Holistic Factors that Impact the Under-Representation of Women in ICT: A Systematic Literature Review

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Abstract. An under-representation of women in the Information and Communication Technology (ICT) industry exits. Current research tend to focus on either social aspects (social construction) or physical aspects as cause for this phenomenon. Consequently, there is a lack of a holistic perspective of factors that causes the under-representation of women in ICT. This research provides a holistic perspective of factors that causes the under-representation of women in the ICT industry.
This research was performed by conducting a systematic literature review that considered 89 articles to identify factors that cause the under-representation of women in ICT.
The identified factors were classified as: organizational, economical and socio-psychobiological. The under-representation of women in ICT can now be better addressed by holistically considering this classification of factors to increase female participation in ICT.

Keywords: ICT, Women in ICT, Systematic Literature Review.

1 Introduction

For decades women of all ethnicities have been trying to empower each other and proof their worth in society. For the most part of history, it has been a long and tiresome journey to ensure that future generations of women will be able to work alongside men without being solely defined by their gender [1-2].

There are still women who are facing gender discrimination in the modern day and age [2-3]. This is mainly caused by the different societies that these different women are a part of. Gender essentialism is an active element that contributes to the under-representation of a specific gender in certain career industries such as women in the ICT industry [4-7].

Current factors that causes the under-representation of women in ICT are classified into two schools of thought. First, there is inherent differences between genders that are responsible for the under-representation of women in the ICT industry. Secondly, that the male-domination in the ICT industry is a cause of social construction making the industry more suitable for men and less suitable for women [6].

The systematic literature review performed in this research, provides a holistic classification of factors which influence career selection and career choices of women towards the ICT industry. Insight is given into the struggles that women face and need to overcome to be equally represented in the ICT industry.

2 Literature Background

This section briefly discusses characteristics of the ICT industry, thought schools, gender development theories and computer phobia, which has been shown to be responsible for the under-representation of women in the ICT industry.

2.1 Characteristics of the ICT Industry

The ICT industry expanded rapidly over the past 20 years into an extensively innovative, competitive and demanding industry [8]. Powerful economies strive to be in possession of technologies that would give them an economic advantage, implicating that ICT is a developmental instrument [9-10].

The ICT industry can be summarized as a demanding, masculine, ever-changing, moving industry that interferes with work-life balance. [11-14]. The industry has been shown to cause burnout and lead to high levels of stress [15]. These intimidating characteristics discourage women from entering, or staying in the ICT industry, even in cases where anti-discrimination legislation (e.g. The Promotion of Equality and Prevention of Unfair Discrimination Act, 2000[1]) gives preference to women who applies for occupations in the ICT field, with the aim to represent gender fairly in the ICT industry [13].

As the ICT industry expands at an accelerated rate, new and flexible skill sets are required. With new skills sets in demand, new employment opportunities will present themselves [16-17]. One of the characteristic of the ICT industry is that it requires both flexible hard and soft skill sets. Hard-skills refer to a person's ICT technical ability and understanding, whereas soft-skills refer to collaborative interactions and focusses more on the interpersonal and team work [18-19]. People can often progress to reach the executive level of the organization by relying on hard-skills, but often fail due to their lack of soft-skills [18].

Finally, the ICT industry is characterised as an information society is characterized by an increase of information and theoretical knowledge that influence our daily lives and aids in our socio-economic evolution [20-21]. ICT diffusion has played a large role in creating this information society [21].

[1] Comprehensive South African discrimination law that prohibits unfair discrimination (also by gender) by the government and by private organisations and individuals and forbids hate speech ad harassment.

2.2 Thought Schools regarding the Under-representation of Women in ICT

This section briefly discuss the two schools of thought when dealing with the under-representation of women in ICT.

Although improvement is seen in some parts of the world, there is still an under-representation of women in the ICT industry [7, 15, 22-23]. Two main schools of thought exist to think about the causes for the under-represented of women in the ICT industry [15, 24-25]. The first school blames social factors and social construction for the under-representation of women in the ICT industry [24]. The second school of thought blames physical/biological differences between the genders for the under-representation of women in the ICT industry [25]. However, both social and physical factors contribute to a person's perception of careers choice.

Most articles tend to focus only on either the social aspects or the physical aspects and therefore lacks a holistic perspective of the situation. This literature review however provides a holistic perspective and classification that include both these schools of thought in the hope of providing a better understanding of the under-representation of women in the ICT industry. Both social and physical aspects play an important role in determining why women are so under-represented in the ICT field.

2.3 Gender-Based Theories for ICT

There are many gender-based theories that may help us to understand why the ICT sector is mostly male dominated. These theories might provide new and unexplored insights to better understand gender-based career perceptions within adults and also why there is an under-representation of women in the ICT industry. However, this does not mean that the concept of gender and its associated roles are entirely derived from these theories.

Cognitive Developmental Theory. Stereotypical knowledge and behavior concerning gender can be a factor when exploring cognitive theories. However, it is not the sole factor that determines a child's gender preference and gender behavioral patterns.

The cognitive developmental theory is structured on "gender constancy", which is a term used to describe the point in a child's life where they are able to identify themselves with a particular sex and comprehend, in its most basic form, that this is not going to change [26-27]. Children will instinctively begin to shape their behavior and opinions on gender norms by formulating and managing genders categorically [27-28]. They do this by using their physical gender traits to categorize information that is being presented to them during their everyday lives and environment [29].

The way children categorize information can be interpreted from a social constructive perspective. This suggests that children formulates their own perspective of certain gender-based roles, such as the mother conducting house related chores, whereas the father's role is a more technical role [30]. For the purpose of this systematic literature review, the cognitive developmental theory will be discussed as a socio-psychobiological aspect.

Gender Schema Theory. The gender schema theory differs from the cognitive developmental theory in that, it focuses more on the processing of information. It discards gender constancy and tends to focus more on the basic understanding that children have, such as gender identification [31-32].

This theory not only acknowledges that children play a core part in their own gender development, but suggests that they create their own psychological connotations between gender information, which then influences their behavioral patterns [28,33]. It was found that children who started developing their skills to label genders before reaching the age of 28 months were far more likely to play with same-sex toys than those that developed these skills later on [31-32].

Children that distinguishes between types of toys that they perceive to be gender specific, are often influenced by advertisements or simply different parenting styles. However, companies are becoming more concerned with equality and are striving to improve on their advertisements and store layouts in order to create and demonstrate a gender-neutral society [34]. For this systematic literature review, the gender schema theory will be discussed as a socio-psychobiological aspect.

Extremist Views. The future of women in the ICT industry can be predicted by exploring two extreme visions. Firstly, the utopian vision describes women being best suited for the digital age [35]. Women are considered as hybrid workers in this scenario, that will essentially lead the ICT industry to new heights by introducing their inherent 'soft' skills to this industry [36].

Secondly, the dystopian vision describes that women will be at a disadvantage as genetics will play a key role in women being overpowered in the male dominated ICT industry [35]. This scenario is supported by the gender stereotype, that men possess the logical aspects necessary to thrive in technology-based industries that women do not.

These two visions are merely theoretical versions of what the future technological industry could be. Both are influenced by gender stereotypes and what the interpreter believes to be the best suited skills for this industry, whether it be 'soft' or logical skills.

The existing under-representation of females in the ICT industry places to some extent strain on the economy due to losing important and precious skills that women can bring to this industry [37].

Technophobia. Computer use between genders differ. Women tend to send more emails and perform task and study related functions, whereas men are more likely to intensively use the internet and perform personal related functions [38-39]. Women also tend to show more anxious behavior than men, when interacting with new technology [40-41]. When exposed and introduced to new technology, men are more likely to respond with an optimistic and confident attitude where women will indicate a less positive attitude towards the technology [42-43].

It has been found that the amount of anxiety experienced over time relating to computers, reduces significantly for men whereas their female counterparts demonstrated

little improvement [44-45]. Women tend to have less experience with completing intricate computerized tasks as well as programming, it has also been found that females receive less encouragement regarding these fields from friends and family [43, 46].

Gender related technophobia can be a cause of gender stereotypical behavior that is directly or indirectly presented to children at a young age. The lack of computer interaction and encouragement that females experience can be one of the factors that aids their anxiety and lack of self-confidence when introduced to new technology at a later stage in life.

3 Research Method

The following section will briefly discuss the process that was used during the systematic literature review to answer the following research question:

What holistic factors impact the under-representation of women within the ICT sector?

3.1 Search Terms Used

("Gender (NEAR/2) Information and Communication* Technolog*" OR "Femal* (NEAR/2) Information and Communication* Technolog*" OR "Wom* (NEAR/2) Information and Communication* Technolog*") AND (Defin* OR sector* OR industry* OR physical* OR review OR Differenc*)

3.2 Selection Criteria

Table 1 presents the selection criteria (what was included and excluded) for the literature review.

Table 1. Selection criteria for the literature review.

Selection Criteria	
Inclusion criteria	**Exclusion criteria**
1. The ICT sector. 2. Articles that explain the relationship between genders and the ICT industry. 3. English articles. 4. Information relating to developed countries. 5. Articles between 1990 and 2019 6. Qualitative research.	1. All other industries except the ICT sector. 2. Employment losses due to artificial intelligence. 3. Articles published before 1990. 4. All languages except English. 5. Articles that were not peer reviewed.

3.3 Source Selection

The following databases were used in the literature review: Google Scholar, MEDLINE, WorldCat, WorldCat.org, ERIC and Academic Search Complete.

WorldCat returned 30 297 results and by adding the 72 hand chosen results from Google Scholar the total number of results equaled 30 369. The amount of records left after duplications were removed equaled 26 120. We excluded a total of 25 984 irrelevant articles. During the eligibility phase, we selected only 67 qualitative articles. We added an additional 22 articles from Google Scholar to end with a total of 89 qualitative articles for this systematic literature review. A list of all the articles consulted during the systematic literature review was carefully documented, using Microsoft Excel.

4 Analysis of Findings

This systematic literature review examined what influences the under-representation of women in the ICT industry. After exploring 89 relevant articles on this topic, three distinctive categories were identified. These categories include the following: organizational aspects, economical aspects, socio-psychobiological aspects.

4.1 Organizational Aspects

Technology alone can do little for an organization. However, if that technology is strategically introduced and integrated into an organization it can cut expenses and improve business functions [47-48]. Organizational aspects such as culture and ethics can play a role in how women perceive and experience the ICT industry [49-51].

Organizational Culture. The culture of an organization is defined as the collective principles and standards that are practiced in an organization [49]. The culture refers to how people think and act as a group to create the beliefs and value system of that organization. When the rapid evolution of the ICT industry began, it was the norm to associate the ICT industry with masculinity [50]. Male dominated industries, tend to focus on results, whereas feminine industries focus on social interactions [51].

During an interview with fifteen females from the ICT industry, the females suggested that they need additional communication skills to be able to interact with their male co-workers [13]. They needed to converse in a manner that exhibited logical skill sets [13]. Women tend to be more emotionally involved and sensitive, which makes communication in a male-dominated environment challenging.

It is also no secret that the ICT industry is a demanding and rapidly changing industry associated with burn-out and stress. The extensive hours and work that is demanded of employees result in exhausted personnel that struggle to keep up and properly recuperate [52]. The demands and extensive workhours, means that the line between a person's personal life and work life can become distorted [53]. This is difficult for women to

handle since they have responsibilities outside of work such as managing a household and caring for children.

4.2 Economical Aspects

Productivity is the power that controls an economy and innovation determines that productivity [55]. The ICT industry impacts an economy by supporting economic development, economic growth and employment. It is therefore important that women enter this industry.

Development. Nearly 30 percent of all resources in the public and private sector invest in ICT research and development [10]. However, three factors are important to successfully take advantage of ICTs in the public and private sectors. These three factors include infrastructure, expert employees and finances to be able to incorporate the necessary ICTs [56].

Economic Growth. When the implementation and investment in ICTs are done successfully, it provides an organization with a competitive lead in the market [10]. Furthermore, the correlation between ICTs and economic growth are usually positive. In other words, to be able to compete in the global market, it would be wise to make use of available ICTs in order to reap the worth of this resource [57-59].

India for example has developed itself as the leading country in exporting software and services related to ICT. They have increased their ICT export software and services with more than twelve times during the years 2000 to 2013 [60]. In general, one could argue that ICTs cause a positive relationship with economic growth. However, to accurately determine this correlation, both ICT and socio-economical aspects should be considered [61].

Employment. The ICT revolution requires new and improved skills that involves greater problem-solving, innovation and soft skills [62]. There was 210% increase in ICTs and 69% increase in ICT companies in the United States in 2011, as opposed to the 1980s [63]. This demonstrates the rapid growth of the technology industry and with that growth comes new employment opportunities that needs to be filled. Employment opportunities that women should also take advantage of.

4.3 Socio-Psychobiological Aspects

Sociology is the study of the society, social interaction, relationships and every day culture [64]. Sociological factors are socially accepted and cultural norms that may influence gender stereotypes. On the other hand, psychobiology provides a greater comprehension of both psychology and biology. Psychobiology deals with humans on a biological level but incorporates a person's thought process [65]. By combining these sciences, it provides a better understanding of gender development behavior. This section presents various sub-categories of socio-psychobiological aspects that influence the under-representation of women in the ICT industry.

Gender Stereotypes.

The over-representation of males in the ICT industry provokes negative stereotypes related to gender e.g. that females might not possess the necessary skills for these types of industries [66-68]. The fact that such stereotypes exist, means that society is struggling to see that in fact, maybe discrimination against females in the ICT and related industries exist [68]. This suggests that stereotypical behavior masks against a certain gender exist. This then leads to a continued over-representation of men in the ICT field. Women are often less willing to work in environments where they feel that they are being discriminated against [68]. Perhaps if women receive more encouragement to join such occupations and they are assured that they will only be assessed against their skills and not their gender, it will increase female participation.

As previously discussed, two extreme visions can be identified which can be associated with gender stereotypes. The first being, the utopian view. This view suggests that women have inherent soft skills that will aid them in dominating the IT industry. It describes women as being the ultimate hybrid worker [35]. The second being, the dystopian view. This view on the other hand, predicts that women will remain the gender that is at a disadvantage. The ICT industry is and will continue to be a masculine dominated industry in this scenario of dystopia [35].

Gender Encouragement. Women tend to be more drawn to IT courses if they have been exposed to female educators in their early lives [69]. It can be assumed that the views of other female and parental figures in a young female's life, plays a significant part in their understanding and acceptance of the ICT industry [43]. Encouragement is the first step in the right direction to possibly increase the representation of women in the male-dominated ICT industry.

Encouragement programs do in fact exist that are focused on encouraging potential female participation in fields such as ICT. Examples of these types of programs includes the following. Firstly, students from Massachusetts Institute of Technology who are female, provides encouragement seminars with the assistants of the "Women's Initiative Program" to female school pupils [70]. Secondly, certain webpages are demonstrating and presenting their female employees to the public in hope of encouraging young women who aspire to become IT professionals [70]. Lastly, certain ICT organizations are offering more female courses in which these women have the chance to be introduced to and engage with other women that are currently in ICT related occupations [70]. These types of initiatives aim to increase female participation and decrease the over-representation of men in these types of industries. However, female idols are not the only aspect to inspiring young women, it is also important that these idols do in fact present a good image that could make these young women feel more at ease [70]. This suggests that the fact that an idol is female is only one part of the equation, it is important that they do not represent a stereotypical image of female IT professionals [70]. They should rather aim to inspire all types of young women to join these types of fields and not just the stereotypical "geek". It is essential to encourage young females to partake in IT careers not only to provide the industry with a fresh viewpoint but to make high-end occupations accessible to more women [70].

Gender Programs. During 2004, programs such as the LDC Initiative has begun to focus their efforts on sustaining and improving academies [8]. These types of initiatives are finding ways in which they can empower and increase female participation in the ICT industry. A positive correlation exists between women's participation in this industry and their encouragement to related fields. Unfortunately, not many initiatives or programs are set in place to increase female involvement in ICT related sectors [71]. However, a research network formed in 2004 named "Gender Research in Africa into ICTs for Empowerment" in short GRACE, aimed to empower females in the ICT industry and promote equality [72]. The GRACE Network provides ample mentor programs for women. Twelve women from Nairobi that have ICT related occupations were interviewed. These women all participated in the mentoring program. Their support structure has aided them in numerous ways. Firstly, by developing and comprehending the necessary skillsets that they require in ICT [71]. Secondly, they acquired better self-efficacy [71]. Thirdly, they developed a more in-depth comprehension of occupational possibilities in the ICT industry [71]. Fourthly, they received important and beneficial information about the ICT industry [71]. Lastly, they acquired a valuable support structure to assist them on their journey [71].

Gender Development. As previously discussed, gender development is explained by various theories that can be applied to young children. Such theories include cognitive perspective theories and gender schema theories. The cognitive theory relies on a concept known as "gender constancy". It suggests that a child will gradually come to the realization that they belong to a certain gender and allows them to start behaving accordingly [27]. It is believed that this phase occurs between the ages of three and seven [27,73]. Gender constancy is divided into three important categories. The first being, identity. This suggests that the child can acknowledge which gender they themselves and the people surrounding them, belong to [73]. Secondly, stability. The child will comprehend that if they are a certain gender it will be the same gender once they have grown-up [73]. Lastly, consistency. It will be clear to the child that in spite of personal preference, their sex will not be altered [73].

The gender schema theory suggests that once a child acknowledges their sex, they will start to make psychological connotations regarding different sexes [33]. Gender labelling can be influenced by any person or gender specific organization that a child comes in contact with [32]. This gender related labelling plays a substantial role various aspects of a person's life, for example the type of toys that children prefer [33]. Gender related labelling also plays a role in how different genders perceive the ICT industry and may contribute to the under-representation of women in the ICT industry.

Gender Self-Efficacy. Differences in the relationship between gender and technology was more prevalent in the 1980s than today [75]. During the 1990s, only five percent of users on the internet were predicted to be female but of late this number seems to surpass that of men, especially regarding social media [39]. Female users tend to limit their technology usage to explore and sustain contacts, whereas males on the other hand

focus on task related actions [76]. Even though more women are participating in technology related activities, they are still under-represented in ICT careers. Women often experience more anxiety than men, when interacting with new technology [41]. Asian and Western cultures were compared to see if there would be a difference in gender technological usage. It was found that both cultures propose that men's confidence levels were higher than their female counterparts when interacting with technology [74].

It would seem that the reason for this under-representation is the female's self-efficacy combined with a lack of curiosity [43]. Even so, it is suggested in some studies that there were no differences recorded or observed between the two genders [41]. The results of these studies indicate that gender cognitive perspectives of the subjects and not necessarily biology play a greater role in gender-technology usage [45].

Sexual Dimorphism. Men have physical characteristics that differ from women [77]. However, cognitive factors (involving the brain) can also be taken into consideration when distinguishing between the genders [78]. Research indicates that the female brain causes women to possess greater social and recall abilities, whereas the male brain causes men to possess greater visual-spatial and motoring abilities [79]. Neuroimaging is used to determining these differences between genders in one's brain. Women were found to have a smaller crania[2] with their grey matter[3] percentage higher than men's [80]. Men on the other hand demonstrated a higher volume in their white matter[4] [79].

Empathy is defined as the response to the state of another individual's emotions when witnessed [81]. Research on neuroimaging suggest that there are gender differences in the neuro-functional processes related to both cognition and emotions in certain areas of the brain [82-83]. Women tend to showcase higher levels of empathy when they are observing another individual's state of emotions [81]. On the other hand, men depend more on their cognitive abilities to decide on how to express empathy towards another person [81]. These results provide some insight to why men are deemed to be more suited for industries such as ICT which is regarded as task orientated and logical. On the other hand, this may also provide some insight into what women with inherent soft skills, could potentially offer to the ICT industry.

The ICT industry has been previously seen as a logical career, but more recently it started to recognize the need to include emotional and inter-personal aspects as well such as customer and social collaboration skills [84-85]. Social interactions can be divided into two main categories namely agentic and communal. Men tend to excel in the agentic aspect which focusses on tasks, logic, dominance and competitiveness [86-87]. On the other hand, women are more prone to surpass men in the communal aspect which refers to the nurturing side of a person [87]. These behaviors creates gender segregation.

The research suggests that if these traits were widely considered to be accurate, it would suggest that certain career paths are more acceptable for a specific gender than

[2] Part of the skull that encloses the brain.

[3] Responsible for muscle control, and sensory perception such as seeing and hearing, memory, emotions, speech, decision making, and self-control.

[4] The tissue through which messages pass between different areas of gray matter.

other careers [88]. Therefore, if someone were to be more communal in nature, which in this case is associated with the female gender, they should choose a profession that relates to caregiving or social interactions such as providing services to others [88]. On the other hand, if a person were to be more agentic in nature, which in this case is associated with being male. It is suggested that they should consider entering any trade that is task orientated, logical and competitive in nature [88].

5 Conclusion

This systematic literature review has recognized a total of 89 articles that provided a holistic perspective on factors that affect or contribute to the under-representation of females in the current ICT field. The data obtained from these articles were evaluated and grouped into three distinct categories in to answer the research question: What holistic factors impact the under-representation of women within the ICT sector?

The categories were identified as: organizational, economical, socio psychobiological factors. The theories and concepts within the categories are not necessarily linked to each other which could be expanded in further research. The categories that emerged were chosen and used to create a holistic perspective of factors that cause the under-representation of women in ICT.

This review contributes to the body of knowledge by presenting a holistic perspective of factors that explain the under-representation of women in the ICT, not focusing on a single set or group of aspects or factors.

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