasks and risk means to support, help and assist colleagues in urgent cases, handle server and system shutdown, fix virus and bugs, as well as review new IT systems.

Our visualization included video shootings of different scenarios e.g. commute to work, inside and outside of office building and rooms. Recordings took place at various time frames e.g. morning, noon, afternoon and evening, and from different angles, like scenario and people from up front, behind and side.

As our goal is to create a video, which is stereotype-free, filming of faces and anything gender related was avoided. Furthermore, we wanted to create a video, which is interactive. Therefore, interactive flash video elements including pictures, screenshots, icons and symbols were inserted. The final video product is a combination of different visualization elements connected to a comprehensible storyline, which is stereotype-free.

Evaluation Method

In the evaluation method stage, we introduced an updated version of "A day of an IT Security Administrator", after having collected feedback from the audience in the previous presentation. Compared to the initial solution, the video was shortened by one-third, and "artificial" voices were added, which was adapted by a voice changer.

The challenge was now to shorten the video even more, in order to keep the focus of the audience, but still it has to be informative. Furthermore, we decided to audio record and use our own clear voices instead of a synthesizer to change voices. Having these realizations, it is clear, what needs to be done in order to finalize the video.

Evaluation of Self-elaborated Pictures

With the final presentation, we introduced the latest version of our video with a length of around four minutes, which is a reduction of nearly 50% from the initial one. We did a recap on the chosen profession "IT Security Administrator", which is a demanding job with a lot of stereotypes. We were able to clearly visualize its specific tasks. We reflected on the chosen visualization methods, which was a video including recording, flash elements, graphics, heading, pictures, illustrations, symbols, music, sounds, audio recording. The goal for us has always been to illustrate a stereotype-free representation of work and to visualize "IT Security Administrator" in a realistic, interesting and appealing way to the audiences. Furthermore, achieved milestones, such as the processes from idea generation to implementation, eventually creating the product, up to the current state, were discussed.

INTERVIEW PART

In contrast to the everyday dialogue between colleagues or family members, qualitative research interviews are not conducted for their own sake. Norman Denzin and Y. Lincoln defined the interview as "a face-to-face verbal exchange, in which one person, the interviewer, attempts to elicit information or expressions of opinion or belief from another person(s)" (Maccoby and Maccoby in [10]). In most interview studies, the goal is to acquire the participants concrete descriptions, rather than abstract reflections or theorizations. This chapter gives a detailed overview over the development of our interview process.

Interview Preparation

The preparation before conducting the interviews were planned in detail, because we had the instruction to interview at least two people per person, with an approximate duration of one hour per interview. We decided to interview all participants face-to-face.

First of all, we determined the target group. Initially, all students we considered, but then we narrowed down our target group from all students to those pursuing IT related studies. We believed that they would bring along some basic IT knowledge, so it would be easier for them to comprehend the interview content about the field "IT Security" and the profession "IT Security Administrator". Furthermore, we wanted to figure out whether the presented occupation would be relevant and intriguing to them, among other factors.

Our group decided to create a main questionnaire, where we wrote down all kinds of questions that would be interesting and relevant to know in the context of our study project. The main questionnaire was conducted as a qualitative study with open questions, which meant that we were only observing and capturing information, without including our own opinion. The prepared questionnaire was meant as a guide for the interview process, but it was not mandatory to stick to the

questionnaire and ask all of its questions. We could add and leave out questions spontaneously, depending on how they would fit into the moment of the interview, or depending on whether questions were already answered by the participants. We conducted a guided and directed content analysis, which means that the interview would not be too close and too open. For this interview style, we already have our ideas, but need to explore them more throughout the interview. The main interview questionnaire was divided in several parts. We first prepared a short introduction text to welcome the participant. Afterwards, we started to ask questions from the questionnaire. Some questions were asked before the interviewee would see the video e.g. general knowledge about "IT Security", "IT Security Administrator" or stereotypes. Other questions followed, after the interviewee have watched the video, like questions about impressions, thoughts and ideas about the video and the visualization techniques used. It was interesting for us to see whether the video would influence the participant´s view on the "IT Security" topic. Additionally, we prepared backup questions, in case there was time left within the one-hour time frame. In the end, the interviewee could fill out an online form with answer choices about his or her demographic information and education. This information was saved anonymously. The additional online form was created, because questions about demography e.g. education, gender, work experience, and programming skills could be easily chosen out of the given answer options. Furthermore, we gave the participant the space to ask questions, in case he or she would have some.

Besides the questionnaire and online form, an additional proposal of study and consent form were prepared, which our interview participants had to sign prior to having the interview. With the proposal of study, we gave our interview participants a first look into the overall topic, without revealing too much in advance. Some information about the study project was unveiled e.g. project title, main research questions. Furthermore, we revealed information about our research methodology, the study project itself in the context of the Technical University of Berlin, and gave a short description about our goal and methods of using digital tools in order to visualize an IT occupation. We also created a consent form, which was meant to get the confirmation of the participant to be audio recorded, as well as to use the information in a confidential way for our research purposes.

Interview Implementation

First of all, we pretested the interview procedure within our group. Hereby, we asked each other questions from the questionnaire and online form, audio recorded our answers in order to understand the whole interview procedure thoroughly. This procedure also helped us to improve our questionnaire, as we made some interview questionnaire adjustments, e.g. re-ordering the questions.

To further advance, we would approach the students from our network, who would fit into our target group. These were students with an IT related background. Some students declined our request due to e.g. lack of time, or because they were not willing to be audio recorded.

The interview itself was employed in total with seven participants, separately from each other. The average interview lasted averagely around 50 minutes. Regarding the demography, we had a gender balance. The educational background consisted of 50% Master, 25% Bachelor and 25% PhD students (see Figure 1). The whole interview was audio recorded from different devices simultaneously, just to guarantee no data loss.

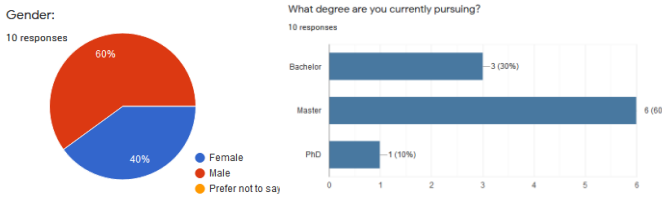

Figure 1 Generic Demographic.

For the convenience of the reader, Appendix 2 lists details about the interview questions, followed by Appendix 3 including participant demography.

It was insightful to observe the body language of the participant throughout the interview process, as they behave in some parts in the same way, in other parts they would differ completely. Some participants felt at ease with their English, while others were a bit unsecure due to the fact that they had to answer the questions in English. Also, their IT knowledge would partly influence their body language and self-confidence during the interview. When participants were excited to answer a certain question, they tend to speak louder, faster and way more than in other situations, when they spoke less or just answered with "I don´t know", so the interviewer would ask them to elaborate and explain more. The participants often took their time to think about a question, before answering the same question.

We noted that our interviewee enjoyed watching the video "A day of an IT Security Administrator", as they smiled while watching, or moved back and forth to the music. Also, worth mentioning is the fact that participants tend to talk more with time passing, in contrast to the beginning of the interview stage. That could be an indicator for them feeling more relaxed and at ease after a while, and were therefore more willing to share their thoughts.

Interview Analysis

Having collected the seven interviews, we started to transcript them manually. Each transcription has an average length of ten pages or more. As a next step, transcript documents were then inserted into the qualitative data-analysis and research software ATLAS.ti. Key words and code member and groups of each transcript was then identified and selected.

The developed video illustrated not only visualization techniques, but career trajectories were also a subject, which were discussed. We refer to the framework of MK Ahuja to represent career stages in our visualization techniques, which offer: career choice, persistence and advancement in the IT field. Additionally, vocational change is often characterized through periods of growth, exploration, establishment, management and disengagement [1,2]. Details referring to our visualization techniques are enclosed in Appendix 1.

Content Analysis

In this section, we will employ content analysis, in order to analyze our interview contents and to examine the transcripts and identify relevant concepts for this study.

Content analysis is a useful methodology for aggregating text and making inferences emphasize with additional exploratory in process, and predictive or inferential in intent [9]. Content analysis methodology is suitable for examining whether research questions are supported by patterns in the content e.g. word, text. This form of analysis has been used to code responses to open-ended questions from a variety of sources e.g. interviews and surveys, and can help address both the problems of lacking scientific and methodological robustness and cognitive overload [9,10].

As starting point during the data analysis process, a coding scheme was used to code the interview transcripts. In consistence with previous theoretical frameworks [3,12,13], we looked at interview sentences and phrases as the unit of analysis, and depicted recurring code groups from all interviews, as shown in Table 1.

After the initial coding process, we had 10 of these clusters. For example, looking at the first row of Table 1, from top left to top right, we see the cluster "IT Workforce", "Stereotypes", and "Visualization" highlighted because they were one of the clusters that were most often mentioned and it made sense to limit the cluster groups for our research. Especially the code group "Stereotypes" was often quoted, with a total number of 478 occurrences in all of the participants answer. As shown in Table 1, "IT Workforce", "Stereotype" and "Visualization" are commonly used code groups with a distribution of 7.93%, 15.92% and 12.52%, which in total already makes 36.37%, which is already over 1/3 of the overall distribution of code groups.

Linking to the contextual aspects of the model examined by Ahuja, we found trends in Table 1 with themes that were way more often covered than others. For example, the code group "education" has been quoted around 415 times, so it can be assumed that stereotyping within the context of digitalization and workforce, seems to be common during university education.

Table 1 Content analysis adopted based on the framework

	computer (7 / 121)		corporation (5 / 288)		education (12 / 415)		IT Workforce (8 / 238)		job (14 / 506)		programming (9 / 113)		security (4 / 260)		Stereotypes (14 / 478)		technology (6 / 207)		Visualisation (7 / 376)		Totals	
1: Participant 1 (145)	2	0,57%	28	8,00%	50	14,29%	30	8,57%	55	15,71%	27	7,71%	26	7,43%	64	18,29%	33	9,43%	35	10,00%	350	100,00%
2: Participant 2 (133)	7	3,66%	18	9,42%	31	16,23%	15	7,85%	37	19,37%	6	3,14%	11	5,76%	26	13,61%	15	7,85%	25	13,09%	191	100,00%
3: Participant 3 (178)	47	13,86%	30	8,85%	27	7,96%	4	1,18%	65	19,17%	6	1,77%	49	14,45%	69	20,35%	1	0,29%	41	12,09%	339	100,00%
4: Participant 4 (179)	14	4,79%	14	4,79%	31	10,62%	1	0,34%	61	20,89%	6	2,05%	55	18,84%	43	14,73%	2	0,68%	65	22,26%	292	100,00%
5: Participant 5 (252)	22	2,83%	96	12,36%	114	14,67%	80	10,30%	122	15,70%	36	4,63%	35	4,50%	132	16,99%	53	6,82%	87	11,20%	777	100,00%
6: Participant 6 (208)	24	2,99%	73	9,08%	118	14,68%	83	10,32%	123	15,30%	23	2,86%	77	9,58%	102	12,69%	81	10,07%	100	12,44%	804	100,00%
7: Participant 7 (152)	5	2,01%	29	11,65%	44	17,67%	25	10,04%	43	17,27%	9	3,61%	7	2,81%	42	16,87%	22	8,84%	23	9,24%	249	100,00%
Student Group (7 / 1247)	121	4,03%	288	9,59%	415	13,82%	238	7,93%	506	16,86%	113	3,76%	260	8,66%	478	15,92%	207	6,90%	376	12,52%	3002	100,00%
Totals	242	4,03%	576	9,59%	830	13,82%	476	7,93%	1012	16,86%	226	3,76%	520	8,66%	956	15,92%	414	6,90%	752	12,52%	6004	100,00%

The theoretical framework has shown that the IT workplace has faced unconscious bias, which exclude individuals from fully participating in the design, deployment, and management of technology [3]. An explanation for the "stereotype threat" in Catherine et al. report [3] offers the following outline: (i) all-male or all-white interview team, (ii) features of the physical office environment with a stereotypically "geeky," "male," or "white" space e.g. action figures, sci-fi posters (iii) attention called to gender or race during application or interview (iv) organizations that see talent as inherent. In conclusion, the literature informs us that the IT work environment has a strong influence on stereotype and career vocations.

Framework Analysis

We decided to conduct interviews with a focus group, consisting of university students with an IT background. Focus groups were an appropriate technique to generate the type of data we need to shed light to our project case. This allows us to observe what opinions students have about certain IT occupations and the occurring stereotypes in these fields.

Our analysis framework is guided mainly by the theory presented by Ahuja [1,2] regarding gender stereotype in the IT industry and by the content analysis model theory of Catherine Ashcraft [3] and Susan Fiske [6]. Besides that, we use Hall [7] and Rose [13] to visualize our content. We developed code groups and corresponding code members, and clustered the three most common code groups as seen in Table 2, which was then applied to our research model.

Details about the code group represented in our content analysis are shown in Appendix 4.

Table 2 Code Group and Member

Code Group	Code	Framework
Stereotypes	age	Catherine Ashcraft [3], and Susan Fiske [6].
	company portrays	
	computer	
	computer developer	
	data and/or information	
	development of coding	
	gender	
	IT	
	IT People	
	stereotype	
	technology	
	urban cities	
	village, region, country	
	working hours	
IT Workforce	age	Ahuja [1,2], and Edgar Schein [15].
	career	
	computer developer	
	IT People	
	IT Security Administrator	
	Java developer	
	Python developer	
	software developer	
	working hours	
Visualization	attractiveness	Gillian Rose [13], and Stuart Hall [7].
	comprehensibility	
	impression	
	interest	
	IT Security Administrator	
	stereotype	
	video message	

Coding Process

In this study project, we employed the ATLAS.ti software in order to code and cluster our transcript content. We started with applying a coding scheme and cluster code member to specific labels. The initial 10 clusters were reduced to 3 main clusters, as shown in Table 3, and member of the clusters shown in Table 2.

Table 3 Normalize cluster of the coding process

	IT Workforce 8 238		Stereotypes 15 525		Visualisation 7 376		Totals	
Student Group 7 1247	238	20,90%	525	46,09%	376	33,01%	1139	100,00%
Totals	238	20,90%	525	46,09%	376	33,01%	1139	100,00%

During the process we repeatedly examined, analyzed and discussed the transcripts to identify the concepts. In the coding process, each project member independently coded the texts, with support from the research perspective e.g. ATLAS.ti software, and grounding from the literature base.

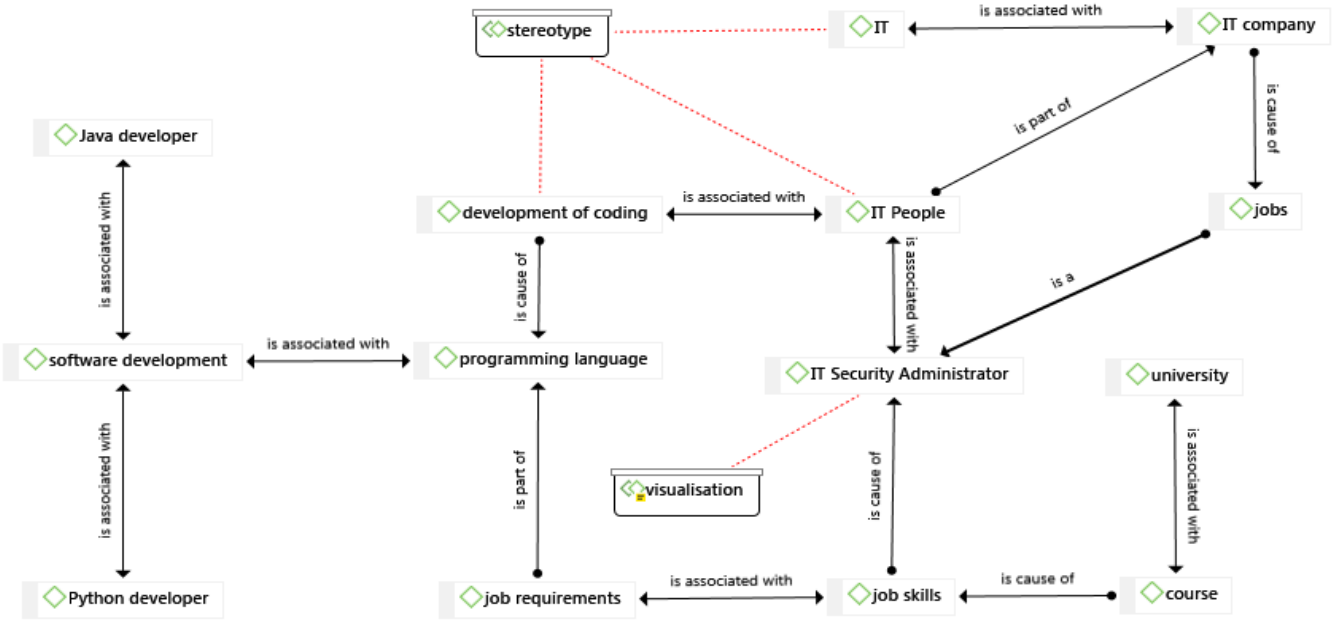

Figure 2 - Research model with the abstraction level of stereotype and relation with IT field

In this stage, the relevance of specific attributes was analyzed. We then grouped together codes and words that are frequently mentioned in the statements. A code was then created to summarize the meaning of the phrase as quotations. Refer to Appendix 4 for details and Table 4 shows highlighted results and concepts with sample phrases from the phase after the interview.

Research on IT career trajectory reveals an important insight about stereotype and IT careers development, which suggests that gender is not an immutable factor for male dominated career. This information suggests that our underlying project study has gender significant data that meet this variability because we did not use gender specific representation in our video material. In our project case, we removed the representation of the female as an underrepresented group by classifying the gender as independent code member, e.g. no terms like "women" and "men" were used in our code, but just the term "gender" instead.

Table 2 provides the baseline information for Table 4. In Table 4, working from right to left, marks that the "Concept description" matches the corresponding "Code member" and "Code group", e.g. in line 1 the description of "hacker" matches the code member "stereotype".

Each project member coded the transcripts independently. Sentences that could belong to code group and code were marked as quoted phrases or quotation. As a next step, coding results were compared, inconsistencies discussed and resolved to reach an agreement within the project team.

Overviews of some code group concepts with quoted phrases are provided in Table 4. For example, the code group concept "stereotype" was grouped under the label "discrimination", developed by the project team, to capture the idea of people not being treated equally or how things are not considered fair to the recipient.

Another example from Table 4, to illustrate "Concept Description", which matches the "Code Group" "IT Workforce", referring to "Participant 3" (= P3, see appendix).

P3: "Yes, as my career plans are continuing my studies with a master in IT Security Cybersecurity. I totally can imagine to work in this field, but more on a conceptual approach. I would like to design systems like system architect, but focusing on the security aspects. I cannot imagine to be like a software engineer, or maybe on a very small scale. But in total more like an architect, like an approach from the architecture side. So, we invent or design systems and take care of possible vulnerabilities of a certain design pattern."

Table 4 Code group concepts with quoted phrases (concept adopted from Table 2)

Quotation Name	Code Groups	Code Members	Concept description and sample phrase from participants
Stereotype in IT security	Stereotypes, IT Workforce	stereotype, career, IT People, IT Security, job requirements, job skills, jobs, thought	Job-related qualities, career anchor and stereotype P3: " ... three types of IT security experts. They are called white, black and grey heads" ... an IT security officer who is on the other side of the table, who tries to prevent his system or her system to be attacked or to undermined ... "... if you say you are working in IT security, like as most of other people think that you are a hacker ..."
Is it the video show the similar task that the job description brief in the advertisement?	IT Workforce Visualisations	attractiveness, IT People, IT Security Administrator, job skills, jobs, specialist, thought, video message	Positive visualisation job-related qualities, needed skill sets. P5: "Yes it is. It's kind of I kind of find a match, it's expected a lot out of him as IT professional in it like the responsibilities or maybe the education and experience it's a lot of things..."
easy way to face certain situations situations because if you meet...	Stereotypes	stereotype	Stereotype threat, appearing "less confident" in formal disucssion. P4: "many people stereotypes are kind of an easy way to to face certain situations situations because if you meet another person and you don't know the person so likes these stereotypes..." "... every person is different or every, every country and every-, and so on and therefore they *hindern*, they..."
IT is I think, it's boring. It's complicated, you have to be good at m...	Stereotypes	stereotype, programming	Stereotype content model, judgemental on the behaviour and education. P3: "IT is I think, it's boring. It's complicated, you have to be good at math. You have to, you can do fancy stuff, like, programming ..."
What stereotype could apply to IT or IT people in your opinion?	Stereotypes IT Workforce	stereotype, IT People, jobs, thought	Stereotype threat with 'fixed' mindsets. P1: "I heard but I don't think at the same direction the same direction that the IT people be boring. They spent more than overall time on starting folder never have a rest just program and program further."
Can you imagine work in that IT Security field	IT Workforce	career, IT People, IT Security Administrator, job requirements, job skills, jobs	Job-related qualities, career anchor and development process. P3: "Yes, as I, as my career plans are continuing my studies with a master in IT Security Cybersecurity ... more like an architect, like an approach from the architecture side..."
Any message after we saw you the video?	Visualisations	video message	Reducing stereotype threat or stereotype content model (stereotype free), work live balance. P2: "... the social contact thats really nice in the job, not that you just have more than one breaks, coffee breaks really love to do , because no one work the whole day, you have be constrained after the lunch" P4: "... it was, it gave a lot of information about what a an ITSecurity Administrator does. And an IT Security Administrator has many breaks". P6: "In IT typically the office spaces are quite nice like the office environment is very nice. Stereotype is. "they have a lot of breaks"

Result Analysis

In Table 5, on the left column, we extract the Codes from the Code Group "Visualization", such as "impression", "interest", "thought" and "video message". The column "gender" represents the Code, which refers to the Code Group "Stereotypes". We inserted the Code Member "IT Security Administrator", in order to analyze the relationship, in our terms "correlation coefficient", or mostly known as "C-index", between all of the selected codes. With the use of the software ATLAS.ti, we could create the C-index, which is e.g. 0.28 (in Table 5) for the combination of "video message" and "IT Security Administrator". A value of 0.28 (rounded up to 0.3) means a strong correlation according to O`Sullivan (in Krippendorff Klaus - Content Analysis [9] p.134) and a dense relationship between these two mentioned "Code" and "Code Member".

Table 5 C-index for IT Security Administrator

	gender (26)	IT Security Administrator (85)	stereotype (170)
impression (44)	7 (0,11)	18 (0,16)	5 (0,02)
interest (74)	8 (0,09)	17 (0,12)	5 (0,02)
thought (64)	9 (0,11)	24 (0,19)	7 (0,03)
video message (80)	10 (0,10)	36 (0,28)	10 (0,04)

As an example, some descriptive phrases illustrate the Codes "impression", "interest", "thought" and "video message" from the Code Group "Visualization". Hereby, we will introduce some answer phrases of participants P2, P4, P6 who share their understandings, impressions, interest and thought about the video and its message:

P2: "...first of all when you get task from your collages or from your departments, it should be fixed, so you have to communicate with them, from other departments IT people, then you have meetings and still have the social contact that's really nice in the job, not that you just have more than one breaks, coffee breaks really love to do, because no one work the whole day"

P4: "So, the video doesn't show any faces (...) In that way the video is stereotype-free. Yeah and of course the IT Security Administrator has to do with IT and computers. So that's kind of a stereotype, but I think it's okay because the video also should

show what the typical job is. But I think in the whole picture, yes the video is stereotype free."

P6: "I think in this case we need to use your video and also awareness on the task itself which saw in your video. And the video was told the right part on the experience required to do the task."

From our data, we can extract that our visualization material has the capability to show our target group a stereotype free representation of a digital occupation, which is relevant in nowadays workforce with digital occupations to better attract and retain a diverse workforce.

With our visualisation material, we were able to create a physical work environment that prevents not only stereotyping, but also tries to integrate a bigger target group into the IT occupation through the portray of not only the work and task itself, but we also highlighted other aspects of the job, which is recommended to be included into the daily worklife such as e.g. have a coffee, chat with colleagues, play table soccer and so on. This enables a sense of belonging to the work environment e.g. to other colleagues, and could attract more talents.

CONCLUSION

Our study project research goals were to perform an in-depth assessment of visualization techniques, stereotype-facing in digital occupation and we also examined the influence of stereotype and work environment using a content analysis approach. This work presents a framework for examining stereotype content alongside vocational choice in IT. As Catherine et al. has suggested, "biases are a problem for all workplaces, but can be especially significant in majority-minority group environments, such as tech" [3] .

Reflect & Takeaway

The purpose of this final report is to describe the whole project process of the last six months, from the generation of ideas to implementation, as well as evaluating on the outcome. Summarizing, it can be said that we have had a huge learning curve throughout this project. Learnings include to work scientifically by doing extensive research on the project topic, with the project goal of how "to build stereotype free representations of digital occupation" always in mind. Then, to conduct a qualitative study with a selected target group and analyzing the collected data with the usage of a research software. After all, a usability study was conducted to evaluate the impact of the concept. From the technical perspective, learning processes included the creation of a video format with the use of mainly scenario recordings, visual and interactive flash elements, as well as inserting sound effects and audio recordings. Furthermore, there were also learnings in the context of creativity and brainstorming, so we could come up with various ideas e.g. story board conceptions, and to test the viability and feasibility of these ideas, before reaching the implementing stage.

This was a challenging, but very insightful and instructive process. Nevertheless, there were challenges along the project work. Challenges include to manage and hold team meetings on a regular basis, to finish tasks accordingly in order to deliver the expected milestones and to meet the deadlines. There were different opinions on how, what or when to deliver various tasks, e.g. choosing one design concept, deciding on the video plot and visualization content, determining the target group – just to name a few. Other challenges include to learn and understand a new software quickly, in order to solve some tasks with it. Nevertheless, we could always agree as a team and find suitable solutions.

Moving Forward

It is a proven fact that there are a lot of stereotypes in digital occupations. It is a good first start to be aware of them. Within the context of our study project, we not only developed an awareness for them, but also tried to tackle the problems of stereotypes in the professional work environment through the creation of visualizations in a non-biased and non-stereotyped way. The visualization results were then tested with the target group, who shared their opinion on them. Having the interview results with this initial target participant as experimental group, we could replicate these to other groups in the future.

Nevertheless, this is one approach and there need to be many more approaches to find solutions against stereotyping in (digitalized) jobs. The more people tackle that problem, the higher the possibility for them to start changing their opinion and attitude towards a more open and stereotyped-free way of thinking.

ACKNOWLEDGMENTS

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We acknowledge that work materials for our visualization techniques, which have been highlighted in this work is available online at https://bit.ly/0-ViDiPP. Finally, we declare that the present project case and associated document was composed by ourselves and that the work contained herein is our own. We also confirm that we have only used the specified resources respectively in references section.

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Appendix 1 – Project Resources

1. Visualisation video source: https://bit.ly/1-ViDiPP
2. Interview resource: https://bit.ly/2-ViDiPP
3. Content analysis source: https://bit.ly/3-ViDiPP

Appendix 2 – Interview Questions

I. Main interview

First of all, do you have **questions regarding the proposal of study** (that we sent you before?)
Today's interview will cover the topic "**IT Security**" and we will have a closer look on the profession "**IT Security Administrator**".

a. Before showing the video

1. What do you think of when you hear the term **IT Security?**
2. Where did you get your knowledge about **IT Security?** *(e.g. from books, studies, online websites …) ?*
3. Would you be interested in learning something new about **IT Security**?
4. Have you ever heard or read of the job title **IT Security Administrator**?
5. What do you think does the **IT Security Administrator** do in his work? (His tasks?)
6. Do you think that the job **IT Security Administrator** is an interesting job?
7. Could you imagine working in as an **IT Security Admin** or in the **IT Security field**? Please explain.
8. What does **stereotype** mean for you? Give an example.
9. Where do you think do **stereotypes** come from & why do you have them?
10. What **stereotype** could apply to **IT** or **IT people** in your opinion?
11. What **stereotype** could apply to **IT Security** in your opinion?
12. What **stereotype** could apply to the job **IT Security Administrator**?
13. Have you ever heard of the **IT frameworks and policies** like COBIT, ITIL? Do you have an idea what it could be?
14. **If yes,** do you still remember what it is about?
15. The **title of the video** is called: "A day of an IT Security Administrator". Regarding that title, what do you expect will be the content of the video?

b. Video presentation

I will now show you a short **video** (4:30 minutes) which me and my group have created. Link to **video**.

c. After showing video

16. What are your **thoughts & impressions** after watching that video? Say everything that comes into your mind.
17. What do you think could be the **message & goal** of that video?
18. Does the video help you to have a **better understanding** of the profession **IT Security Admin**?
19. Do you think the video showed the job/ **tasks** of **IT Security Admin** in an **attractive** way? Were the tasks **interesting**? Give examples from the video.
20. Do you think that the video shows the job of an **IT Security Admin** in a **realistic** way? Explain.
21. A job like IT Security Administrator comes along with typical stereotypes - as we have discussed before. Could you find any of those **stereotypes** in the video or you think the video is **stereotype-free?** Explain.
22. In case you have found **stereotypes** in the video, what are your **suggestions for improvement** in order to get rid of those stereotypes? (e.g. suggestions how we could change our visualization to improve…)
23. Do you **like** this job now **more** than before watching the video?
24. Do you have **ideas for other visualization methods**/ design concepts to make the profession more interesting?
25. Could you now - after watching that video - imagine to **apply** for the job IT Security Admin? Please explain.
26. **If no**, what other profession could you imagine to start your career? Would it be also in the IT field?
27. Are you **interested** in getting to **know more** about this topic "**IT Security**" and profession "**IT Security Administrator**"? Please explain.
28. What is your **career** goal? Will it be IT related?
29. Who is the **influence** to your **career** decision? *(E.g. family, university, online material, audios, videos (as the one we showed to you)*
30. **What** do you think could make the choice for an IT Security **job more appealing** to you? *(e.g. money, reward, knowledge, open work environment, flexible working hours …?)*

d. Back-up questions (if interview time less than 30 minutes, than this questions should be cover)

1. Do you think your **university background** will be **relevant** for your **job**?
2. Would you **recommend others to apply** for an **IT** Security related job? Or IT job in general?
3. What do you think, could be the **consequence** if you do **not follow IT security procedures**? *(e.g. if you do not lock your computer/ use strong password…)*
4. Do you have **ideas for techniques** to **visualize stereotype-free**, e.g. to get rid of stereotypes?
5. Do you think that IT Security measures impact the **privacy and confidentiality** of user's data nowadays more than before?
6. Do you think that there are interference areas between **Security and Privacy**?
7. Do you accept the IT Security to **invade your privacy** to provide more safety for you and others?

8. Would you prefer to have **a work office** including **IT security safety implementations** *(like camera, fingerprint to check-in the office…)*?
9. How much do you think does the **interaction** between **IT Sec Admin and employees/ team** affect the work atmosphere?
10. What do you think - how much does work life balance activities (e.g. kicker, less work hours) inspire the **IT-Admin** to be more **creative**?
11. Why do so many **females** not apply for an **IT profession**?
12. Do you think visualization methods like showing a **video** is a good way to enhance the **attractiveness** of a job (e.g. IT Security Admin Job)? Explain.

II. Online Form

So now please fill out a very short + anonymous "**online form**" about general demography on the laptop and submit it directly from there. **LINK** to online form.

1. Gender: * (mark only one oval).
   - ☐ Female
   - ☐ Male
   - ☐ Prefer not to say
   - ☐ Other:
2. What degree are you currently pursuing? * (tick all that apply).
   - ☐ Bachelor
   - ☐ Master
   - ☐ PhD
   - ☐ Other
3. I am currently studying: * (tick all that apply).
   - ☐ Information System Management
   - ☐ Computer Science
   - ☐ Computer Engineering
   - ☐ Media Informatics
   - ☐ Other:
4. Year of graduation: … … …
5. What is your current status? (Multiple answers possible and tick all that apply).
   - ☐ Full-time student
   - ☐ Part-time student
   - ☐ Having work/ job/ internship
   - ☐ Not looking for work/ job/ internship
   - ☐ Looking for a work/ job/ internship
   - ☐ Other:
6. During your university education, have you gained some work experience? * (multiple answers possible and tick all that apply).
   - ☐ Internship
   - ☐ Working student
   - ☐ University employment (tutor, researcher)
   - ☐ Full-time employment
   - ☐ Part-time employment
   - ☐ No experience
   - ☐ Other:
7. Do you have any work experience in an IT related field? * (mark only one oval).
   - ☐ Yes
   - ☐ No
   - ☐ Not sure
   - ☐ Other:
8. What level of experience do you have with security related programming language? * (mark only one oval per row).

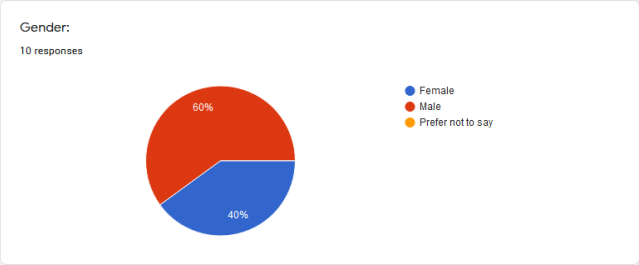
	Not at all	Beginner	Advanced	Expert
C, C++	◯	◯	◯	◯
JavaScript	◯	◯	◯	◯
Python	◯	◯	◯	◯
PHP	◯	◯	◯	◯
SQL	◯	◯	◯	◯

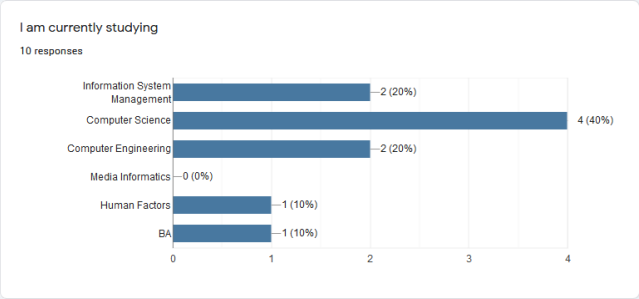
III. Questions from Participants

Thank you for participating in this interview & answering my questions.

Do you have any questions left?

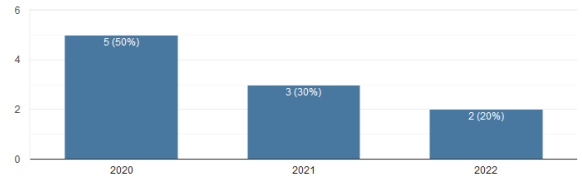
Appendix 3 – Participants Demographic





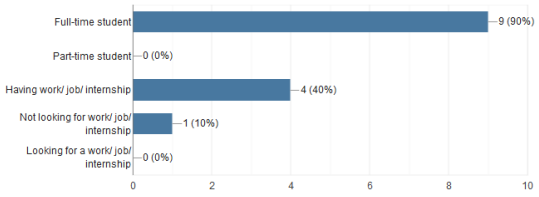
Year of graduation:

10 responses



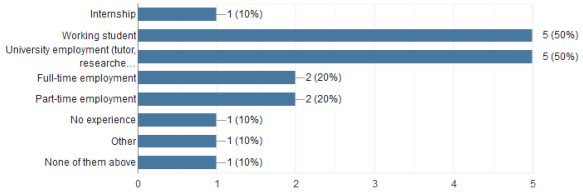
What is your current status? (Multiple answers possible)

10 responses



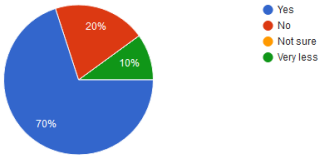
During your university education, have you gained some work experience? (Multiple answers possible)

10 responses

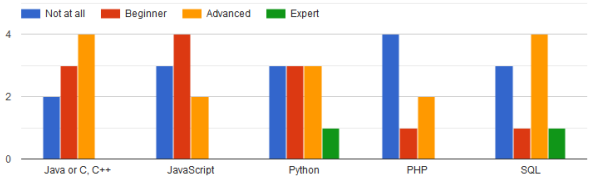


Do you have any work experience in an IT related field?

10 responses

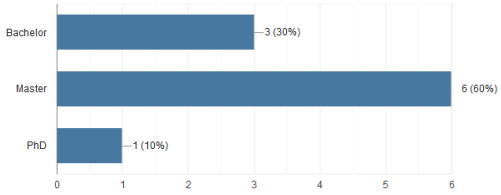


What level of experience do you have with security related programming language?



What degree are you currently pursuing?

10 responses



Appendix 4

Code Group	Code
programming	application computer developer data and/or information development of coding Java developer programming language Python developer software developer software development
technology	artificial intelligence clouds Cybersecurity digitalization IT Web
security	Cybersecurity encryption IT Security IT Security Administrator
stereotypes	age company portrays computer computer developer data and/or information development of coding gender IT IT People stereotype technology Urban cities village, region, country working hours
education	course creating awareness digitalization education and/or online courses engineers or engineering students job skills learn and knowledge research oriented software development specialist thought university
job	career Cybersecurity development of coding interview, salary IT Security IT Security Administrator job requirements job skills jobs LinkedIn Python developer software developer software development working hours
corporation	company company portrays IT company IT People technology
computer	application clouds computer operating system server servers | server servers and network
IT Worker	age computer developer IT People IT Security Administrator Java developer Python developer software developer working hours
visualisation	attractiveness comprehensibility impression interest IT Security Administrator stereotype video message