

DEMYSTIFYING THE SHRINKING PIPELINE OF WOMEN IN ICT EDUCATION AND CAREERS: A SOUTH AFRICAN CASE STUDY

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ABSTRACT

This research is an attempt to verify certain myths surrounding the causes for the low numbers of women participating in Information and Communication Technology (ICT) education and careers through both qualitative and quantitative analyses. The paper approaches this issue through the experiences of women in an ICT workplace in comparison with those of men in the same workplace. This investigation was conducted in the form of case study at South Africa's Advanced African Institute for ICTs – the Meraka Institute.

The research found that the ICT environment was engendered, with women representing only a small percentage of the staff. This is because of a weakness in the school curriculum which does not expose large numbers of girls to ICTs at an early age, and does not give adequate support at university and college levels to learners who have come out of such an environment.. Although women are just as capable as men in the ICT workplace, building self-confidence in their abilities to perform well on the job could help in retaining them. The research found that those women who are already in the ICT market are happy and do perform as well as their male counterparts irrespective of their family commitments, long working hours and the demand for networking opportunities. Happiness in the ICT workplace among female employees is determined by a combination of factors such as levels of remuneration, output potential and management style. To improve women's participation in this workplace, there is a need to improve policies for recruitment and on-the-job training and sometimes even adopting affirmative action to provide better-balanced gender representation.

Keywords: women, education, information and communications technology (ICT)

1. INTRODUCTION

There are many theories surrounding the reasons why women do not take up ICT education and careers, and why it is not easy to retain them in the ICT workplace. The dwindling numbers of women participating in science education and careers as one moves from secondary education through university and college and eventually into work is referred to as the shrinking pipeline.

There are two aspects of the relationship of women with technology which need to be distinguished: namely 'women in ICT', concerning women who are employed in ICT occupations and/or sectors or undergoing ICT training, and 'women and ICT', concerning women's interactions with and uses of various ICTs in everyday life. The general picture which emerges is that to an increasing extent virtually all women are involved as 'women and ICT' – in the home, at work and for leisure – and that the numbers involved as 'women in ICT' remain small. While both groups have the potential to shape the design and use of ICTs, those who create new technologies are clearly more directly and consistently engaged in shaping the process than users are; for this reason alone it is important that women be better represented within ICT education and careers [26].

It is an issue of concern to policy makers, employers and gender equality practitioners that despite attempts to attract women into ICT education and careers, women remain such a small and declining proportion of ICT professionals. A wide variety of issues related to female under-representation has been investigated including the issue of how to narrow the ICT gender gap. These include social contexts, media influences, gender stereotypes, education and the work environment and recruitment and retention. Once enrolled on an ICT academic course, women are more likely than men to drop out with the result that the proportion of women with higher degrees in ICT is reduced. The truth is that fewer women end up with higher academic qualifications in ICT.

This research concentrates on women's experiences of the ICT industry, whether they are moving into industry (career choices, recruitment), moving up in industry (pay and progression), and moving on (retention) from industry and compares them to those of men in the same industry. The research aims to explore in-depth experiences of these women and also to explore the situated knowledge that structures life in the ICT workplace. Further, it provides the opportunity to explore the nuanced links between women's domestic situation and their working life.

This research is in line with the UN Millennium Declaration [29] which resolved to promote gender equality and empowerment of women as effective ways to combat poverty, hunger and disease and to stimulate development that is truly sustainable and to ensure that the benefit of new technologies, especially ICTs, is available to all. It is also in line with the Agreed Conclusions 2003 of the 47th session of the UN Commission on the participation and access of women to the media and ICTs and their impact on and use as an instrument for the advancement and enhancement of women [10] which states, "ICTs offer tools for enhancing women's full access to the benefits of information and new technologies." It also supports the South African National Department of Education's e-Education White paper [5] which encourages the use of ICT to accelerate teaching and learning goals and the ICT empowerment charter 4th

working draft's objective to increase the extent to which women, communities, disabled persons, workers, cooperatives and youths participate meaningfully in all areas of the ICT sector [4].

The research was conducted as a case study at the Council for Scientific Research (CSIR)'s Meraka Institute in South Africa, which is an ICT research institution. The CSIR is a leading scientific and technology research, development and implementation organisation in South Africa. The organisation undertakes directed and multidisciplinary research, technological innovation as well as industrial and scientific development to improve the quality of life of the South African people. The Meraka institute is managed by the CSIR, and facilitates national economic development through research and innovation leading to products and services based on Information and Communication Technologies (ICTs). It is a national ICT institute based in Pretoria, South Africa. The Meraka runs a number of research groups, namely, the digital doorway, wireless Africa, ICT for independent living, human language translation, ICT for earth observation, high performance computing, ICT for education, youth and gender, remote sensing and the open-source centre.

The vision of the digital doorway project is to make a difference to computer literacy among disadvantaged communities. A free-standing 4-seat computer, that provides simultaneous access, and whose content is customised to a local community and includes educational programs, games and music, is installed at remote sites. The Wireless Africa group researches on developing sustainable communication networks and conducts social research on community-owned wireless infrastructure. The group conducts research on mesh networks, low-cost messaging, low-cost access points and antennas and network security.

The ICT for independent living group enhances development and independence of persons with disabilities through the creation of a highly innovative and efficient information and communications system to enable people with disabilities to access information and services. The human language translation technologies develop systems to make it easier for people to interact with machines by providing translation of text-based information into audio.

ICT for earth observation is involved in the development of sensor-web technology to revolutionise earth observation through the provision of comprehensive and continuous monitoring of the earth. The mandate of the high-performance computing group on the other hand is to create a significant computational infrastructure for South African research institutions to enable them to engage in computationally intensive research challenges. The ICT in education, youth and gender groups work on ICT interventions in the educational domain.

The remote-sensing group is involved in urban settlement mapping, fire detection and time series. Urban settlement mapping monitors urban expansion, by detecting both formal and informal settlements in order to assess the impact of settlements on the environment. Time series involves research on mapping over time. Images are collected over a period and analysed according to dates in order to monitor specific phenomena such as changes in vegetation over a period. In fire detection research, satellites monitor and detect active fires. The open source centre conducts research into the integration of open source into the South African society.

2. Methodology

2.1 Purpose of the research

The aim of this research was to obtain information from women in ICT careers about those experiences and attitudes that influenced their and other girls' decisions on whether or not to take up ICT education and careers right from secondary school level, through university and into employment and how this information compares with the other researches that have been undertaken in this field, and with those of men in the ICT field.

The questions that this research asks are:

- What is the role of education in the theories around the shrinking ICT pipeline in women?
- How does education affect the experiences of women in ICT?
- How do the experiences of women in ICT compare against those of men in the same field?

2.2 Data collection

This research is a case study. A case study follows the interpretive tradition of seeing the situation through the eyes of participants [31]. A case study is a research strategy that investigates a phenomenon within its real-life context. This study was carried out at the Meraka Institute because of its concentration of ICT professionals. The study was qualitative in that it aimed to establish the personal experiences of the ICT professionals.

Data collection was done in two stages. Initially, five women were interviewed to find out their experiences with ICT education and the ICT work environment. The questions asked included issues on what they liked or disliked about their work environment, and also what they would like to see in the environment. The interviews included questions about years at university and secondary school to discover factors that had impacted on their career choices.

The answers to these questions formed the underlying base to a literature survey. The literature survey looked at issues that had been raised in the interviews with the women in the ICT environment. The questions that arose from the literature survey then became the basis for the questionnaire. The questions were formulated in order to obtain the perceptions of the participants in the following matters:

- The participants' previous education background and its impact on career selection
- The participants' perceptions on factors influencing entry into ICT education and careers and deterrents
- The level of family support of women and its impact on balancing work and home life
- Factors impacting on the levels of happiness in the workplace, such as feeling of appreciation in the workplace, performance, responsibility, remuneration/workload relations and management style
- Questions on human resource management policies and support for the well-being of women in the work environment

2.3 Profile of respondents

The questionnaires were rolled out to both full-time staff and contract workers at the Meraka Institute. Of the total number of 98 staff, responses were received from 59 participants. The participants consisted of 28 women, of which 18 were full-time personnel and 10 were contract workers. As a control sample, the questionnaire was distributed to 31 men, 9 of whom were full-time members of staff and 22 contract. This was done in order to understand and compare how the issues of the ICT environment affect both men and women to the benefit of women.

The ICT professionals referred to in this study are people possessing a diploma or higher from a recognised university or higher education institution and currently actively employed by the Meraka Institute on a part-time or full-time basis. Those in management of ICT hold an ICT qualification in addition to their management qualifications. Contract workers consist of employees on MSc and PhD studentships, and students on work placements for a year (also known as interns). These interns are normally diploma or bachelors' degree holders. Full-time employees of the staff consist of researchers, technical support staff, project managers and senior managers. The researchers were Meraka Institute staff members involved in gender and ICT research. The researchers left the questionnaires with the respondents and collected them after they had been completed.

Table 1 shows the distribution of respondents to the questionnaire by age and gender.

AGE	GENDER (numbers)		FREQUENCY (%)		
	MALE	FEMALE	MALE	FEMALE	TOTAL
20 25	7	5	11.8	8.5	20.3
26 30	13	8	22.0	13.6	35.6
31 35	4	6	6.8	10.2	17.0
36 40	4	5	6.8	8.5	15.3
41 44	0	3	0	5.1	5.1
45 and above	3	1	5.1	1.7	6.8
TOTAL	31	28	52.5	47.5	100

Table 1: Respondents by age and gender

The results show that the skills base of the respondents is quite youthful. 72.9% of the respondents are below the age of 35 years, while only 1.7% of the respondents are 45 years of age and over. 67.9% of the females respondents were below 35 years of age.

Table 2 shows the distribution of respondents by gender and ICT qualifications.

QUALIFICATION	GENDER		FREQUENCY		TOTAL
	MALE	FEMALE	MALE	FEMALE	
PhD	4	2	6.8	3.4	10.2
Masters	9	4	15.2	6.8	22.0
Bachelors'	16	18	27.1	30.5	57.6
Diplomas	2	4	3.4	6.8	10.2
TOTAL	31	28	52.5	47.5	100

Table 2: Respondents gender and ICT qualifications

Generally, the surveyed population was highly qualified. 10% had PhDs, 21.7% had Masters' degrees, 58.3% had bachelors' degrees and 10% had diplomas.

Table 3 shows the distribution of the respondents by gender and positions within the Meraka's career ladder system.

CAREER LADDER POSITION	GENDER		FREQUENCY (%)		TOTAL
	MALE	FEMALE	MALE	FEMALE	
Senior management	0	2	0	3.4	3.4
Research	11	14	18.6	23.7	42.3
Studentship	13	5	22	8.5	30.5
Internship	6	4	10.2	6.8	17.0
Technical support	1	1	1.7	1.7	3.4
Project management	0	2	0	3.4	3.4
TOTAL	31	28	52.5	47.5	100

Table 3: Respondents by gender and position in career ladder

The researchers and those on studentships and internships make up 89.8% of the sample. 42.3% of these are researchers, 30.5% are in studentships and 17% in internships. Those from senior management, technical support and project management constitute 3.4% each.

2.4 Ethical considerations

According to Cooper [32], ethics are norms or standards of behaviour that guide moral choices about behaviour and our relationships with others. For this study the researchers ensured that ethics were complied with. The main ethical consideration was respondents' privacy. The researchers had to comply with the principles aimed at protecting the dignity and privacy of every individual who provided personal information. No names of individuals can be revealed regarding their opinions. The participants were notified of the aims, methods and benefits of the research, and assured of their right to abstain from participation and the right to terminate their participation.

2.5 Study protocol

The development of a protocol enabled the study to improve and achieve reliability. Table 4 shows this study protocol.

Purpose	Study issues	Effects
To solicit information on the experiences of professionals in the ICT field and evaluate related policies and programs on grooming and retaining them	Identify issues of concern and then translate these into questionnaires.	The questions to be included in the questionnaire should address concerns arising and relate these to existing policies and programs in the ICT pipeline
Identify respondents	The respondents should be ICT professional who are active in the field. Meraka Institute was chosen as the source because of a concentration of ICT professionals.	The study targets people who are in the ICT workplace because they are in a position to answer questions relating to concerns regarding the experiences they have had.
Identify role of researcher	The role of the researcher is to identify issues of concern by interviewing a few individuals initially, then conducting a literature survey to support the issues identified, and subsequently compile a questionnaire and distribute it.	The researcher is a person within the Meraka Institute and has an established relationship with the targeted staff. This makes the job of distributing the questionnaires and making follow ups much easier.
Ensuring optimum response is obtained	Opinions of respondents are gathered and analysed at this stage. Effort should be made to get optimum response in terms of the numbers of respondents.	The respondents' opinions are recorded and analysed.
Facilitate good timing	The researcher should to follow up on the questionnaires within a reasonable time limit.	It should be expected that not all people that the questionnaire is distributed to will respond, and that not all will respond in time. Effort should be made to distribute as many questionnaires as possible and a follow up made within reasonable time on the questionnaires for maximum response.

Ensure the questionnaire is the perfect resource	The questionnaire should be unambiguous, in English, and adequate.	The questions should be easy to answer. The questionnaire should not be too long but should be able to solicit enough content. No expertise in the language should be required for anyone to answer the questions contained in the questionnaire.
Check out the ethical concerns	All responses will be anonymous to protect the privacy of the respondents.	Privacy is guaranteed. No revelations of respondents' private information will be made. Authenticity of results is also guaranteed.

Table 4: The study protocol

3. FINDINGS OF RESEARCH

The research came up with the following findings:

3.1 The engendered environment

The low numbers of women in ICT research at the Meraka Institute reflects an engendered environment. Women involved in research constitute 29% of the research population in the Meraka Institute. Of the whole research population 18% are females in full-time research, 5% are female interns, and 6% are females on studentships. The full-time research population includes project managers, technology developers and research leaders.

The distribution of women according to competency area is as follows: ICT in Education, Youth and Gender - 44%, Wireless Africa - 0%, Human Languages Translation - 27%, Intelligent Environments for Independent Living - 60%, Digital Doorway - 40%, Remote Sensing – 40% and ICT for Earth Observation - 42%

Of the total number of PhD holders in the Meraka Institute, 16% are women. Of the total number of Master's degree holders, 37% are women. Of the total number of Bachelors' degree holders, women constitute 25%. Of those with diplomas women constitute 80%.

From the above analysis, there is some representation of women at the Meraka Institute, although it does not reflect the South African national population of 51% women versus 49% men. There is concern as well as to why a group such as Wireless Africa has no female representation. The large number of female diploma-holders compared to males is a result of affirmative action to attract more women to the workplace. Access to ICT education and higher qualifications in the field has been a factor in deterring women from entering the field.

3.2 Factors that motivate/d Meraka women into ICT careers

There are many factors cited by the respondents that motivate South African women to take up ICT careers. ICTs are seen as a route to rewarding job opportunities, due to their application in all spheres of life and their potential impact in the future. Those who have a passion for problem-solving, while at the same time having strength in science and mathematics, are the ideal candidates for an ICT career. This, coupled with a passion for experimenting with computers and technology and good career guidance, is a recipe for a career in ICTs. Women generally have a passion for working with people and since ICTs are a tool for community development in this environment, many women are taking interest in this area. Further, those who are interested in furthering their careers academically are given an opportunity in Meraka. For those who are from non-ICT disciplines, this was an opportunity to integrate ICTs into their areas of specialisation. Also, generally, ICT jobs are relatively better paying than other jobs.

The responses from women on factors that motivated them to take up ICT careers were as follows:

- *“We are living in a technology world, so I thought I should join the bandwagon and not be left out. ICTs are relevant in today's environment”*
- *“The field of ICT has rewarding job opportunities and ICT professionals are well paid. Why lose such an opportunity. I have a desire to be globally competitive in the job market and a career in ICT offers me just that”*
- *“The area of ICT is a new, emerging and dynamic area that is challenging and exciting.”*
- *“We women are more interested in people-oriented careers, and since there is a strong link between technology and society I decided to go the ICT way. I want to be able to make an impact in my community through ICT”*
- *“My sister is a programmer, and my interest in the work she does motivated me into the ICT arena”*
- *“I have always taken an interest in science and mathematics from an early age, which is the foundation to a career in ICT”*

3.3 Factors that generally deter women from ICT careers

There are a number of factors that could have discouraged these women from taking up careers in ICT. Engineering and technology have always been considered men's fields, and are dominated by men. Therefore women do not venture into that world for fear of failure. Women often lack self confidence and do not trust their abilities to handle technical work. For women, the barrier to progressing is therefore low self-esteem.

Women do not believe enough in themselves to progress on a positive ICT career path and they are less sure of their abilities to work in an ICT environment.

There is also the issue of gender stereotyping. Women are said to relate better to people than to technology because of their caring nature. Women therefore do not take up technology education and careers. Unlike boys, girls are not exposed to technologies early in life, which would dispel that fear. As a result there are few female role models to emulate in the field of technology.

The following are responses from women on factors that deter other women from participating in ICT education and careers:

- *“Nothing discourages women from participating in ICT education and careers. I think they place 'a silicon ceiling' on themselves”.*
- *“In the rural environment in which I grew up I was taught that technology is for the man and boy and that a woman's place is in the home. That was enough to intimidate any girl. I am sure the fear of the unknown is bad enough”*
- *“Most women lack knowledge on ICTs and their benefits. Efforts should be made to expose them to this knowledge early enough in life to enable them to make informed career choices.”*
- *“Lack of a background in mathematics and science is a deterrent to entry into technology-related careers”*

3.4 Being appreciated in the work place

One of the reasons why women are not retained in the ICT workplace centres around being appreciated. 75% of the full-time females and males in Meraka indicated that they felt appreciated in the workplace. The story is different for the part-time employees, however. While 75% of the males in part-time employment felt appreciated, only 40% of the women felt the same. The reasons given by the women for the dissatisfaction were varied.

The majority of the contract workers felt that they were not sufficiently exposed to technology and research, and hence were denied the opportunity to gain industrial experience. As most of them would have just graduated from university or college they were not trusted enough to handle many tasks. Qualifications also play a big role. Those women with diplomas felt they were not valued as much as those with degrees although the two may be performing the same jobs. The diploma holders felt that the programmes taught in Technikons, which they had done, encourage hands-on work, unlike the university programmes which are theoretical. Therefore according to them they should be judged on the basis of capability, output and performance rather than on the qualifications they hold.

The feeling was that for the effort the women on contract put into work, they receive hardly any positive feedback or acknowledgement. Even in situations where they participate in project teams, they are treated as add-ons, and not as equal members of the team. They felt that it was important that in communicating with the project members on the progress of any project, they should not be sidelined. In short, they are also employees of the organisation, and should be treated as equals.

3.5 Policies of human resource management

To improve women's participation there is a need to implement consistent policies for recruitment, training, appraisal and development, as well as working time, and to implement these policies as whole packages. Among the full-time members of staff only 24% of the female respondents and 11% of the male respondents were aware of any policies that support women in the ICT work place. Ironically, among the contract workers, none of the female workers were aware of any such policies as opposed to 6% of the males. From the above statistics both men and women are either not interested in issues that support the empowerment of women or haven't been exposed to them. It is for this reason that women miss out on some of the benefits of the workplace, which could otherwise have led to their retention in the workplace. At Meraka there are policies in place such as the flexible employment model including 5/8 or 6/8 work time, the employment equity act, an employment well-being programme for counselling, maternity benefits, medical aid, and the thirteenth cheque.

60% of the women with children have never taken any maternity leave since joining the Meraka institute. They had had their children before joining Meraka. This means that on recruitment they were a low risk in terms of taking a break from their careers, and hence were employable on the same basis as the males.

The skills development profile shows that women come into jobs with lower qualifications than men. This is why, in Meraka's skills development programme for full-time employees, men are undergoing training from Master's degree and higher levels, while women's training starts from first degree to higher levels. We went back 16 years and found that even then the minimum entry requirement for men was a bachelors' degree, while women were recruited from diploma level. Affirmative action in the recruitment of women has always existed, but it hasn't impacted much on the number of women in the field.

There has recently been an upsurge in the recruitment of males. An analysis of the participants shows that 61% of the males in employment currently were recruited within the past year, as compared to 7% of the total number of women who were recruited within the same period.

The reason given is that few women apply because of shortages inherited from the university system. At the same time research in ICT sounds like something not easily attainable to most women.

The average age of women in full-time employment is 36 years, while that of female part-timers is 28 years. The average age of male full-timers is 38 years, with that of male part-time employees being 28. This shows that Meraka is heavily recruiting the younger generation. Clearly, however, the younger generation have been exposed to better ICT education and research. There is no clear-cut relationship between the age and career ladder position in the research career ladder. Career peaks are reached between the ages of 28 years and 48 years in Meraka.

3.6 Balancing work and home life

In traditional African culture a woman's role is focused on family responsibility, especially on taking care of her parents and parents-in-law, serving her husband and educating the children. If a woman fails to take care of her responsibilities, she would not be portrayed as an ideal woman no matter how successful she might be in her career life. Women have to juggle work and family commitments. In addition to looking after family they are expected to compete with their male peers at work. Family responsibilities prevent them from travelling on work-related issues. Long working hours present problems to their well-being and family lives. For these reasons the number of single women in the ICT industry increases, while that of married women does not. Of the female respondents in this survey, 59% were single. On the other hand, of the male respondents 67% were single. The numbers of single employees is significantly high for both males and females, which confirms that to be a successful career person, commitments and responsibilities have to be reduced.

This section studies the situation at Meraka institute to find out the work-home life balance situation among women, given the above hypotheses, that is, the balance between work and home life, travel on work-related business, socialising with colleagues after hours, and networking with other experts in their fields.

a) Children and balancing work life:

39% of the males surveyed as opposed 62% of the female participants have children. But of these, 84% each of the males and females indicated they were able to balance work and home life. This was due to the fact that they have support from their extended families. 87% of the total male participants and 81% of the total female participants indicated they are supported by their extended families in various degrees.

Age has an impact on the decision to have children. Of the total number of respondents, of the 4 women who are under 25 years of age, only one has a child, while of the 4 men who are under 25 years of age, none has children.

61% of the males surveyed as opposed to 38% of the females surveyed are without children. The likelihood that those people without children can balance work and home life is quite high. 81% of men and 71% of women without children are able to balance work and home life satisfactorily. These percentages are not so different from those for people with children. This shows that the children factor does not have an impact on balancing work and home life for employees.

Working on the assumption that the younger the children the greater the workload, the research found that in men, 100% of those with children in the 0-5 years range could balance their work, although only 60% of them were married. For women, 88% of those with 0-5 year olds were able to balance work and home life successfully, although only 14% of them were married. A woman does not have to be married to achieve balance in work and home life. Extended family support is adequate. 68%, 100% and 100% of women with children in the age ranges 6-10 years, 16-20 years and above 20 years respectively could balance their work and home life successfully. Therefore the age of the children has no impact on the issue of balancing work and home life.

b) Marriage and balancing home and work life:

84% of single women with children as compared to only 14% of single men with children are able to balance work and home life. This is a measure of the effort that women put into managing their family life.

Of the women with children who are able to balance work and home life, 31% are married and 69% are single. On the other hand, of the males with children who are able to balance work and home life, 75% are married and 25% are single. This means that men have to have supporting partners to balance things out, and yet women with partners and children still carry the burden of the family and hence cannot cope. It also means that single employees are better placed to cope.

c) Socialising with colleagues after hours:

80% of males in full-time employment and 84% of the females in full-time employment rarely socialise with colleagues after work. This reflects the pressure of work and family commitments, which explains why the number of women who do not socialise is slightly higher than that of males.

d) Travelling on work-related business:

During the past year alone 42% of the women have travelled out of town on work-related business, 27% outside the country, and 31% haven't been anywhere. The distribution is not very different from that of men which is 41%, 14% and 45% respectively. This shows that there is no discrimination in selection of candidates for travelling on the basis of gender in this workplace. Knowledge of the project, the scope of the project, relevance of the individual in the project and communication skills are the factors that determine whether or not one can travel on work-related business. This also means that family responsibilities do not hinder women from undertaking work-related travel. Of the total number of trips made by women, 78% were out of town while 22% were out of the country. Of the total number of trips made by men, 81% were out of town while 19% were out of the country. Women in this workplace actively participate in the organisation's activities.

e) Working from home after hours:

Both part-time and full-time employees recorded a large number of occasions upon which they work after hours. 77% of the males and 82% of the females in full-time employment work after hours, while 75% of the males and 70% of the female part-timers work after hours. While full-timers are driven by a passion for work, contract workers are working towards student deadlines. Because they are students the final onus to achieve results and graduate lies with them, and this is reflected in the amount of effort they have to exert.

Among the males in full-time employment 50% have access to the Internet after hours, while 68% of the female full-time employees have access. Among part-time employees on the other hand, only 30% of the females have access to the Internet, compared to 38% of the males. Among the part-time employees the majority do not have access to the Internet outside working hours, probably due to the low student budgets.

f) Networking:

Both full-time and part-time employees have established networks with other experts in the field. Among the female full-timers, 26% are part of international networks, 24% are part of regional networks and 24% are part of local networks. Among the part-timers this ratio is 21%, 14% and 44% respectively. There are also a few not participating in networking: that is 8% of the full-time women and 21% of the part-time women. Among the male full-timers, 33% are part of international networks, 29% are part of regional networks and 33% are part of local networks. Among the part-timers this ratio is 17%, 13% and 45% respectively. There are also a few not participating in networking: 5% of the full-time women and 25% of the part-time women.

The numbers of part-timers participating in networking is slightly lower than that of full-timers in the majority of cases because most of the part-timers have yet to establish themselves in their fields of expertise since they are still students.

Although team work can be a blessing in situations in which team members all contribute effectively, it can also cause stress in women. The women indicated that they feel used in situations where they have to carry other team members who are not conscientious enough to do their job.

3.7 The level of happiness among employees

There are a number of factors that impact on the levels of happiness among employees, including pay package, responsibility, performance, balancing work and home life and management style in the workplace.

a) Remuneration:

Of the total number of males in full-time employment, 78% of the employees who indicated they were happy fell within the middle level income bracket. Of the total number of people who fall within this salary bracket, 16% were unhappy in the work place. This means that the pay package is not the only factor that influences the level of contentment among employees. Among the full-time female employees the following was noted among those who indicated they were happy in the workplace: 33% of these were in the low-income bracket, 11% in the middle to low-income bracket, 44% in the middle income bracket and 11% in the high-income bracket. In the same brackets, however, there are also unhappy people. 33% of the respondents in the low-income bracket and 67% of the respondents from the middle to low income bracket were unhappy in the workplace. Among the full-time male employees the following was noted among those who indicated they were happy in the workplace: 14% in the middle to low-income bracket, 72% in the middle income bracket and 14% in the high-income bracket. In the same brackets there are also unhappy people. 50% of the respondents in the middle to low income bracket and 50% of the respondents from the middle income bracket were unhappy in the workplace.

b) Publication:

Employees who are kept busy are happier than those who are idle. The research found that the people involved in serious research publication and production of technical demonstrations and community development work were much happier than those who did less work. It is, therefore, a question of keeping people busy.

Among full-time employees, those who are actively involved in research (91% of males and 68% of women) are happy, compared to those who are involved in active research (9% male and 5% women) but are unhappy. Also the percentage of those involved in community work who are happy is 36% of the males and 37% of the total females as compared to 9% of the men and 10% of the women who are involved in community work but are unhappy.

Publication levels among part-timers are much lower than those of the full-time employees. Of the male population in full-time employment who indicated that they were happy, 91% of these were serious publishers. Of the male population who were in part-time employment and happy, 32% were serious publishers. Among the women who indicated they were happy, 68% of the serious publishers were from the full-time staff as opposed to 30% from the part-time staff. Among those employees who indicated a level of unhappiness in the workplace, contract workers produce more publications than full-time workers. Among male employees, those that publish constitute 16% of the part-time employees and 9% of the full-time employees. In women, this ratio is 10% of the part-time employees versus 5% of the full-time employees.

Generally contract workers are not bothered with publication because they are not part of the career ladder system which places employees in standard grades and remuneration scales depending on their performance. Also the problem could be that not enough skills related to publishing have been imparted to part-timers. The culture a business-orientated focus is yet to be phased out in an effort to adopt a culture of scientific research at Meraka Institute.

c) Balancing work:

Balancing work is not the ultimate factor to happiness, because there are some employees who can balance work and home life and still be unhappy. Therefore balancing work is only a contributing factor to employees' happiness. Among the full-time employees, 55% of the happy males and 63% of the happy females are those that can balance home life and work as compared to 18% males and 16% of the women who can balance home and work life but are still unhappy. The same principle applies to part-time staff. 53% of the happy men and 60% of the happy women can balance work and home life while 26% of the unhappy males and 30% of the unhappy women can balance home and work life too.

d) Women and management:

One of the myths in the shrinking pipeline is that women are under-represented in management positions. The reasons given are that the availability and commitment of women are questioned, and that there is a lack of gender sensitivity. But is this true at the Meraka institute?

In Meraka women constitute 45% of those in research management.

Those employees who get along well with their managers are happier in the workplace than those who do not get along with their managers. Among the full-time employees 71% of the male employees are quite happy with their managers as opposed to 48% of the women. Among these full-time employees 72% of the males with female managers are very happy as compared to 60% of the female employees who have female managers. Can it be true that women cannot work together? Of the group that indicated that they were generally unhappy among the full-timers, 14% each of the females and males generally do not get along with their female managers.

Among the full-time employees, 100% of the male respondents are happy under their male managers, while 50% of the women are happy under male managers. Only 25% of the females who indicated they were unhappy in the workplace often relate well to their male managers. Does the myth that women work better under female managers hold then? Meraka women in full-time employment felt they would be more comfortable if they had female bosses because such would be in a better position to understand their problems.

Among the contract workers who indicated that they were happy in the workplace, only 44% of the males get along well with their female managers, and yet none of the women contract workers indicated getting along with their female bosses. They exercise tolerance towards their female managers. Among the generally unhappy women in contract employment none get along well with both their female and male managers. They exercise tolerance. Among the male part-time employees 100% get along well with their male managers as compared to 68% of the female part-timers who have male managers. But the percentage among the females is higher in the case of male managers as compared to that in relation to female managers (60% versus 68%). This means that women on contract work prefer male managers to female ones in the Meraka Institute. Men are generally happy to be led by other men. The picture is different when it comes to female managers. The response is mixed from being totally unable to relate to them at all, to relating to them quite well.

56% of the males in full-time employment and 47% of the females in full-time employment have managed projects. Part-timers, though, do not get the opportunity because they are predominantly on studentships. Anyone in fulltime employment with the capacity and skills has the opportunity to manage a project. Researchers are encouraged to put together project proposals for funding of their activities.

e) Workload/pay relationship:

The individualisation of wage relations is unfavourable to women. This means that informal career patterns are more disadvantageous to women than formal ones. Half of the full-time and part-time male employees were happy with their workload/ pay relationship. On the other hand 63% of the females in the full-time employment were happy, while of the part-timers only 40% were happy with the workload/pay relationship. This can be explained as women having more family responsibilities than men in the African family context. The part-time salary scales are constant across the board, depending on the level of entry into research. The part-time salary scales are not dependent on effort and output.

f) Job satisfaction:

As a measure of job satisfaction only 26% of the females in full-time employment as compared to 12% of the males in full-time employment have made applications for jobs elsewhere in the past year. The majority of the Meraka staff are not preparing to move out of the place in the near future – they are happy with the environment as it provides them with job security. On the other hand 38% of the male part-timers as compared to 40% of the female part-timers have made applications elsewhere in the past year. This is explained as those in internships who are only here to gain industrial experience and move on in the majority. For those on studentships employment is guaranteed through being bonded by Meraka on completion of the studentships, hence they do not apply for jobs elsewhere.

3.8 ICT education, curriculum and skills

There are a number of barriers that diminish the numbers of women in top posts in an ICT environment. These include lack of mentorship and training opportunities, limited prior exposure to ICTs in schools, entry requirements into university ICT courses and the university ICT curriculum and environment.

a) Mentorship and training opportunities:

Mentoring has been shown to be an effective method of retaining women in ICT education and careers whilst still encouraging them to pursue advanced degrees. This has been done through internships and studentships at the Meraka Institute. Of these the females make up 42% of the interns, and 22 % of those on studentships.

Interns are mentored by Meraka staff, for the one year period in which they are attached to the institute for practical experience.

Those on studentships are normally part-timers registered for formal education with the local universities and they are jointly supervised by university academics and Meraka staff. Meraka offers the practical experience. They work on Meraka projects related to their university work for 20% of their time. There was a general dissatisfaction with the lack of informal training opportunities on-the-job for full-time employees. Most of the employees were continuously self-training and learning as a normal requirement for their job. If the employer were to offer on-the-job training in order to reap a suitable return on investment, the employees would then be in a position to get higher salaries and be in an improved position of contentment and retention. While the cost of training employees could be high, the cost of taking a new employee could be even higher. The problem with these informal training sessions at Meraka is the bureaucracy one has to get through in order to have access to the training. Approval has to be sought from a number of people in the management ranks.

Full-time employees tend to sit back and relax, in terms of taking up formal education. Only 12% of the men who have first degrees are studying towards their Master's degrees, and an equal percentage is progressing from their Master's degrees to PhD programmes.

b) Exposure to computers:

Among the male full-time employees, 30% started accessing computers at primary school, 10% at secondary school, 50% at university and 10% at work. On the other hand, among the females in full-time employment, 11% started accessing the computers at primary school, 39% at secondary school and 33% at university, 11% at work and 6% through informal learning channels. This discrepancy in access at primary level shows that men have access to technology at an earlier age than women. The majority of full-time ICT professionals who participated in this survey started accessing computers at university level.

The story is different for the part-time employees. 14% of the males started accessing computers at primary school as compared to 20% of the women. This reflects a change in the distribution of resources for the younger generation. While previously access to computers was the preserve of the privileged few, now that more people have access, the gender dimension does not play as big a role as it did before. At secondary school 56% of the males and 30% of the females had access. This explains boys' dominance of technology in the classroom. 24% of the males and 40% of the females started accessing computers at university level. The majority of males that join university would have had access earlier, reflecting a decrease in male numbers who were accessing at later stages. Through informal learning channels 6% of men and 10% of women had access to computers. Women have to catch up, hence they resort to informal learning channels.

Age is a factor in the full-time and part-time access differences. The average age of full-timers is 35 years while that of part-timers is 23 years. The older generation only had access at university because computers were not provided in schools then, but now computers are available at school level.

The response to the level of computing knowledge that the respondents had before university shows that word processing is the most common application known to 53% of the males and 41% of the females before entry into university. Knowledge of spreadsheets, e-mail, any programming language, web surfing and presentation programs stood at 43%, 40%, 40%, 30% and 30% of the respondents respectively for the males, and 34%, 21%, 24%, 24% and 34% respectively for the females. The percentage of women that had knowledge of computing before university entry is lower than that of men.

While among full-time males, career guidance, parents and self interest influenced their decision to take up computers at 32%, 25% and 25% respectively, the younger generation of part-timers was driven by self-interest, parents and career guidance at 52%, 16% and 16% respectively. Self interest takes the centre stage with the younger generations because they were exposed to technology early enough.

c) University curriculum and the work environment:

What is covered in the university syllabus and what is practiced in the work environment are two different things. In a South African university an electrical engineering student is taught about the structure of diodes. But that's as far as the student can go with the diodes, because S.A industry does not produce such technologies. This is an example of a conflict between expectation and what's on the ground, and this becomes a shocker to the new employees.

d) Entry requirements into university for computing courses:

The research shows that science subjects and Mathematics are the most popular at secondary school for those who eventually take up ICT courses, with 100% of the respondents having taken those courses. Mathematics and English top the list with 100% of the respondents having taken these. English is an essential tool for communication. Physical science and Biology come next among the males at 73% each. With women it is reversed, with Biology coming before Physical science at 67% and 53% respectively, Computer Applications, although an important component, is at 37% for boys and 20% for girls. This reflects the inadequate resources in schools. Girls generally are scared of taking Mathematics and Science in secondary school, and as they do not take these subjects they cannot do an ICT program at university.

If the urban/rural ratio of those who are now in ICT careers was 56%/44% for males at primary school, for females it was 69%/41%. The urban/rural ratio for secondary schools is 76%/24% for females versus the 74%/26% for males. Among males there is a 33% increase in urban secondary education versus a 10% increase in urban secondary education for females. This is because a number of people that attended rural primary schools eventually migrated to urban secondary schools for a better education.

3.9 Redefinition of skills

Non-traditional routes to ICT occupations are clearly common among women for getting into these jobs without having taken ICT degrees. 15% of the women in Meraka came into the field through 'non-ICT' degrees as compared to 10% of the men who came in through the same route.

3.10 Responses from female respondents

The following were responses obtained from female respondents on why they loved their ICT jobs:

- *"I work in an exciting, stimulating, dynamic and satisfying ICT environment. I am in a real ICT research world"*
- *"The pay is quite reasonable. The ICT environment pays well compared to other careers"*
- *"I rub shoulders with top scientists in the ICT field and I get an opportunity to network"*
- *"I am learning a lot in my job and gaining experience and can see the prospects of career development in the field"*
- *"I feel happy to work as part of a team. I feel my colleagues accept and appreciate my efforts"*

The female respondents gave the following reasons on why they hated their ICT jobs:

- *"I am on contract work hence I do not feel secure in my job"*
- *"My job is not challenging enough. Most of the time I cannot find anything to do actually."*
- *"I wish I could get adequate in-service training so that I can understand the dynamics of the ICT working environment. I feel really left out and unappreciated in the work place."*
- *"My workload is too high compared to the salary I get. I hate the idea of being overburdened with administrative work when I am supposed to be working as a researcher."*

On the problems that women experience in the workplace which men don't, the following responses were received:

- *"We are expected to perform as well as men in the workplace and are judged on the same criteria as men, when in the homes we are overloaded with work. I have to take time off from work frequently to look after a sick child, for instance, since my support network is small. We women have to take career breaks for maternity leave occasionally, while men don't"*
- *"There is generally a lack of role models in the ICT field. There are no female chief researchers in this organisation, for instance. This just says the story about women traditionally not being 'pioneers'/leaders. I have no one to look up to or turn to in this male-dominated environment."*
- *"I wish my efforts were appreciated in this place. That would definitely make me stay."*

4. DISCUSSIONS

This section discusses the findings of this research and supports these discussions through literature.

4.1 Engendered environment

The research found that the environment in Meraka was engendered, with only 29% of the ICT research population being female, and with some of the competency areas such as Wireless Africa without any female representation. There are many reasons given by the various researches for the engendered ICT environment.

According to Moorman [20], from a young age, boys and girls are often given different toys to play with; boys are more likely to be given mechanical toys such as toy vehicles and plastic tools, while girls are more commonly given domestic toys such as baby dolls and faux cooking supplies. Because ICTs are often considered mechanical toys, boys are more likely to receive them as gifts or to have greater access to them. Therefore boys are more likely to embrace ICT education and careers than girls.

The existing predominance of men in the ICT industry has created a series of factors which discourage young women from pursuing ICT careers. One explanation for differences between female and male participation in ICT-related courses has been in general historical and – though more recently to a lesser extent – ongoing social conditioning and stereotyping of females and males in relation to technology which commonly genders its creation and programming as "masculine" domain.

Also young women perceive ICT as “machine-focused, boring and unsociable” – the antithesis of their interest in communication and people-centred professions [14]. The hope has long been expressed that, as a new technology field, ICT would not be 'tainted' by history that has marked engineering as a masculine endeavour and domain. In practice the picture which emerges is less optimistic and the factors marking the gender in/exclusiveness of computing occupations are extremely contradictory [26].

Female students often feel inferior to and/or dominated or intimidated by male students within learning settings [11]. Research suggests that this could be a result of girls viewing themselves as being low in confidence and awareness with respect to ICTs. Girls in single-sex schools therefore tend to perform better in science and technology: they are given enough space to exercise their creativity and access technologies.

Girls do not perceive their own computer use as 'proper computer use'. They tend to define 'proper computer use' as something like what their fathers do at work, while 'proper computer users' are antisocial boys who have no friends and spend all their time in front of the computer [9]. The combination of the idea of 'proper computer use' and its relationship to the image of a computer nerd limits girls' freedom to explore computers and interest in computer science education.

The on-going engendered environment in ICT has been defined as the perpetuation of the 'old corporate boys' club' syndrome [22]. This implies that while women are not precluded from entering the industry, little action is taken to recruit them or to foster their career advancement. The reason given is that women are not interested in high technology jobs, and that they prefer jobs in which they do not get their “hands dirty”.

Career choice centres on “clean work”. Women do not like jobs which get their “hands dirty”. The emergence of information work has brought a shift in the nature of work. A career in ICT is generally considered “clean” though an employee interacts directly with dirt or factory machinery [28]. But ICT is no longer a “clean” job at the CSIR. The amount of field work that is involved means that even women have to get their hands dirty.

Historically, the gender gap is mainly due to division of labour based on differences in physical strength and educational, social and cultural backgrounds. As a new field, ICT demands little physical strength, thus does not put females in an inferior position. The only obstacle is the cultural and educational gap left by the traditional division of labour based on physical strength [25].

4.2 Motivating and demotivating factors

A number of factors were identified as having motivated women into ICT careers. These include the prospects of better job opportunities, a strong background in science and mathematics, sound career guidance and high salaries in the ICT industry. The demotivating factors have been lack of confidence among the women in their abilities to handle technology, and gender stereotyping.

According to Fan [6], it is one's self-efficacy that significantly determines performance outcomes, not necessarily the underlying skills one possesses. Low ICT efficacy is one of the main causes of resistance towards ICT technology. When findings of studies regarding prior ICT experience, self-efficacy and academic performance are considered in combination, it seems to indicate that This sentence is not complete. After the comma you actually begin a new sentence., in Taiwan female students who decided to enrol in the ICT programmes were more confident in their ability to compete with males in this male-dominated field, due to appropriate amount of maths discipline and ICT experience they gained prior to entering college.

Females tend to blame failure on their own personal inadequacies or lack of ability, while males tend to blame external factors [27]. Women students tend to underestimate their own technical skills relative to other measures of their technical competence [12], which is why they are few in technology fields such as ICT.

4.3 Appreciation in the workplace

Although 75% of the full-time female workers felt appreciated in the workplace, only 40% of the part-time female workers felt the same. The reasons were that they were denied unconditional exposure to research and technology and hence could never feel that they were part of the organisation. The CSIR uses career ladders as a way of avoiding the disadvantages of informal career patterns. It is easy to progress under a career ladder system and also to obtain job satisfaction. Salary is linked to performance, qualifications and output. A career ladder is a consistent approach to job evaluation which is accompanied by a grade structure that is linked to remuneration. The objectives of the career ladder are to [2]:

- facilitate the process of career development,
- provide a dynamic recognition and reward system that recognises the development, contribution and performance of staff, and
- provide more flexibility and transparency in human resource processes, providing a clear picture of why staff were placed in current positions and what they need to do to advance their careers.

Only full-time employees are part of the career ladder system, which explains the small number of part-time employees who felt appreciated in the work place. For the part-timers there is no correlation between output and benefit, which can be a demotivating factor.

4.4 Policies of human resource management

Evidence confirms the view that formal organisational policies and practices have a major impact on women's participation in computing professions [30]. To improve women's participation there is a need to implement consistent policies for recruitment, training, appraisal and development, as well as working time, and to implement these policies as whole packages.

An analysis of the participants shows that 61% of the males in employment currently were recruited in the past year, as compared to 7% of the women. But the Meraka has made an effort to recruit more women by reducing the qualification threshold for women. Diploma holders are predominantly women, constituting 80% of the population of diploma holders. The large numbers of female diploma holders compared to men is a result of affirmative action to attract more women to the workplace. Access to ICT education and higher qualifications in the field has been a factor in deterring women from the field. Affirmative action is cited as one of the most important events shaping the field of human resources [7]). But there is also evidence to suggest that there are negative, albeit unintended consequences of affirmative action. Such programmes give rise to the perception that candidates of affirmative action are successful not because of their unique skills and talents. In the argument against affirmative action for women directors in Israel, it was argued that affirmative action was contrary to the intention of the amendment, which was to assure that only those most suited to the position be appointed directly [16]. Affirmative action means selecting a person who is less qualified because the person is a woman, and that for truly competent women there was no need for affirmative action – they will be selected on their own merits. A key finding of a study conducted in Tanzania however is that affirmative action programmes succeeded in increasing female enrolment generally and in traditionally male-dominated specialisations such as engineering, medicine, chemistry, physics and mathematics, specifically [18].

Lemons identifies three types of barriers to promotion that women in technology occupations encounter: gender socialisation, corporate cultures and educational issues. Since it is a relatively young field, it had initially been assumed that impediments to the advancement of women long existent in other fields, such as an established “old boys” network or a large pool of more qualified and experienced male professionals would not present barriers to women [24, [17].

Poor advancement opportunities for women may also be due to corporate culture issues such as the emphasis on short-term profits, lack of training programmes for the long term, overall corporate reluctance to invest in training, or managerial preference for employees with a particular set of skills [15].

Research shows that employers prefer young single men or men generally to women in recruitment in order to avoid lost time when women go on maternity leave. In some countries where maternity leave is standard, employers prefer to employ men to women because of the costs associated with such leave.

4.5 Balancing work and home

The issue of balancing work and home life for professionals in ICT and other careers has been looked at in many researches. The data in Lemons' research suggests that women in the ICT field anticipate difficulties in balancing their career and family responsibilities, which they attempt to minimise by remaining unmarried or childless [17]. According to Rimenschneider [24], the potential conflict of balancing the demands of the workplace with the demands of the family/home is a possible source of stress. Additionally, the job demands (e.g. continually working to meet a deadline, the need to stay current with new technology) of the ICT profession can also be a potential source of stress. This deters women from entering such career fields.

There is a myth that poor career progression of women in ICT occupations in terms of pay and status is due partly to the lack of family-friendly working hours and career structures [19]. The ICT sector is in favour of young single men and women willing and able to work long hours, travel away from home, etc. This research has shown that at the Meraka, of the respondents, 59% of the females were single as compared to 67% of the males. Family commitments retard career development for professional women. Women with children cannot work after hours as men do. Neither do they have time to socialise with colleagues after hours. 39% of males as opposed to 62% of female participants have children. Research shows that men have the advantage that they can have contact with their bosses after work and that they may have opportunities to discuss pressing issues. 80% of males compared with 84% of the females rarely socialise after hours. Lack of being part of informal networks prevents women from moving to the top of their field. These informal networks may take the form of having 'drinks after work'. Important decisions are made outside formal hours. This means that women are excluded in decision making [19]. But this research has proven that Meraka women actively participate in local and international networks.

Unpredictable rhythms and continuous time pressure raise barriers to women's access and careers. Project work can be unpredictable, involving tight deadlines and so evening and weekend work is not unusual. It is no surprise that with these kinds of working patterns, the sector predominantly employs men .

4.6. Employee happiness

This research shows that the pay package is not the only factor that influences the level of commitment among employees. The ability to balance work and home life, the style of management of the employee and the workload/pay relationship also contribute. The research also found that employees who are kept busy in the workplace were happier. According to Grifeth [19], some of the distal determinants of job satisfaction include job scope, stress, leader-member exchange, procedural justice, promotional opportunities, performance-contingent rewards, job satisfaction and pay and pay satisfaction

4.7 ICT education, training, mentorship, skills and curriculum

The presence of a good mentor is crucial to anyone's well-being and learning potential. Mentorship can build an individual, while poor mentorship can have long-lasting consequences to those being mentored [21]. For the interns and students to find scientific direction in their ICT careers, it is important that they be mentored. The CSIR runs a CSIR Mentoring catalyst programme. The programme embraces the concept of 'Power Mentoring Relationships" where protégés can select their own mentors, set up their own Board of Mentors, and select what type of mentoring relationship will fit with their career ladder and plan. There is a strong emphasis on networking skills and the new Power Mentoring Relationship and learning intervention will be of benefit to both protégé and mentor. Attendance of this learning intervention will provide mentors within CSIR accreditation as CSIR mentors. Continual training and development is an important means of retaining women in ICT. ICT is a dynamic field and constant update of skills is of vital importance.

There is a progressive hybridisation of skills taking place in ICT professions. Business and management skills are increasingly used alongside technical ones, and indeed technical skills seem less important in comparison with business and management skills as ICT professionals progress in their careers [30]. On-the-job learning and skill maintenance are critical in the ICT profession as means by which professionals develop their capabilities in most recent technical developments. Skills requirements for all ICT professionals are constantly changing and there is a perpetual need for them to update their professional skills.

With the expansion of e-business come professionals who combine technical skills with business and communication skills. Currently, however, ICT skills shortages focus on computing science and engineering and exclude other disciplines. This discourse has unintended consequences by privileging disciplines which tend to be male-dominated and excluding disciplines which include higher representation of women [1]. Henwood found that women on more hybrid courses tend to do better than women on the more narrowly technical side [13]. The less technical a subject sounds and the more it is related to either creativity or a medical (caring) profession, the higher the percentage of women it attracts.

With the integration of interdisciplinary subjects and a focus on real-life projects, ICT is not merely seen as technical, but as needing social, management and cross-cultural skills. This approach underlines the fact that there are many ways to be in ICT, and that women with a wide range of interests can get into ICT.

There has been a tendency in industry, government, the media and educational institutions to translate the shortage of ICT workers or professionals into a shortage of computing scientists and engineers, in spite of the evidence that ICT managers, database administrators, etc. are also in demand [1]. ICT skills focus on computer science, robotics and engineering and exclude other disciplines; yet there is room for “soft skills” and interdisciplinary approaches such as finance, information systems, telecommunications, e-commerce, ICT management, database administration, etc. Females are more attracted to disciplines where there is application of technology rather than technical bits. To attract a female population, the disciplines constructed as “male” over female disciplines should not be overrated.

Preliminary work conducted by Randall, et al. [23], for instance, seems to indicate that curricula involving multidisciplinary applications will attract a higher percentage of women. There should be interaction of industry, professional associations, educational institutions and media which produce these discursive patterns. Dennis emphasises the growing demand for “hybrids”, a cadre of information systems professionals with knowledge and skills in technology, business management and interpersonal skills to effectively lead organisational integration and process re-engineering activities [3].

5. CONCLUSION

This paper sets out to establish and verify the reasons why women are under-represented in ICT education and careers. This is despite all the efforts to attract women to participate in the economic development of the country through ICT education and careers. This research adopts a case study to

explain issues related to the shrinking pipeline of women in ICT. The research was conducted at South Africa's sole ICT research institute – the Meraka Institute. The reason was to highlight the South African dimension on the issue of ICT education and careers. The results of this research are an effort to influence the policy-makers, by exposing them to information on their home situation. Although researches have been conducted on the same issues in other countries, these researches cannot conclusively be applied to the South African environment. Every country has its own unique characteristics that are determined by a number of factors such as the level of economic development, policies on gender, education systems, etc.

The limitation of this research is that it looks only at the situation in one particular institution and generalises it to the entire country. Therefore there is scope for the research to target a larger audience and also to come up with measures that can be put in place to increase the ICT pipeline. The results of this research can be utilised in defining the various education policies that determine women's well-being from an early age.

The research found that the ICT environment was engendered, with women representing only a small percentage of the staff. This is because of a weakness in the school curriculum which does not expose large numbers of girls to ICTs at an early age, and does not give adequate support at university and college levels to learners who have come out of such an environment. Although women are just as capable as men in the ICT workplace, it is self-confidence in their abilities to perform well on the job that could help in retaining them. The research found that those women that are already in the ICT market are happy and do perform as well as their male counterparts irrespective of their family commitments, long working hours and the demand for networking opportunities. Happiness in the ICT workplace among female employees is determined by a combination of factors such as levels of remuneration, output potential and management style. To improve women's participation in this workplace, there is a need to improve policies for recruitment and on-the-job training and sometimes even to adopt affirmative action to give a gender balance to the representation.

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