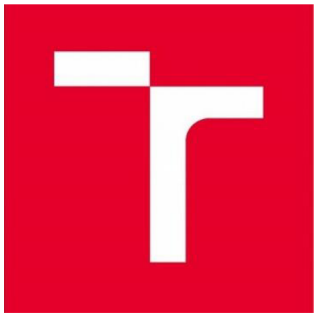

BRNO UNIVERSITY OF TECHNOLOGY
VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ

FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION
FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ

DEPARTMENT OF FOREIGN LANGUAGES
ÚSTAV JAZYKŮ

A PERPETUAL GLASS CEILING? THE POSITION OF WOMEN IN THE ICT SECTOR
PERMANENTNÍ SKLENĚNÝ STROP? POZICE ŽEN V OBLASTI ICT

BACHELOR'S THESIS
BAKALÁŘSKÁ PRÁCE

AUTHOR **Anastasiia Sobina**
AUTOR PRÁCE

SUPERVISOR **Mgr. Ing. Eva Ellederová**
VEDOUCÍ PRÁCE

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Bakalářská práce

bakalářský studijní obor **Angličtina v elektrotechnice a informatice**
Ústav jazyků

Studentka: Anastasiia Sobina ***ID:*** 189822
Ročník: 3 ***Akademický rok:*** 2017/18

NÁZEV TÉMATU:

Permanentní skleněný strop? Pozice žen v oblasti ICT

POKYNY PRO VYPRACOVÁNÍ:

Charakterizujte vývoj a současný stav postavení žen v oblasti informačních technologií, analyzujte faktory, které způsobují nízký počet žen v této oblasti, a navrhněte možné řešení, jak posílit povědomí o rovnosti žen a mužů a zvýšit zastoupení žen v ICT profesích.

DOPORUČENÁ LITERATURA:

1) Cheryan, S., et al. (2013). The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women. *Sex Roles*, *69*(1-2), 58-71.
2) Gürer, D. (2002). Pioneering Women in Computer Science. *SIGSCE Bulletin*, *34*(2), 175-183.
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Vedoucí práce: Mgr. Ing. Eva Ellederová

doc. PhDr. Milena Krhutová, Ph.D.
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Abstract

The purpose of this Bachelor's thesis is to examine women's position in the ICT sector. This thesis analyses the low representation of women in the ICT professions and in the ICT companies. It also deals with the hypothesis that females are facing a so-called "glass ceiling" that prevents women and minorities from obtaining upper-level positions, basing on stereotypes and prejudices. The theoretical part of this thesis consists of the following topics: the role of women in the historical development of computers, the list of some of the most outstanding females in the computer science world, the reasons for under-representation of female specialists in the ICT sector, the concept of "glass ceiling" and the description of the current situation in Europe, specifically in the Czech Republic, which is also complemented by the research statistics of the Czechitas organization. The information was collected by studying literature and analysing studies related to the topic. In the empirical part of this thesis, qualitative and quantitative research was conducted. The data were gathered by means of a questionnaire survey and interviews.

Key words

glass ceiling, ICT sector, under-representation of women, IT, gender inequality, STEM, stereotypes, gender studies, influential factors, female specialist

Abstrakt

Cílem této bakalářské práce je prozkoumat postavení žen v sektoru informačních a komunikačních technologií (dále jen ICT). Práce analyzuje nízké zastoupení žen v profesích ICT a v ICT firmách. Dále se zabývá hypotézou o ženách čelících takzvanému „skleněnému stropu“, který brání ženám a menšinám získat pozice na vyšší úrovni založené na stereotypech a předsudcích. Teoretická část této práce se skládá z následujících témat: role žen v historickém vývoji počítačů, seznam některých nejvýznamnějších žen v oboru informatiky, důvody pro nedostatečné zastoupení specialistů ženského pohlaví v ICT, koncepce „skleněného stropu“ a popisu současné situace v Evropě, konkrétně v České republice, kde tato data doplňují statistické informace organizace Czechitas. Informace byly shromážděny studiem literatury a analýzou studií souvisejících s daným tématem. V empirické části této práce byl proveden kvalitativní a kvantitativní výzkum. Data byla shromážděna prostřednictvím dotazníkového šetření a rozhovorů.

Klíčová slova

skleněný strop, sektor informačních a komunikačních technologií, nedostatečné zastoupení žen, informační technologie, nerovnost mezi pohlavími, předměty STEM, stereotypy, genderová studia, ovlivňující faktory, ženy specialistky

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Prohlášení

Prohlašuji, že bakalářskou práci na téma *Permanentní skleněný strop? Pozice žen v oblasti ICT* jsem vypracovala samostatně pod vedením vedoucí bakalářské práce a s použitím odborné literatury a dalších informačních zdrojů, které jsou všechny citovány v práci a uvedeny v seznamu literatury na konci práce.

Jako autorka uvedené bakalářské práce dále prohlašuji, že v souvislosti s vytvořením této práce jsem neporušila autorská práva třetích osob, zejména jsem nezasáhla nedovoleným způsobem do cizích autorských práv osobnostních a/nebo majetkových a jsem si plně vědoma následků porušení ustanovení § 11 a následujících zákona č. 121/2000 Sb., o právu autorském, o právech souvisejících s právem autorským a o změně některých zákonů (autorský zákon), ve znění pozdějších předpisů, včetně možných trestněprávních důsledků vyplývajících z ustanovení části druhé, hlavy VI. díl 4 Trestního zákoníku č. 40/2009 Sb.

V Brně dne ....

Anastasiia Sobin

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I would like to express my gratitude to my supervisor Mgr. Ing. Eva Ellederová and I would like to thank her for help and support throughout writing of this thesis.

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1 Introduction

Albeit European countries put the significant amount of the efforts into establishing an equal right for both women and men in the workplace, there are still a large number of female specialists who are struggling to break the so-called "glass ceiling".

The concept of this phenomenon can be described as a specific type of gender or racial inequalities that prevent minorities from acquiring positions of higher ranks (Cotter at al., 2011). The effect of the "glass ceiling" in particular, can be seen in the ICT[1] sector, where males constitute the vast majority of the total number of ICT specialists, whereas the number of females in this sector is gradually decreasing.

The problem of under-representation of women in the ICT sector is the main focus of attention in numerous west countries, such as the United States, Great Britain, Australia, Canada, Germany, Italy, France and Denmark, the governmental and non-governmental institutions of which are attempting to find a solution to this situation so that the potentials of women could be fulfilled. Eurostat (2017, September 28) informs: "The empowering women in the tech sector will provide a boost to the economy and allow for full participation in society". It is not only a matter of concern for the governments but also for female students who are graduating from technical universities with no assurance about the equal treatment at the workplace.

The objectives of the bachelor's thesis are: to describe the historical positions of women in IT[2], gather the information about a low representation of women in the ICT sector, provide an overview of foreign theoretical studies and hypotheses explaining this phenomenon, and finally, depict the current situation in the Czech Republic and compare it to European countries.

The main research question is:

1) What are the main factors that hinder women from ICT career?

The sub-questions are listed below:

2) Why are female specialists underrepresented in the ICT professions?

3) How can gender barriers in the ICT sector be reduced?

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[1] ICT refers to Information Communication Technology

[2] IT refers to Information Technology. The terminology has not become established as some sources use ICT and others IT, therefore both abbreviations are used in this thesis.

The whole thesis is divided into two parts: theoretical and empirical. The theoretical part provides an introduction of the historical background of women in ICT development and also their achievements in science world, some of the greatest females were included in the chapter. The next chapter deals with barriers that female specialists and female students encounter with when attempting to join the ICT boy's club or when they are trying to get on a higher position. A separate chapter was devoted to the effect of "glass ceiling" where a more detailed concept of it is explained. The final chapter of the theoretical part gives a real picture of women's position in the ICT sector in the Czech Republic as well as in some of European countries. The empirical part of this thesis handles questionnaire that was designed in order to prove or disapprove the labelling and stereotyping of those women who are fascinated by exact science. In the concluding chapter, the research questions that are outlined in the beginning are answered according to the findings.

2 The theoretical part

2.1 The role of women in ICT history

Even though the history of computer science is well-documented, there are very few women who were mentioned in it. Because of that, one may think that women did not play a significant role in the development of computer science. However, it would be wrong to suppose that it is true. In fact, there were many of them who made important contributions in informatics and communication evolution. Since the very beginning of the first computer machines women were involved in all stages of their development, from launching projects to designing and programming the machines. In fact, during World War II almost every programmer was a female. During that period, women were called "computers" or "calculators" Gürer (2002, p. 176). Suffice to say that they were stereotyped to be good candidates for being programmers as Gürer (2002) asserts, "Programming requires a lot of patience, persistence and a capacity detail and those are traits that many girls have" (p. 175).

The next chapter is devoted to just some of the women who were pioneers in computer science, and whose work on the first machines or even programming languages resulted in a breakthrough in technical development.

2.2 Famous women in ICT history

Ada Lovelace

Algorithm Enchantress

The early history of electronic computing was launched with contributions of great woman named Augusta Ada Byron Lovelace, daughter of Lord Byron, who is better known as "Ada Lovelace". She is the first author of a computer program, even though she lived more than a century before the first modern computer was invented.

Ada Lovelace was born in London on December 10, in 1815. At an early age, Ada had already showed that she was gifted for mathematics. Around the age of seventeen, Ada Lovelace became friends with an inventor and mathematician Charles Babbage, who then became a mentor to her. Ada Lovelace got a chance to translate an article on Babbage's analytical engine that had been written by Italian engineer Luigi Federico

Menabrea for a Swiss journal. She not only translated the original French article into English, but also wrote her own ideas and thoughts about the difference engine, the first automatic calculating device and the analytical engine, which contained the first set of principles for a general-purpose programmable computing machine (Gürer, 2002). Her commentaries contained a table describing the operations necessary for solving mathematical problems. In the end, her voluminous notes were three times longer than the original text. Then, in 1843, her work was published in an English science journal. In her annotations, Ada described the way in which codes can be created for the device in order to handle symbols, letters and numbers all together. She also formulated a method for the engine for repeating a series of instructions. This process is known as looping and it is used by all computers today. Ada also offered up other forward-thinking concepts in the article. For her work, Ada is often considered to be the first computer programmer.

The contribution of Ada Lovelace to the field of computer science was not discovered until the mid-twentieth century. Only in 1953, B. V. Bowden reintroduced her notes to the world in *Faster Than Thought: A Symposium on Digital Computing Machines*. Since then, Ada has received many posthumous honours for her work. In 1980, the U.S. Department of Defence named a newly developed computer language "Ada," after Lovelace (Biography.com, 2017).

Grace Murray Hopper

Programming pioneer

Another great woman who demonstrated an ability to see the future directions of computer science is Grace Murray Hopper. She was born in 1906, in New York. Connor and Robertson (1999) mention that by the age of thirty-five she had achieved the rank of associate professor of mathematics and won a faculty fellowship for study at New York University's Courant Institute for Mathematics. Growing up in a family who followed military tradition, it was not surprising for anyone when she resigned her teacher post to join the Navy WAVES (Women Accepted for Voluntary Emergency Service) in December 1943. Then, in July 1944, she became a lieutenant and was the third person invited to join the research team of a professor (and Naval Reserve lieutenant) Howard H. Aiken. Working on a project on the electromechanical computing machine Mark I, Hooper learned to program by putting together a 500-page *Manual of Operations for the*

Automatic Sequence-Controlled Calculator in which she outlined the fundamental operating principles of computing machines. By the end of World War II in 1945, Grace Murray Hopper was working on the Mark II under the command of Aiken. It was in this machine that the first actual "computer bug" was found. Four years later she joined the newly formed Eckert-Mauchly Corporation where BINAC and UNIVAC, the first commercial electronic computers, were being developed. She found a way to program a computer by using words rather than numbers, which provided the foundations for the program language well-known as COBOL (Connor & Robertson, 1999).

Hooper continued to work until she was eighty years old, and at this age she was the oldest active duty officer in the United States. Due to her diligence, she was elected a Fellow of the Institute of Electrical and Electronics Engineers (1962), a Fellow of the American Association for the Advancement of Science (1963), and received Achievement Awards from the Society of Women Engineers (1964) and from the Institute of Electrical and Electronics Engineers (1968) (Connor & Robertson, 1999). Hopper is undoubtedly one of the greatest women of the century who was worldly admired and respected not only for her professional achievements but also for her enthusiasm, energy and willingness to serve as a mentor.

Sister Mary Kenneth Keller

Developer of BASIC

It may seem that being a religious person and scientist at the same time is almost an impossible combination. But it is not the case of Sister Mary Kenneth Keller who was not only the first woman to earn a Ph.D. in Computer Science, but also a nun.

Mary Kenneth Keller was born in Ohio, in 1914. She became a member of the Sisters Charity in 1932. Although it is more typical of a nun to be partially isolated form society, she was determined to participate actively in the wider world. For that reason, she studied at DePaul University, where she obtained a B.Sc. degree in Mathematics and then M.Sc. in Mathematics and Physics. When Keller studied at Dartmouth College all women there were banned from using the computer centre, but especially for her, an exception to that rule was made. It helped Mary Kenneth to develop the computer language called BASIC (uCatholic, 2017). This language served as a "translator" for ones and zeros of a computer code to something more intuitive and straightforward. By that time only mathematicians and scientists had had an ability to write custom

software, nonetheless BASIC made it possible for everyone who would learn that language to do so, and, as the result, computers became much more accessible to a wider public.

According to uCatholic (2017), Keller's dissertation, written in CDC FORTRAN 63 was titled *Inductive Interference on Computer Generated Patterns.* It involved constructing algorithms that performed analytic differentiation on analytic expressions. In 1965, she became the first American woman to earn a Ph.D. in computer science. The computer science department was founded afterward at Clarke Collage in Iowa under the guidance of Sister Mary. She chaired it for twenty years. Sister Mary also established a master's degree program for computer applications in education (uCatholic, 2017).

Edith Clarke

Professor of electrical engineering

Edith Clarke was born in 1883 in Maryland, during the time when almost no women were gaining a college degree. She graduated with A.B. degree from Vassar College in Poughkeepsie, New York, where she studied mathematics and astronomy. Four years later in 1912 Clarke became a computing assistant to George A. Campbell, who was the owner of AIEE's Edison Medal. She learnt the theory of transmission lines and electric circuits. At the age of 37 she earned an M.S. in Electrical Engineering. Then, in February 1926, Edith Clarke became the first women to present at an AIEE[3]meeting. TheFamousPeople.com(2017) report that her technical paper *Steady-State Stability in Transmission Systems* was later published in AIEE Transactions. Clarke later earned the AIEE's 1932 Best Regional Paper Prize and the 1941 National Paper Prize.

Marissa Mayer

CEO, Yahoo!

It is undeniable that not only men are capable of leading a well-known company successfully. And a great example of it is Marissa Ann Mayer. She was born on May 30, 1975, in Wausau, Wisconsin. At school, Mayer was selected by the Governor of Wisconsin itself to attend the National Youth Science Camp. She went to Stanford

[3] AIEE refers to American Institute of Electrical Engineers.

University where she got her B.Sc. degree in Symbolic Systems and then M.Sc. in Computer Science. Being an extremely gifted student, Marissa specialized in artificial intelligence in her university. It is not surprising that when time to choose the job came, she received more than twenty high paying job offers. Although having offers of more prestigious jobs, Marissa chose to join a start-up company called Google. At that time, there were only nineteen employees at the company, and she became the first female engineer in it. She worked for thirteen years at this company as a designer, engineer, product manager and executive. Biography.com (2015) note that Marissa Mayer helped to develop some of the most successful projects of Google like Google Search, Google Images, Google News, iGoogle, Gmail, Google Maps, etc. 10 years later she was made Vice-President of Search products and User Experience. Thanks to her contributions Google went from being a small start-up company to a global super powerful internet company in the world today. Nevertheless, it was not the greatest point in her career. Marissa Mayer joined rival company Yahoo! as its CEO and President. Marissa is included in the list of America's 50 Most Powerful Women for six years from 2008 to 2013 (Fortune.com, October 8, 2012).

Sherly Sandberg

COO, Facebook

Sheryl Sandberg (see Figure 1) was born in Washington, D.C., in 1969. She finished Harvard University where she received her bachelor's degree in Economics. After working in the World Bank and in the U.S Department of the Treasury, Sheryl moved to Silicon Valley and worked for Google as a vice president of global online sales and operations for seven years. Currently she is a Facebook's chief operating officer. According to Biography.com (2017), in 2012 Sandberg became the first female member of the company's board of directors. She also received the seventh place in the *Forbes*' list of The World's 100 Most Powerful Women in Tech 2016 (Howard, 2016).

Not only individually but also in cooperation women achieved marvellous results in programming. Gürer (2002, p. 177) mentions a group of six women: Kathleen McNulty, Frances Bilas, Elizabeth Jean Jennings, Frances Elizabeth Snyder, Ruth Lichterman and Marilyn Wescoff who were chosen out of a group of one hundred women for programming the world's first electronic general-purpose computer, designed by Presper Eckert and John Mauchly, which was unveiled in 1946 as the Electronic

Numerical Integrator and Computer (ENIAC). Programming of it was very distinctive from what we use today; at that time, "machine code" was applied. They used ENIAC's basic arithmetic and logical functions to calculate quantities such as rocket trajectory.

Figure 1. Sheryl Sandberg. Reprinted from https://www.wsj.com/articles/sheryl-sandberg-women-are-leaning-inbut-they-face-pushback-1474963980

2.3 The reasons for the lack of women in the ICT sector

Considerable national and international measures have been taken towards gender equality and women liberation, but, unfortunately, there is still a lack of them in the ICT sector. Eventually, the majority of potential female specialists are born in cultures where, when it comes to maths and science, male abilities are highly promoted, whereas female abilities are underestimated. It can be mostly referred to the countries with a patriarchal society. A psychologist Welsh (2016, October 16) has identified several factors that largely influence girls in choosing STEM[4] subjects. Those factors can be observed in the Figure 2.

[4] STEM refers to science, technology, engineering, and mathematics.

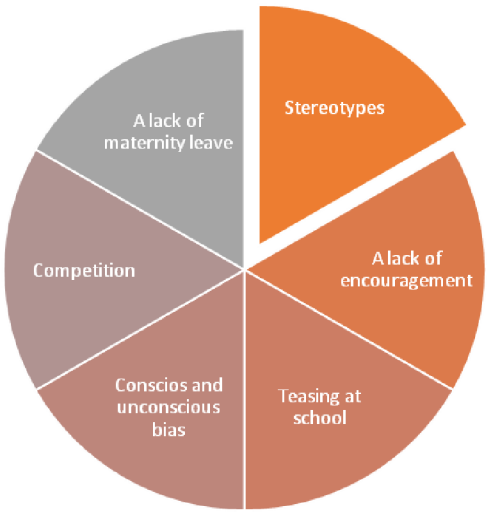

Figure 2. Factors that limit women's presence in the ICT sector. Adapted from Welsh (2013, October 16).

Factor 1: *Teasing at school* is a critical issue. Even at the high school level, a girl who is interested in advanced physics and math may be stereotyped by classmates and teachers. As an emotional state of any teenager is very sensitive to criticism and disapproval that come from peers or even teachers, it can discourage a young woman from studying the exact science.

Factor 2: *A lack of encouragement* from teachers and parents might play a significant role in pupil's motivation to study. A physicist major Pollack (2013, October 3) admits, "I didn't go on in physics because not a single professor — not even the adviser who supervised my senior thesis — encouraged me to go to graduate school. Certain this meant I wasn't talented enough to succeed in physics, I left the rough draft of my senior thesis outside my adviser's door and slunk away in shame".

Factor 3: *Stereotypes*. It is undeniable that the impact of stereotypes can be very devastating and harmful for everybody. Such discriminatory images as 'girls cannot study STEM subjects', 'Science is not for girls, cooking, cleaning, washing – are the only women's work' and 'girls cannot be in charge' are displaying the wrong and inappropriate portrait of females. Cheryan et al. (2013) report that when female adolescences hear about a non-stereotypical computer scientist, their interest in the field increases. Moreover, when females are exposed to "nerdy-white guy" stereotypes, it also discourages them from the STEM fields (Armstrong, 2013, June 25). That statement proves the following graph, which shows women's and men's interest in

majoring in computer science after reading a newspaper article claiming computer science majors fit or did not fit current stereotypes. The scale ranged from 1 (strongly disagree) to 7 (strongly agree). According to the Figure 3, the interest among the weaker sex in computer science significantly increases after reading a non-stereotyping article.

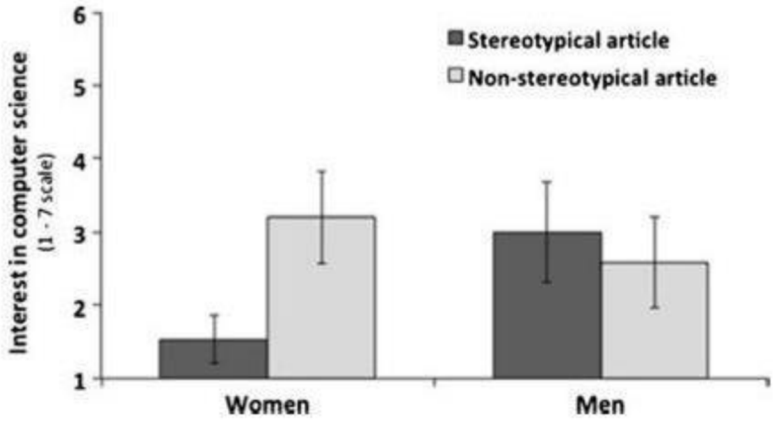

Figure 3. Women's and men's interest in majoring in computer science. Reprinted from Cheryan et al. (2013).

Media also play an important role in forming gender stereotypes. In the TV show *The Big Bang Theory*, Penny is an example of such stereotypical representation of a female. Even though she is considered to be a part of the geeks' group, she has an image of a "dumb blond girl" in it.

Factor 4: *Childcare*. Welsh (2013, October 16) suggests that the luck of maternity leave and childcare after having kids is one of the frequent reason for which females leave STEM fields earlier in their career. Albeit some start-ups and academia allow flexible days and even home office, there are still 41 % of women postdocs who after having babies retreated from their original goal of being a research professor, versus 20 % of those who do not have children (Philippidis, 2013, October 15).

Factor 5: *Competition*. Women are generally said to be less eager and competitive than men. That is why their desires to go up the career ladder in the science are decreasing when it comes to resist the constant competition to publish, which is the major determinant of a flagging career (Margolies, 2016). Those female specialists whose personalities are naturally not inclined to be aggressive can become exhausted because of the constant push to compete. In addition, they often under evaluate their own skills, thus preferring to stay aside when it comes to compete with other women or especially men.

Factor 6: *Conscious and unconscious bias*. According to Welsh (2013, October 16), "Women in the STEM fields face a constant bias against them, not just from male colleagues, but also from females". Males are often considered to be better candidates by both male and female employees when it comes to choose between two candidates with identical resumes of both genders. Prives (2013) points out that 40 % of employees avoid hiring female specialist of childbearing age; furthermore, the same percentage of employees admits being wary of hiring women who have already had a child. Furthermore, there is a large number of people who are prejudiced unconsciously. They are completely unaware of holding these negative implicit biases (Next Generation.,2015, September 15).

2.4 The glass ceiling effect

It is believed that women in ICT professions are facing a "glass ceiling", a concept which Cotter et al. (2011) explain as "artificial barriers to the advancement of women and minorities". In other words, "glass ceiling" means an unacknowledged upper limit in organisation and corporations which is difficult or even impossible for females/minorities to rise above in rank. Such a barrier occurs due to implicit prejudice based on ethnical, political, sexual and religion affiliation and age. Unfortunately, most of the time people may not be aware of its existence until they encounter it. The most common issues that limit a female career are lack of experience, patriarchal society and stereotypes.

2.5 Current situation in the Czech Republic

The Czech Republic belongs to those countries where there is still great disproportion in ICT professions and technical studies. It is believed that males are predominant in this sector, whilst females are minorities. In order to prove it, the following statistics must be taken into account.

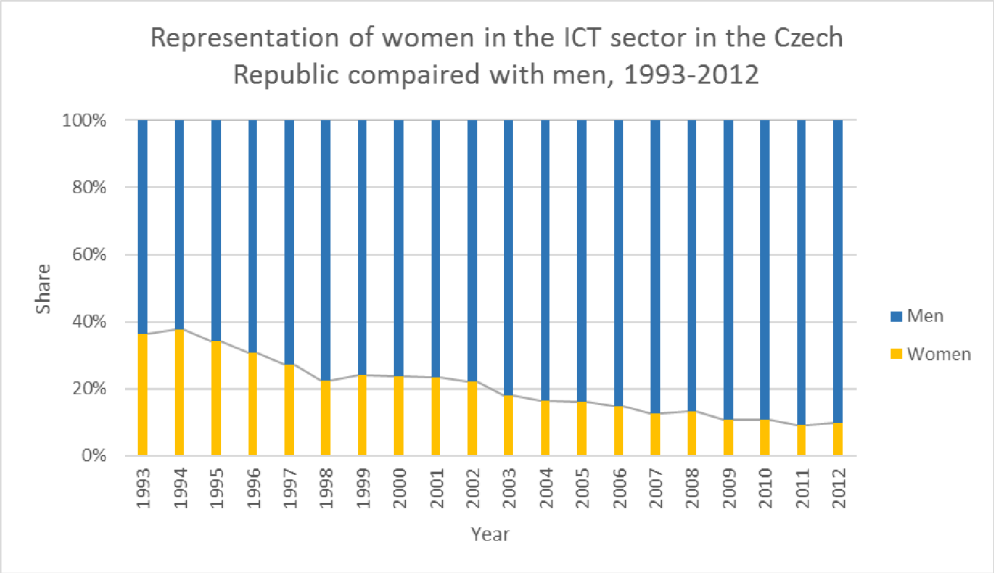

Figure 4. Representation of women in the ICT sector in the Czech Republic compared with men, 1993–2012. Adapted from Český statistický úřad (2017).

Firstly, the Czech Statistic Department (Český statistický úřad, 2017) claims that in 2015 there were only 9.8 % per cent of female specialists in the ICT sector working in the Czech Republic; albeit, in 1993 there were 36.4 % per cent of them (see Figure 4). It follows that women represent only one fifth of the total number of the ICT specialists.

Table 1. *ICT professionals and technicians in the Czech Republic (in thousands).*

Year	1995	2000	2005	2010	2011	2012	2013	2014	2015
ICT professionals*	**25.9**	**34.7**	**36.8**	**48.9**	**69.1**	**70.5**	**73.3**	**83.6**	**86.0**
men	20.3	29.0	33.1	44.7	61.9	63.4	64.9	75.3	77.2
women	5.5	5.7	3.7	4.2	7.2	7.1	8.4	8.2	8.8
ICT technicians**	**33.6**	**37.8**	**41.9**	**72.7**	**79.0**	**80.0**	**79.1**	**76.9**	**69.1**
men	18.8	26.4	32.9	64.0	72.2	70.7	72.8	70.8	63.2
women	14.8	11.3	8.9	8.7	6.8	9.3	6.3	6.1	5.9
total (in thousands)	**59.5**	**72.5**	**78.7**	**121.6**	**148.1**	**150.5**	**152.4**	**160.4**	**155.1**
men	39.2	55.4	66.1	108.7	134.1	134.2	137.7	146.1	140.4
women	20.4	17.1	12.6	12.9	14.0	16.4	14.7	14.3	14.7

Note. Adapted from Český statistický úřad[5] (2017).

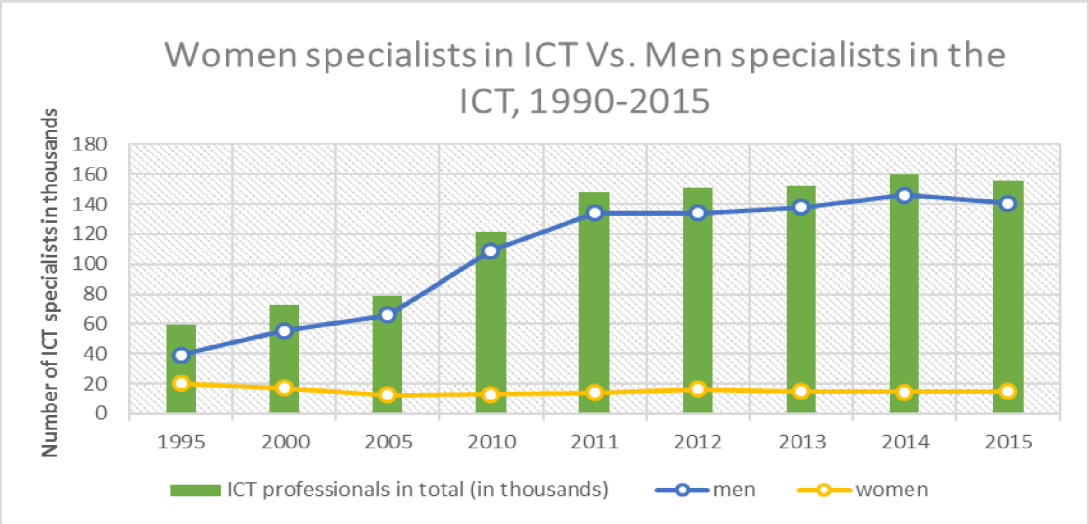

Figure 5. Women specialists in ICT vs. Men specialists in ICT, 1990-2015. Adapted from Český statistický úřad (2017).

Secondly, the pessimistic tendency can be observed in Table 1 above which represents ICT professionals, experts and specialists. The Czech Statistic Department (Český statistický úřad, 2017) defines that ICT experts are "Scientists and experts in the field of computer technology", while ICT specialists are "Technicians in the field of computer technology". This statistic is showing that the total number of ICT female professionals has not changed that much during period from 2000 to 2015. The average percentage of 14.6 % is about the same throughout these years and has slightly varied. In contrast, men's statistic tendency is more encouraging. The Figure 5 indicates that theirs number has noticeably increased from 40 thousand to 140 thousand people. It means that, since

[5] *ICT professionals are mostly people with no university degree.
**ICT technicians are those with a university degree.

2005, only 2 100 women joined the ICT field, whereas there was an increase in number of men by 74 300 people.

Finally, Eurostat (2017, September 28) published a report, where 32 European countries were involved in, which clarifies that in such countries as Turkey, Slovakia and the Czech Republic there were the most pronounced gender inequality in 2016, as it can be seen in Table 2. It also states that those countries had the proportion of men in the ICT sector workplace of 90.1 %, 90.8 % and 89.8 % respectively. The highest proportion of male and female professionals can be seen in Bulgaria (30.2 %), Romania (26.3 %), Latvia (24.8 %) and Lithuania (24.8 %).

Table 2. *Comparison of female specialists in the ICT sector in EU countries (percentage), 2007-2016.*

GEO/TIME	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Belgium	15.9	15.6	15.8	17.1	15.2	17.1	15.5	15.2	15.1	14.1
Bulgaria	27.2	34.2	38.3	34.8	33.4	32.9	27.1	32.2	27.7	30.2
Czech Republic	29.7	28.3	23.7	21.8	10.6	12.3	9.9	10.3	9.9	11.2
Denmark	23.2	20.5	19.8	20.9	17.3	16.8	17.0	16.6	18.5	20.0
Germany (until 1990 former	21.7	18.0	15.7	15.2	13.5	15.2	15.6	16.5	16.3	16.6
Estonia	36.4	38.3	40.9	40.1	23.0	25.8	19.6	19.1	20.3	18.7
Ireland	23.2	26.5	25.2	22.5	21.8	21.1	21.7	20.1	18.9	19.0
Greece	24.8	26.0	27.2	24.8	15.4	18.3	18.0	17.1	13.2	12.7
Spain	18.3	22.1	22.3	17.6	19.3	16.4	19.1	18.0	17.4	15.4
France	17.1	18.3	19.8	19.0	18.3	18.4	19.3	15.5	16.6	18.1
Croatia	20.2	22.5	19.4	21.2	13.3	14.8	17.0	14.2	16.6	13.3
Italy	16.8	16.6	16.7	16.2	14.4	15.9	14.1	13.7	13.8	14.2
Cyprus	21.9	20.4	21.8	22.5	17.6	17.9	14.1	11.9	17.1	19.8
Latvia	33.0	30.6	32.1	29.5	24.8	20.9	20.5	23.4	24.7	24.8
Lithuania	29.2	44.0	35.5	32.4	-	23.2	-	-	20.1	24.8
Luxembourg	16.2	8.2	13.7	12.2	12.5	10.5	11.5	10.8	12.6	13.7
Hungary	32.9	34.0	36.4	39.0	9.5	10.6	10.1	11.7	11.9	13.1
Malta	22.7	21.6	24.3	28.4	16.3	9.4	15.1	15.9	16.1	11.7
Netherlands	15.4	15.1	16.1	14.2	12.1	13.1	14.4	12.2	13.0	15.6
Austria	21.7	18.1	19.3	19.6	13.2	16.7	14.0	13.3	14.2	17.2
Poland	31.7	31.1	31.4	31.1	14.1	16.0	14.2	13.9	13.5	14.5
Portugal	18.9	17.2	23.3	22.9	14.6	11.9	11.6	13.7	15.3	16.1
Romania	29.7	33.9	34.0	30.9	21.7	21.3	23.3	21.5	27.2	26.3
Slovenia	25.2	26.9	24.8	26.2	15.8	13.9	12.7	13.3	16.0	17.3
Slovakia	34.4	34.1	33.8	36.1	16.5	12.9	9.1	12.0	11.4	9.2
Finland	23.1	24.5	27.6	24.5	19.4	17.5	20.1	21.6	22.4	21.9
Sweden	21.0	20.9	21.0	20.7	19.0	19.4	19.6	19.1	18.9	20.8
United Kingdom	23.6	22.8	23.1	24.6	15.7	15.8	16.8	16.5	16.2	16.2
Iceland	24.6	22.4	25.9	25.6	15.1	16.7	16.9	21.4	22.7	22.0
Norway	15.3	15.9	15.6	16.2	15.3	14.4	16.6	16.1	17.0	19.4
Switzerland	17.6	18.0	18.0	17.3	13.0	12.8	14.6	13.9	14.7	14.6
Turkey	20.6	20.5	21.2	22.5	10.0	11.3	13.3	13.1	11.6	9.9

Note. Adapted from Eurostat (2017, September 28).

In conclusion, the studies clearly demonstrated that women are highly under-represented in most STEAM related educational fields and careers in the Czech Republic; moreover, the statistics proved that there is a huge gap between two genders in ICT area, where men are dominant gender.

2.5.1 Czechitas findings

Czechitas is a Czech non-profit organisation that aims to educate and inspire girls and women to choose an information technology sector, as well as to build a community of girls who are interested in ICT. With the help of a variety of workshops and courses, the organisation is trying to solve the problem of the lack of gender diversity in the ICT environment. Those who are interested can learn basics of website development, programming, graphics and data analytics. The greatest inspiration for this organisation was the American project "Girl Who Code" (Czechitas.cz, n.d.).

In 2017, Czechitas conducted quantitative and qualitative large-scale research on the motivation, inspiration and future of women. This research was attended by 302 women from different cities of the Czech Republic. Some of the findings are observed in this chapter and then compared to the findings of my research in the conclusion. The answers to the survey are the following:

Why did you become interested in the ICT sector?

More than one third of women (34 %) became interested in the ICT sector because they wanted to try something new out of curiosity. The second most popular motivation (16 %) was that respondents were attracted by the school subjects that dealt with information and communication technology. Slightly smaller number of them (14.9 %) said that it was a possibility to get a new job.

What discouraged you from ICT?

Only 10 % of female respondents said that they were discouraged by parents from ICT, mainly due to the gender stereotypes related to ICT. Teachers and classmates in schools discouraged approximately 6 % of those respondents. Almost 78 % of women did not experience any discouragement from anyone.

What according to the employees discourages women from ICT?

Nearly 60 % of the female and male representatives of the firms that were addressed believe that there are barriers which prevent women from entering the ICT sector, the rest 60 % did not find any factors. Firstly, the most common causes of women's under-representation are, in their opinion, societal prejudices and stereotypes. It is supposed that the ICT sector is a men's world where women will never be as good as men. Furthermore, there is a widespread misconception in society that ICT work is unattractive and boring. Secondly, a "poor education system" was claimed as one of the

crucial factor that explains this phenomenon. The participants of the research explain that there is a great deal of pressure on the teaching of exact subjects and informatics, which, in their view, discouraged girls from these subjects. Thirdly, according to respondents, the reason for the shortage of female specialists in the ICT sector is maternity or parenting. The fact that women take maternity leave for a quite long time means that they are losing their pace with the rapidly changing ICT environment. This leads to the resulting lack of knowledge and skills which are required for the current job positions.

Why are women not interested in pursuing an ICT career?

Based on the questionnaires that were filled in by the interviewed women, Czechitas (2017) found that women are often discouraged from starting the ICT career by the complexity of the ICT specialisations (25 %). At the same time, a large number of them doubt about their own abilities (19 %). The need for mathematical and analytical thinking (13 %) ranks third. There is also a fear of a predominantly male environment (11 %). In addition, women from ICT are discouraged by a variety of personal barriers, including lack of courses, English skills or a sedentary style of work (see the category Other in the chart of Figure 6).

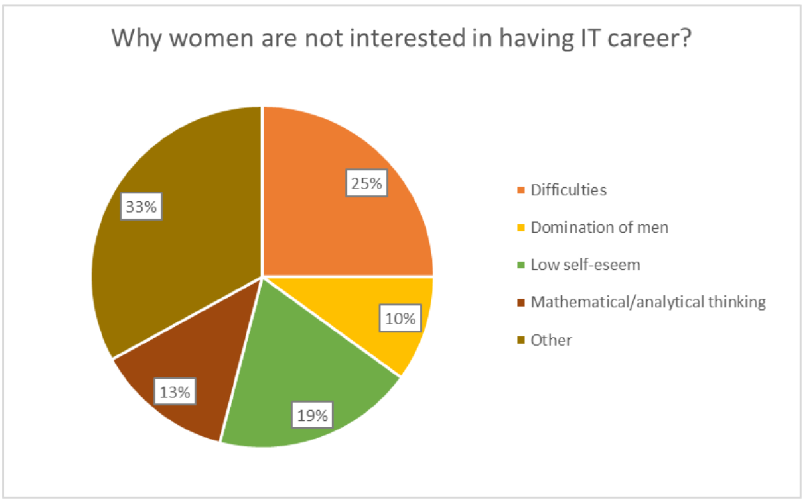

Figure 6. Why are women not interested in pursuing an ICT career? Adapted from Czechitas (2017).

3 Practical part

3.1 The aim of the research

This chapter concerns the quantitative and qualitative research based on online questionnaire survey and interview. A mixed methods research was selected due to the complexity of the issue. Creswell and Plano (2007) imply that such method "provides strengths that offset the weaknesses of both quantitative and qualitative research" (p. 9). The quantitative research constitutes the main part of the thesis; while, the qualitative research was conducted for gaining a better insight into females' experiences of having men-dominated occupations.

The main aims of quantitative research are the following:

1) To examine a hypothesis predicting that women in ICT professions and women who are interested in STEM subjects are stereotyped and underestimated in society.
2) To explain the reasons for the lack of female specialists in the ICT field mainly from the students' point of view.

The intermediate aim is:

3) To propose, based on the findings of the research, possible solutions for increasing a number of females in the ICT sector.

The quantitative research's goal is:

4) To describe current position of women of the ICT professions.

In the following chapters, the phases of the research will be described, the gathered data analysed and interpreted.

3.2 Phases of the research

The research design consists of three main phases:

- Preparation phase
- Realisation phase
- Evaluation phase

3.3 Preparation phase

At the beginning, I conducted literary research to examine the position of women in the ICT sector. After the objectives and aims that I wanted to achieve had been established, I proceeded to the selection of potential respondents and a data collection method.

Questionnaire

I had to define the target respondents that my survey would address by using a stratified random sampling method. I divided the respondents into homogeneous groups, such as students under 18, students in the age range from 18 to 26 and students that have more than 26. This method allows to distinguish a specific subgroup within the population and it ensures the presence of the key subgroup within the sample (Explorable.com, n.d.).

A questionnaire survey was selected as a method of collecting data because the results of such a method can be quickly analysed and easily quantified in spite of having a great number of respondents. The online generated questionnaire in the Internet software SurveyMonkey® was chosen for this purpose. I shared the questionnaire on the several Facebook pages such as my personal page, the page of the Brno University of Technology students group called Prvaci na FEKTu 2015, and, to gather responses from other countries, the post with the questionnaire was uploaded to the Survey Sharing group[6] that mostly consists of the target audience of my survey. The research sample consisted primarily of the university students of both female and male genders aged from 18 to 26, but ages above and under this range were also taken into consideration. The reason for this choice was to demonstrate attitudes of people towards the problem of under-representation of women in the ICT sector.

Interview

To conduct the qualitative research for this thesis, I chose to carry out an interview, so the extended answers could complete or even compensate the weaknesses of the questionnaire.

As a sampling strategy, I applied criterion based sampling which is usually used when there is a need for understanding and identifying the cases that are extremely

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[6] Survey Sharing 2016/2017 is a Facebook study group that was created in order to help students all around the world gain respondents for their surveys by filling in the surveys of other people. Besides data collecting, it is also used for discussions of research-related topics. The group has 5,064 members.

informative. There were three critical criteria for selecting the participants for the qualitative phase: (A) be a woman; (B) work in the ICT sector; (C) work for at least one year in that field.

3.4 Realisation phase

Questionnaire

During the process of questionnaire designing and data collecting, the questionnaire was changed several times. A pilot version was launched in order to identify whether respondents have any problems in answering and understanding questions. During this stage, the constructive criticism was received from a few respondents. The questionnaire had to be modified because some questions were misleading and respondents were confused with the questions formulation and the rating scale.

Based on the recommendations that were given, the final version of questionnaire was designed (see Appendix 1). For simplicity of data evaluation, the matrix and closed questions were chosen to be the dominant type of questions. In the matrix questions, the Likert rating scale was used and for closed-ended questions the binary scale was chosen. Likert scale offers a range of answer options from "strongly dislike" to "strongly like", at the same time, the binary scale offers only two possible answers that depend on the purpose.

Interview

Considering the criteria that were predefined, I started to look for those who may be good candidates for my research among my friends. The best option was using a "snowball[7]" method. When interviewing one respondent, I asked for a contact of another person who could provide me a help with data collecting. As a result, there were five female respondents, whose names were not revealed to maintain the confidentiality of the responses.

When designing an interview, I used a standardised open-ended interview approach, which Turner (2010) defines as an approach that "is extremely structured in terms of the wording of the questions. It allows participants to fully express their viewpoints and experiences" (p. 756). There was used only one close-ended question that helped to

[7] Snowball method is a non-probability method that relies on referrals from existing respondents to other respondents that can be suitable for the research. It is often used when it is hard to find a potential participant (Changingminds.org, 2014, August 23).

reduce the overall time of answering. The purpose of the interview was to get the information about women's reflections on their position in the ICT sector and their experience in it. For that reason, the questions were divided into three subgroups. The first subgroup is related to respondents' field of activity and company they are working for. The second subgroup has a single question which is dedicated to the reason why they chose a technical career. And the last, third subgroup consists of the questions about their experience of being stereotyped or unrecognised. All female respondents were asked to provide honest answers.

3.5 Evaluation phase

The emphasis in the evaluation phase was on an analysis of responses that were received from the online generated questionnaire. In the case of quantitative survey, the first step was to divide the respondents into two groups according to the gender, thus I could parallel the opinions of each gender. The second step was classification of the answers of open-ended questions into groups according to the frequency of occurrence in the answer sheet, so similar answers are linked together. The grouped responses then were compared and analysed.

In the quantitative research, data evaluation of the answers was carried out according to the subgroup of the questions that were described in the chapter 3.4 Realisation phase (Interview).

3.6 Interpretation of quantitative research results

Question 1. What is your gender?

Figure 7 and Table 3 show that male respondents comprise the majority of respondents: 57 %. There were also 43 % of women who comprise a comparatively lower proportion of respondents.

Table 3. *Gender of respondents.*

	Absolute value	Percent
Male	50	57 %
Female	37	43 %
Total	87	100 %

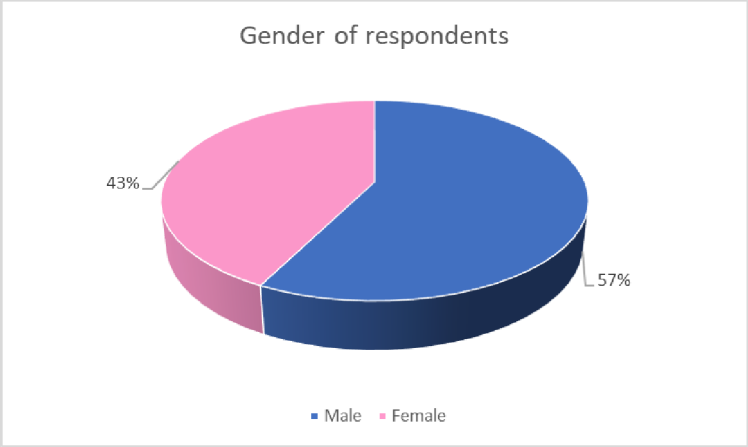

Figure 7. Gender of respondents.

Question 2. What is your age category?

Table 4. *Age category of respondents.*

Age	Absolute value		Total	Percent
	Male	Female		
Under 18	7	6	13	15%
18 - 26	30	29	59	68%
Above 26	13	2	15	17%
Total	50	37	87	100%

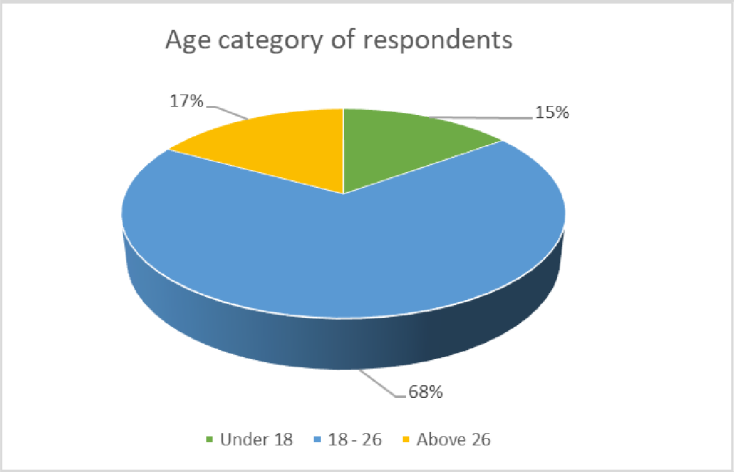

Figure 8. Number of respondents according to their age.

If only gender is taken into the account, it follows that there were less women than men who took part in the survey. However, regarding the age category (see Figure 8 and Table 4), it becomes clear that student groups of males and females in the age range from 18 to 26 are almost equal. There 30 males and 29 females took part in the survey.

Question 3. Rate each of the following subjects.

Table 5. *Women's interests in STEM subjects.*

	1 Strongly dislike	2 Somewhat dislike	3 Nither like nor dislike	4 Somewhat like	5 Strongly like	Total
Mathematics	16.21%	18.90%	5.40%	32.42%	27.02%	
	6	7	2	12	10	37
Physics	22.73%	31.82%	13.64%	18.18%	13.64%	
	8	12	5	7	5	37
Informatics	4.55%	27.27%	31.82%	27.27%	9.09%	
	2	10	12	10	3	37
Chemistry	18.18%	22.73%	27.27%	18.18%	13.64%	
	7	8	10	7	5	37
Biology	0.00%	18.18%	22.73%	45.45%	13.64%	
	0	7	8	17	5	37
Total number of answers	23	44	37	53	28	185
Average	**5**	**9**	**7**	**11**	**6**	**37**

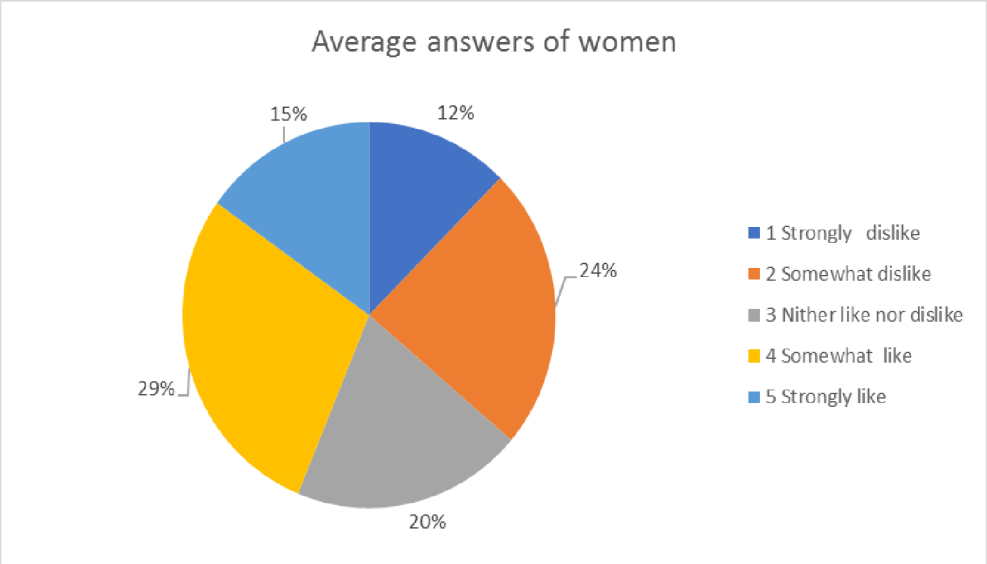

Figure 9. Women's frequent average answers.

Table 6. *Men's interests in STEM subjects.*

	1 Strongly dislike	2 Somewhat dislike	3 Nither like nor dislike	4 Somewhat like	5 Strongly like	Total
Mathematics	7%	3%	28%	48%	14%	
	5	2	14	24	7	50
Physics	10%	7%	7%	66%	10%	
	5	4	4	32	5	50
Informatics	0%	6%	10%	30%	54%	
	0	3	5	15	27	50
Chemistry	26%	28%	28%	14%	4%	
	13	14	14	7	2	50
Biology	17%	30%	20%	30%	3%	
	9	15	10	15	1	50
Total number of answers	32	38	47	93	42	250
Average	**6**	**8**	**9**	**19**	**8**	**50**

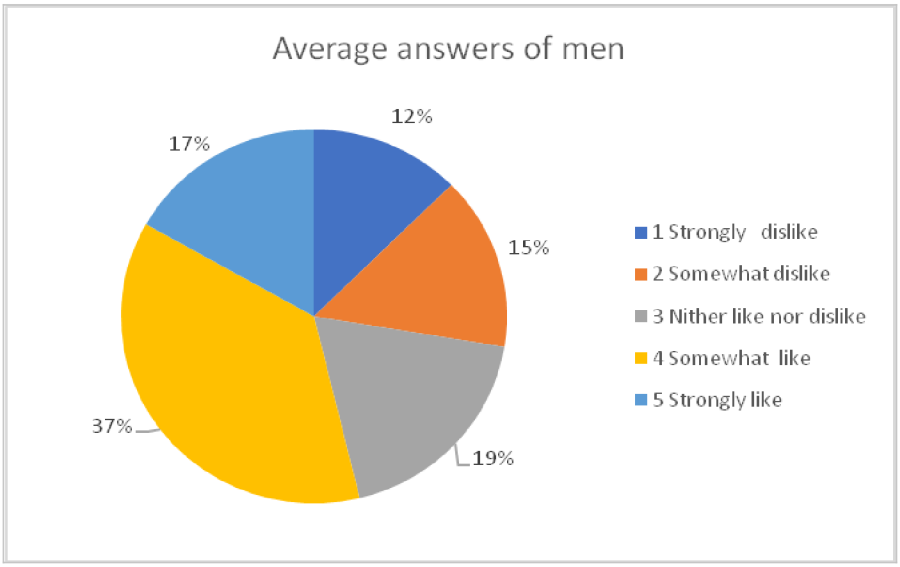

Figure 10. Women's frequent average answers.

It is misleading to say that women are not interested in STEM subjects. In fact, according to Figures 9 and 10 as well as Tables 5 and 6, the responses "strongly like" and "neither like nor dislike" of female respondents were almost as frequent as males' responses. Slightly higher difference can be observed in the dominant responses "somewhat like" where the average number of females' answers were 8 % lower than males' percentage. Unexpectedly, both sides have the same amount of average answers for "strongly dislike" (12 %). It can be derived from the results that men and women are almost equally interested in studying STEM subjects.

Question 4. Give reasons for rating some of the above-mentioned subjects with the mark less than 3.

Having reviewed 87 responses of women and men who evaluated subjects with the mark less than 3, the similar answers were put together. The following 6 answers were chosen as most detailed and complex explanation of the under evaluation of STEM subjects. The rest of the answers consisted of rather short descriptions as "*I don't like it*" or "*It is hard*" and were not listed below as being not fully defined.

Female 1: *"Chemistry and Physics never fascinated me, there was just a bunch of information and theory and we rarely did anything practical. When we did, nobody explained to us what the experiment was about."*

Female 2: *"I didn't like my teacher of Informatics in school. I fell asleep every time he started to explain theory. It was so booooooring!"*

Female 3: *"I don't like Informatics. I cannot understand it, or have difficulty imagining it. I want to relate and be able to refer it to real life, I need understandable examples. I had to go through the materials more slowly than other students did, otherwise I couldn't understand it."*

The conclusion that can be derived from the female answers above is that the interest in subjects was lost because the information that was given was rather theoretical than practical. Their teachers did not inspire them to appreciate the beauty of science, and instead they taught them to learn everything by heart. The crucial point for the first and third female students was the fact that the given knowledge was not based on real-life examples.

For comparison, the answers of the three male students should be considered as illustrated below.

Male 1: *"I find Physics to be a difficult subject and I have yet to pass a physics class. There is a lot of information to process and not enough time for me to remember everything."*

Male 2: *"Physics – I'm bad at remembering the formulas for things. Chemistry – I just don't like it… Biology – not interested in it."*

Male 3: *"I was always bad at Maths. So many formulae to remember."*

Unlike women, who related their low marks with a lack of understandable examples and explanations as well as incompetent teachers, men were more concerned about the

fact that STEM subjects contained a large number of formulae and materials that are hard to remember. Moreover, in their opinion, there was little time to remember everything they needed.

Question 5. Rate the statements from strongly agree to strongly disagree.

In Table 7, the most considerable disagreement was about the statement number 4: "There is no place for women in IT", which received 100 % of negative answers. The statement number 14: "Women are responsible for raising children." was given 19 positive answers, which corresponds to 38 % – the highest percentage of the positive answers in the whole table. However, at the same time, it was the most confusing question for male students. It also has 13 neutral and 18 negative responses. The rest of stereotypical statements were mostly evaluated as negative. Those responses where the value of uncertain answers "neither agree or disagree" had more than 20 % of the overall responses, such as the statements number 1, 7, 12 and 13 could be defined as semi-negative answers. Surprisingly, in the statement 13, the opinions were almost proportionally divided: The same amount of people chose "neither agree or disagree" (11 %) and "disagree" (11 %) but quite similar number or participants chose "agree" 13 and 15 were for "strongly disagree".

Table 7. *Male's rate of the stereotypical statements.*

		1 Strongly agree	2 Agree	3 Nither agree nor disagree	4 disagree	5 Strongly disagree	Total
1	It is hard to teach women to code.	0%	6%	30%	44%	20%	
		0	3	15	22	10	50
2	It is always men who work in science, engineering, and other technical fields.	4%	6%	6%	44%	40%	
		2	3	3	22	20	50
3	Women are not as smart as men.	0.00%	0.00%	6.00%	34.00%	60.00%	
		0	0	3	17	30	50
4	There is no place for women in IT.	0.00%	0.00%	0.00%	32.00%	68.00%	
		0	0	0	16	34	50
5	Women are supposed to cook and do housework.	6.00%	4.00%	24.00%	14.00%	52.00%	
		3	2	12	7	26	50
6	Women are bad in decision-making professions.	0.00%	26.00%	18.00%	30.00%	26.00%	
		0	13	9	15	13	0
7	Women are supposed to have "clean jobs" such as secretaries, teachers, and librarians.	10.00%	10.00%	20.00%	28.00%	32.00%	
		5	5	10	14	16	50
8	Women are supposed to make less money than men.	4.00%	4.00%	10.00%	22.00%	60.00%	
		2	2	5	11	30	50
9	Women are quieter than men and not meant to speak out.	0.00%	10.00%	0.00%	22.00%	68.00%	
		0	5	0	11	34	50
10	Women are supposed to be submissive and do as they are told.	6.00%	6.00%	12.00%	20.00%	56.00%	
		3	3	6	10	28	50
11	Women are never in charge.	2.00%	8.00%	4.00%	30.00%	56.00%	
		1	4	2	15	28	50
12	Women are meant to be the damsel in distress; never the hero.	4.00%	4.00%	22.00%	24.00%	46.00%	
		2	2	11	12	23	50
13	Women do not have technical skills and are not good at "hands on" projects such as car repairs.	0.00%	26.00%	22.00%	22.00%	30.00%	
		0	13	11	11	15	50
14	Women are responsible for raising children.	8.00%	30.00%	26.00%	10.00%	26.00%	
		4	15	13	5	13	50
Total number of answers		22	70	100	188	320	700
Average		**2**	**5**	**7**	**13**	**23**	**50**

Higher certainty can be seen in Table 8 with women's responses. Most of their answers were "strongly disagree", and, except 3 statements, there were almost no responses that would correspond to "strongly agree". As well as men, women were unanimously disagreed with the statement that "There is no place for women in IT". In case of statement number 6 "Women are bad in decision-making professions," the answers of

the two groups significantly differ. Only 8 % of women hesitated to give the exact answer, while the others gave negative or strongly negative answer, while in the male's group, the same number of men strongly disagreed (26 %) and agreed (26 %) to this statement.

Table 8. *Female's rate of the stereotypical statements.*

		1 Strongly agree	2 Agree	3 Nither agree nor disagree	4 disagree	5 Strongly disagree	Total
1	It is hard to teach women to code.	0.00%	10.81%	13.51%	43.24%	32.44%	
		0	4	5	16	12	37
2	It is always men who work in science, engineering, and other technical fields.	0.00%	27.03%	13.51%	54.05%	5.41%	
		0	10	5	20	2	37
3	Women are not as smart as men.	5.41%	0.00%	0.00%	13.51%	81.08%	
		2	0	0	5	30	37
4	There is no place for women in IT.	0.00%	0.00%	0.00%	21.62%	78.38%	
		0	0	0	8	29	37
5	Women are supposed to cook and do housework.	5.41%	0.00%	21.62%	8.11%	64.86%	
		2	0	8	3	24	37
6	Women are bad in decision-making professions.	0.00%	0.00%	8.11%	18.92%	72.97%	
		0	0	3	7	27	37
7	Women are supposed to have "clean jobs" such as secretaries, teachers, and librarians.	0.00%	5.40%	8.11%	27.03%	59.46%	
		0	2	3	10	22	37
8	Women are supposed to make less money than men.	0.00%	8.11%	0.00%	5.41%	86.49%	
		0	3	0	2	32	37
9	Women are quieter than men and not meant to speak out.	0.00%	5.41%	5.41%	32.43%	56.76%	
		0	2	2	12	21	37
10	Women are supposed to be submissive and do as they are told.	0.00%	5.41%	5.41%	8.10%	81.08%	
		0	2	2	3	30	37
11	Women are never in charge.	0.00%	5.41%	0.00%	32.43%	62.16%	
		0	2	0	12	23	37
12	Women are meant to be the damsel in distress; never the hero.	0.00%	0.00%	5.41%	13.51%	81.08%	
		0	0	2	5	30	37
13	Women do not have technical skills and are not good at "hands on" projects such as car repairs.	0.00%	5.41%	13.51%	27.03%	54.05%	
		0	2	5	10	20	37
14	Women are responsible for raising children.	5.41%	37.84%	13.51%	18.92%	24.32%	
		2	14	5	7	9	37
Total number of answers		6	41	40	120	311	518
Average		**0**	**3**	**3**	**9**	**22**	**37**

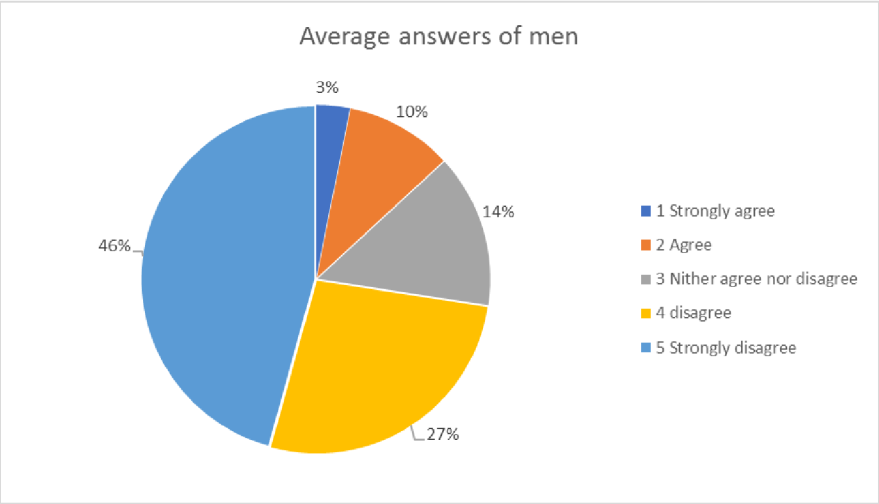

Figure 11. Male's rate of the stereotypical statements.

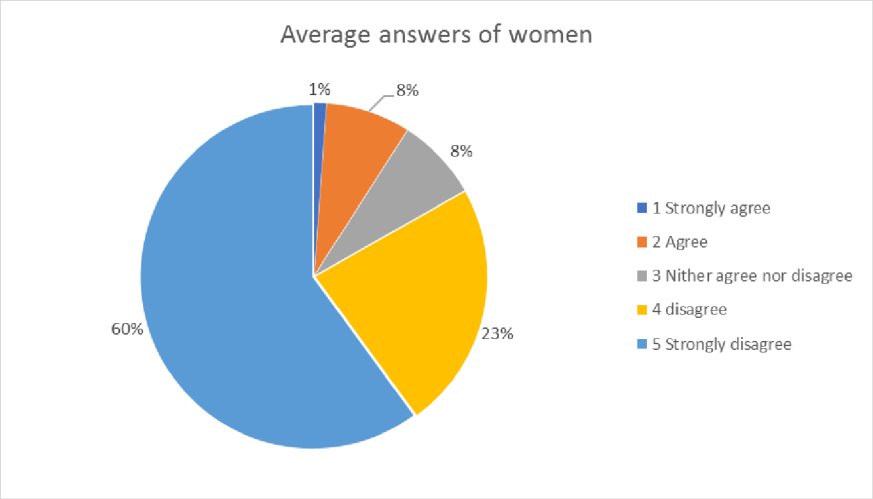

Figure 12. Female's rate of the stereotypical statements.

According to Figures 11 and 12, the predominant number of male students (45 %) and female students (60 %) strongly disagreed with the stereotypical statements. Responses, such as "strongly agree", "agree" and "neither agree nor disagree" got the lowest percentage values in both groups. It can be concluded that, in spite of several differences, the view of women and men on the gender stereotypes is largely negative.

Question 6. Rate women and men according to their potential ability in 10 professions (ranking from 1 to 10 where 1 = poor and 10 = excellent).

Table 9. *Perception of men's and women's potential abilities.*

	Average number given by women to:		Average number given by men to:	
Professions	women	men	women	men
Computer Programmer	7	8	7	8
Computer Support Specialist	8	7	7	7
Computer System Administrator	7	8	7	8
Computer System Analyst	7	8	7	8
Database Administrator	8	7	7	8
Information Security Analyst	7	8	7	8
IT Manager	7	8	7	8
Software Developer	7	8	7	8
Web Developer	8	8	8	8

The assumption about gender abilities can be described based on the results taken from Table 9. According to the average numbers given by female respondents, the highest level of abilities women have only in professions as Computer Support Specialist, Database Administrator and Web Developer, whereas men were mostly given ratings equal to 8. A slightly smaller value of 7 was given to men's abilities in professions such as Computer Support Specialist and Database Administrator.

When it comes to compare the rating that was given by men to women, it follows that in almost all professions females have the potential ability of 7, with an exception of Web Developer which has score of 8. In contrast, the men's abilities of 8 out of 9 professions were rated with the value of 8. The crucial point that can be derived from Table 9 is that male as well as female respondents rated men with a higher score, whilst women were rated with rather lower scores.

Question 7. Rate the importance of the following factors/barriers that may hold women back.

Table 10. *Important barriers/factors that hold women back.*

	Not relevant	Neither important nor relavent	Very important	Total
Stereotyping and preconceptions that are applied to women's roles and abilities.	13.79%	28.73%	57.48%	
	12	25	50	87
Family/personal responsibilities (taking care of children and home).	9.20%	19.54%	71.26%	
	8	17	62	87
Underestimation of their own abilities and lack of confidence.	14.94%	34.48%	50.58%	
	13	30	44	87
No recognition from colleagues.	27.58%	43.68%	28.74%	
	24	38	25	87

The most important factors that hold women back, according to Table 10, were stereotypes (57 %), family responsibilities (71 %) and lack of confidence (51 %). Neither important nor important barrier was the idea that women receive no recognition from colleagues 42 (43 %).

Question 8. Do you think that gender stereotypes are reinforced by... ?

Table 11. *Institution by which gender stereotypes are reinforced.*

	Yes	No	Total
Media	63.21%	36.79%	
	55	32	87
Your family	42.53%	57.47%	
	37	50	87
Scociety	82.76%	17.24%	
	72	15	87
School/University	34.48%	65.52%	
	30	70	87

Table 11 provides a clear picture of what institutions mostly reinforce stereotypes. Society (83 %) is believed to be the greatest factor that puts labels on what people are supposed to do or not. At the same time, media (63 %) also reinforce gender stereotypes to a great extent. School and university (35 %) are said to be rather neutral when it comes to producing and reinforcing stereotypes.

3.7 Presentation of qualitative research findings

3.7.1 Professional characteristics

The respondents were asked to briefly provide some general information about the company they work for and describe their position in it. Three women out of five said that the sector of activities of their companies was "IT service" that included maintenance of hardware and software, consulting services, e-services, etc. The other two respondents mentioned "software" and "web and other technical design".

The following answers were received to a question about their positions and main tasks that they perform in them:

Respondent 1: *"I have been working as a web designer/developer for almost ten years. Generally, I am responsible for creating an interactive and functional design for web pages based on the clients' requirements and preferences. I often have to take business trips in order to meet a client."*

Respondent 2: *"My position is a senior compliance engineer. I am working in this position for three years. I perform, monitor and analyse the results of product compliance tests. Then I evaluate the test results and make design change recommendations. I also develop and implement an appropriate level of operating procedures, policies and standards that are necessary to support the internal product safety lab and all product safety testing."*

Respondent 3: *"I am having a position of a programmer for almost five years. I am programming desktop, web and mobile applications in Java language."*

Respondent 4: *"I am a technical customer support of the French and the Dutch. It is my second year in this position. My main tasks are providing help to customers by diagnosing, troubleshooting, and resolving of issues with the scanning, wireless networking and mobile computing families of products."*

Respondent 5: *"I work as a senior software test engineer for five and a half years. I am leading several different projects on testing and debugging infrastructure. As a part of my job, I assist and advice developers in the design or modification of firmware."*

However, respondents indicate that the approximate percentage of women working in the same division is not higher than 15 %.

Another question the respondents were asked was about their satisfaction with their work conditions. Three female participants (Respondents 1, 2, 3) were totally satisfied with it because their work could be done remotely. Respondent 1 explains: *"I work from home; I only need to go to the office a few times a week if there is a team meeting. I am glad that I can arrange my everyday schedule as it suits me."* Nevertheless, the other two women are rating working conditions as less satisfying. There are some of their arguments: *"I am the only woman in men's collective. In our open-office, the air conditioning is set according to the men. During the summer I often catch flu because the temperature inside is significantly lower than outside"* (Respondent 4). *"Most of the time I work much more than eight hours per day. Sometimes I come to work at seven o'clock in the morning and finish at half past six in the evening."* (Respondent 5).

3.7.2 Way to the ICT career

The next question was dedicated to the respondents' motivation and the way they became interested in pursuing a career in ICT. The Respondent 1 clarified that 10 years ago, when she was graduating from the University of Arts, in Poland, she faced the reality that the market of designers was oversaturated. She was advised to try web developing that is one of the most attractive jobs today. Although it was quite risky at first as she had no experience in programming, she was eager to try and learn something different. She admits that the job is interesting and well-paid, so she does not regret choosing the ICT field.

The Respondents 2 and 3 were both encouraged by their high school teachers, who equally promoted girls' and boys' skills in STEAM subjects. They were not afraid of trying new things and asking questions. This allowed them to feel confident in the technical field.

According to the Respondent 4, her main motivations were a possibility of having a good salary and also escaping from the country[8] with a high rate of unemployment. As she was born in a family with four children, she wanted to be able to earn enough money to help them. She learnt English as well as the basics of the programming language Java. Then, after applying for a job in the multinational company that has a branch in Brno, she moved there to have a better life.

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[8] The rate of unemployment in Morocco in 2017 was over 10.7 % (Ieconomics.com, 2017, December 12).

The last female, Respondent 5, said that she had been always interested in STEAM subjects at school. For that reason, she always wanted to have an ICT career.

3.7.3 Concerns

The next two questions were aimed to verify whether respondents are experiencing gender stereotyping at the workplace or not and to determine if, according to them, men are more likely to be promoted in the ICT sector. The answers showed that only two respondents sometimes faced this problem at the workplace. The Respondent 4, who works as a technical support agent, sometimes has the feeling of being underestimated because she is a woman. She says: "*It is hard to deal with customers who think that the fact that I am a woman means that I am not capable of providing sufficient service when it comes to solve technical issues. They just do not take you seriously.*"

The senior compliance engineer (Respondent 2) confesses that: *"I was promised to get a new higher position in our company's branch because I have been working really hard for the last few months. Unfortunately, I discovered several days after that my place had been given to a man who did not even have any experience required for this position."*

Although only two interviewers admitted being discriminated, all female respondents agreed that men have higher chances of being promoted. The Respondent 2 says: *"Unfortunately, even in the EU there are still some prejudices, such as men are better workers than women. The situation has improved, but occasionally, you can still hear how more efficient, professional, logical, even smart men are compared to women. Regarding the promotion - the most frequent reason is a maternity leave. Some employers do not want their workers to vanish for 2-3 years."*

3.8 Discussion

The respondents of both the qualitative and quantitative parts of the research were assured that all their answers would be kept in the strict confidentiality. For that reason, their answers were not influenced by the fear of being judged. As it was expected, responses of the questionnaire varied as they were based on expressing respondents' own opinions, values and believes.

The online questionnaire has shown that almost the same percentage of women is interested in STEM subjects as much as men do. But what the answers to the open-ended questions have revealed is that one of the most important factors for females is having life-applicable examples, which would help them to build the understanding of how it works in reality. In contrast, some males admitted that the vast quantity of information and the lack of time were the main reasons for not being interested in STEM subjects.

When considering the amount of positive answers to stereotypical statements received from men and women, it becomes clear that a considerable number of respondents do not support reinforcing of stereotypes, in fact, neither women nor men displayed noticeable differences in answers.

Although the general overview shows that men evaluate their potential skills in eight out of nine ICT professions more than women do, the rating of potential skills that was received by women from men was still quite high. The difference of one point in the scores cannot be taken as a conclusive underestimation of females' abilities.

Family and personal responsibilities as well as stereotypes are believed to be the most significant factor that forces women to leave ICT careers. Finally, in the respondents' opinions, it is the society that plays the crucial role in reinforcing gender labelling and stereotyping.

The interview research results have shown that women are choosing the ICT career due to high salary, a desire to try something new and because they were attracted by the STEAM subjects at school. Women also choose the ICT career because it gives them an opportunity to travel and work in different countries.

The questionnaire has not proved the hypothesis that women in ICT professions and women who are interested in STEM subjects are stereotyped and underestimated in society; however, the interview has revealed the fact that some women are indeed experiencing discrimination at the workplace. Moreover, the interview has confirmed the idea that women of the ICT specialisations suppose that men are more likely to be promoted than women.

4 Conclusion

The bachelor's thesis had two main purposes: to investigate the problem of a low representation of women in the ICT sector and to verify whether women in ICT professions and women who are interested in STEM subjects are stereotyped and underestimated in society or not. Eurostat (2017, September 28) concludes that girls are largely in a minority, they composed only 17 % of all ICT students in 2015. Despite the fact that European countries acknowledge that situation, there is still a large gender gap in the ICT sector. The lack of gender diversity delays the development of innovations. It is useful to explore this topic on both local and global scales. For this reason, the investigation of this problem was carried out among the students and women in ICT professions so that some interesting findings could be observed and discussed.

Literary and empirical research was conducted for this thesis. Literary research was done by studying foreign topic-related literature and examining statistical reports. In the empirical part, I conducted two surveys. Data for those surveys were collected with the help of the Internet questionnaire and an interview. The Internet questionnaire consisted of eight matrix and close-ended questions where responses were based on the Likert and binary scale rating so that the results could be easily linked together and then analysed, whereas the interview was based mostly on the open-ended questions.

After undertaking the quantitative research, the following conclusions were made:

- To increase the interest of women in STEM subjects, it is necessary to explain theoretical issues in the particular subject in a practical way so that a clear correlation between the studied subject and the reality can be established. In most cases, female students become bored because of a large amount of theory that is rarely supported by practice or illustrative examples.
- The evaluation of stereotyping statements shows that students of both genders have negative attitudes towards women labelling.
- While men tend to overrate their abilities in ICT professions, women tend to underrate their own abilities. Inner persuasion that they are not as good in this field as men are might significantly decrease the desire for studying science and technology.

- The most significant barriers that hold women back are family/personal responsibilities, stereotypes that are applied to women's role and underestimation of their own abilities.
- Lastly, society was chosen by the majority of respondents as an institution that reinforce stereotypes.

In the qualitative research, I found out that female respondents of technical professions do not only program and debug programs, but they also suggest solutions, communicate with colleagues, programmers and clients, and participate in a few different projects at the same time. It contradicts a general assumption that the ICT professions are boring and routine. The working conditions for most of the women are satisfying, but there are still some improvements that can be made.

The conclusions about motivation and way to the ICT sector were to a large extent similar to the results of the Czechitas research. In both, the largest number of respondents had mostly internal motivation such as interest in the STEAM subjects and desire to try a new field. What was not fully covered by the Czechitas survey is the fact that women can be also motivated to enter ICT professions because it gives them the possibility of higher salaries, better working conditions, traveling opportunities and also a chance to move from the countries with a poor economic situation.

The quantitative research did not prove the existence of the "glass ceiling" as the biggest obstacle for women in the ICT sector. Nevertheless, the qualitative research gave us a better understanding of the problem of the underrepresentation of women in the ICT. It showed that there are definitely some minor barriers that women face at the workplace. Although women feel quite confident in the ICT sector owing to the enhancements of women's role in that sector and an active promotion of the equality at the workplace, some of them still face hidden discrimination and underestimation from the clients as well as from the high-rank employees.

4.1 Benefits of having gender balance in the workplace

A large number of sociologists and specialists admit that maintaining a gender balance in the workplace would bring lots of benefits to company. However, some may wonder how exactly organisations can profit from having more women in the workplace and why it is important. In fact, McNally (2015, March 5) proposes that there are multiple

reasons why global and local ICT organisations should be interested in having more female specialists. These advantages are introduced bellow.

- The way of perceiving a situation or a problem by man and woman is typically different, so are the methods of solving the problem. A wide variation in creative ideas and in-depth insights lead to a greater company performance.
- A gender-balanced organisation would always have potentially superior reputation than other organisations. This point is supported by McNally (2015, March 5) who claims that "your business is represented to your audience, your employees, your investors and your *future talent pool* is undoubtedly a key definer of overall success".
- The expansion of the customer base and the improvement of services can be quicker achieved with a gender-balanced workforce. It also helps to acquire better industry knowledge, access various channel of information and access further resources. (Theflexiport.com, 2017, May 17).
- The companies that are renowned for eliminating discrimination are enhancing the ability to attract talented employees, as candidates are confident in showing their skills without fear of being discriminated.
- According to Bharadwaj Badal (2014, January 20) "gender-diverse organisation has 14 % higher revenue than less-diverse companies (5.24 % vs. 4.58 %)."

4.2 Recommendations for reducing a gender gap in the ICT sector

Firstly, it is pivotal to promote a young women's positive attitude towards the ICT sector by eliminating stereotypes related to this sector and also by creating role models of leading women in the sector.

Secondly, encouraging girls participating in educational programs that foster acquiring of STEM-ICT professions would significantly increase the interests among female students in STEM subjects. The courses as project designing, programming, robotics, digital art and architecture for personal and social purposes can be integrated into school programs in order to attract more teenage girls. As the answers to the survey in the previous chapters revealed, all these courses should be applicable to real-life situations

and problems. Therefore, an active cooperation between the university teachers, secondary school teachers and parents should be encouraged.

Thirdly, students should be well-informed about the advantages of working in the ICT sector, such as high salaries, flexible working hours and good employment prospects.

Finally, ICT companies should be informed about benefits of having gender balance at the workplace. Financial or educational support should be provided to companies in order to give an employee satisfaction.

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8 Appendices

Appendix 1: Questionnaire

I am conducting research on the position of women in the ICT sector. I would like to ask you for some information about yourself so that I can put your replies in the greater context of my Bachelor's thesis. Be assured that all the answers you provide will be kept in the strict confidentiality. Thank you for agreeing to take part in my survey.

Anastasia Sobina
Faculty of Electrical Engineering and Communication
Brno University of Technology

Please answer the following questions. Where it is possible, write a full answer, or tick one or more options.

1) What is your gender?

Male ☐
Female ☐

2) What is your age category?

Under 18 years ☐
18-26 years ☐
Above 26 years ☐

3) Rate each of the following subjects.

Rating scale	**1 Strongly dislike**	**2 Somewhat dislike**	**3 Neither like or dislike**	**4 Somewhat like**	**5 Strongly like**
Mathematics					
Physics					
Informatics					
Chemistry					
Biology					

4) Give reasons for rating some of the above-mentioned subjects with less than 3.

……

5) Rate the statements from strongly agree to strongly disagree.

Rating scale	**Strongly agree**	**Agree**	**Neither agree or disagree**	**Disagree**	**Strongly disagree**
It is hard to teach women to code.					
It is always men who work in science, engineering, and other technical fields.					
Women are not as smart as men.					
There is no place for women in IT.					
Women are supposed to cook and do housework.					
Women are bad in decision-making professions.					
Women are supposed to have "clean jobs" such as secretaries, teachers, and librarians.					
Women are supposed to make less money than men.					
Women are quieter than men and not meant to speak out.					
Women are supposed to be submissive and do as they are told.					
Women are never in charge.					
Women are meant to be the damsel in distress; never the hero.					
Women do not have technical skills and are not good at "hands on" projects such as car repairs.					
Women are responsible for raising children.					

6) Rate women and men according to their potential ability in 10 professions (ranking from 1 to 10 where 1=poor and 10=excellent).

Jobs	Man	Woman
Computer System Analyst		
Software Developer		
IT Manager		
Web Developer		
Database Administrator		
Computer Support Specialist		
Computer System Administrator		
Computer Programmer		
Information Security Analyst		

7) Rate the importance of the following factors/barriers that may hold women back.

	Not relevant	Neither important nor relevant	Very important
Stereotyping and preconceptions that are applied to women's roles and abilities.			
Family/personal responsibilities (taking care of children and home).			
Underestimation of their own abilities and lack of confidence.			
No recognition from colleagues.			

8) You think that gender stereotypes are reinforced by ...

	Yes	No
Media	☐	☐
Your family	☐	☐
Society	☐	☐
School/University	☐	☐

Appendix 2: Interview questions

1) What is the sector of activities of your company?

- Telecommunication infrastructures (networks, software and applications, equipment and systems, etc.) ☐
- Telecommunication services (mobile services, audio-visual content, etc.) ☐
- Hardware ☐
- Software ☐
- IT services (maintenance of hardware and software, consulting services, e-services, etc.) ☐
- Web and other technical design ☐
- Other (please specify) ☐

2) What is your position in the company?

3) How long have you been working there?

4) Please, describe the main task you do in your position.

5) What is the approximate percentage of women working in your division?

6) Why did you start to be interested in having a technical profession?

7) How would you evaluate your working conditions? Give reasons for your answer.

8) Do you feel you are experiencing gender stereotypes at the workplace (e.g. women do not have technical skills; there is no place for them in IT)?

9) Do you think that men are more likely to be promoted?