

# WHAT LEADS WOMEN TO PURSUE A RESEARCH CAREER IN THE FIELD OF ICTS? THE CASE OF SPANISH PUBLIC RESEARCH INSTITUTIONS<sup>1</sup>

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## ABSTRACT

Although the presence of women in universities and research centers is on the increase, the dearth of women in the ICT field is not something new. As we ascend in the hierarchy of research activities, women's under-representation becomes more evident. The main aim of this paper is to analyze the presence and position of women in ICT research activity. For this reason, different quantitative (a database and a survey) and qualitative (study cases, in-depth interviews and biographies) methods were used in order to know more about the main characteristics of research groups, their location within Spain, the type of participation of women in these research groups, research inputs and outputs of these research groups, specific strategies to promote the search for talent, the implementation of work-life balance and equality measures within these institutions. All these aspects have been analyzed considering the particularities of the Spanish academic system (the conception of an academic career, the search for talent, the assessment of scientific excellence, etc.). ICT research activities could be a great opportunity for women's inclusion, as excellence and talent of individuals are considered to be its main asset. Nevertheless, the old gender barriers have been transferred to new activities; the scientific career seems to be designed to suit the young male model, without consideration of the attainment of reconciling work and family and gender equality issues.

## Keywords

gender; female researchers; ICT; public research careers.

## 1. INTRODUCTION

Both the literature and the research on this topic converge in remarking the existence of the following scenario within the ICT field in the academic arena:

*-Horizontal segregation:* it's been frequently proved the low presence of women in the ICT-related studies and professions, despite the high participation of women in university studies and their incorporation in the labor market (Eurostat, 2008; MSED, 2008)

*-Vertical segregation:* it is common to observe the low representation of women in posts of responsibility within the ICT field, considering not only the labor market, but also the academic research activity (Castaño, Sáinz and Gonzalez, 2007).

*-Critical mass versus gender bias:* On the one hand, the theory of the "critical mass", which is based on the premise that minorities, when reach a sufficient number of people, can lead to a qualitative change and attract more people from this group. Unfortunately, it is still not clear that the presence of a critical mass of women may change anything. On the other hand, gender bias in the scientific system may have an impact on the selection, hiring and promotion procedures, on the distribution of resources and on the assessment of scientific excellence (Osborn et al, 2000; Addis, 2004).

*-Stereotypes about feminine and masculine roles* are crucial in the division of tasks and roles congruent with those stereotypes. Gender stereotypes reinforce the low competence of women to master technologies and

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discourage women to choose and pursue studies and careers related to technologies (Eccles, 2007; Faulkner and Arnold, 1985; Wajcman, 1991).

*-Work organization and time use:* The traditional scientific career is based on the model of an out-of-date male life course (NAS, 2006). The model of ‘total availability’ is nowadays prevalent in the ICT sector (Valenduc et al, 2004). These models assume that individuals have an unlimited commitment to their academic/professional career throughout their working lives.

*-Scientific excellence.* The definition and measure of scientific excellence is not an easy task. In the analysis of gender bias in scientific excellence it is important to distinguish conceptually between: 1) the ways in which scientific excellence is defined and measured and 2) the specific procedures for assessing scientific excellence (Feller, 2004).

The ideal scientific career is currently based on a masculine model of success, based on long working hours, an uninterrupted scientific career and an active participation in extra activities such as expert panels and assessment committees. Nonetheless, there are also evidences of gender bias in the assessment of scientific excellence. The system of peer evaluation is grounded on the idea that the scientific community is the most prepared to judge other scientists (peers). Nonetheless, it assumes that the evaluators are free of social prejudices and that their judgments are totally objective (EC, 2004). Conversely, as Wenneräs and Wold (1997) acknowledge, the peer evaluation system cannot be considered as fully gender-neutral.

This panorama should be taken into consideration when studying the academic context in a country like Spain. For this reason, all the above mentioned aspects have been considered during the research design and also during the analysis and interpretation of its main findings.

In the context of Spain, special attention is being paid to the equal presence of women and men in science and in the labor market. The Gender Equality ACT (2007) states that companies have eight years (until 2015) to achieve equal proportions of women and men (40% at least of each sex) on boards of directors and selection committees, while the Reformed University Law (2007) states that all university and scientific committees must be gender-balanced.

## 2. OBJECTIVES

The main aim of this paper is to analyze the low representation of women doing research in the ICT field in public research institutions in Spain:

- Mapping the presence and position of women in the research groups

- Analyzing the existence of gender biases in different stages of the research activity (selection, promotion, professional path, etc.)
- Evaluating the implementation of policy measures oriented to a more balanced gender composition of the ICT research activities (i.e. gender equality measures; mentoring; quotas; policies for reconciling work and family duties)

Accordingly to the above aspects, we present the results of a research project carried out in an attempt to give answer to the following research questions:

1. Where are women located at every level (from research assistants to top positions) of the ICT-research field in public institutions? Which specific fields can be considered “female friendly”? Which ones are the most “male-dominated”?
2. What kind of positions do female researchers hold in the field of ICT? How many women hold posts of responsibility within the research groups and institutions? Is the presence of women positive for the achievement of scientific outputs?
3. Do research institutions promote measures and special policies to attain work and life balance and gender equality in women’s entry, promotion and development in the field?
4. What are the principal barriers for women to access posts of authority in these research fields? Are these barriers cultural or institutional? How could they be tackled?
5. What are the main features of the ICT research field as a male dominated area?

As the final goal of this paper is to gain more knowledge about the personal and professional trajectories of those women who decided to pursue a research career in the ICT field, several quantitative and qualitative methods have been combined (as we are going to detail below). In order to analyze the number of women doing research in ICT and the role they play in public research institutions, a primary database detailing ICT-related research groups was created. A survey was also carried out in order to gather information about women’s preference for ICT-related domains, specific lines of research, the profile of women doing research in the field, the number of women who had attained a position of responsibility in the field, policy measures to achieve work-family balance, together with the importance of female role models and mentors. The qualitative analysis (interviews, case studies and biographical analysis) explored what leads women to pursue a research career in ICT fields and the main features of the field as a male dominated area, identifying strengths and weaknesses in the initiatives carried out for

encouraging women to enroll in public ICT research centers.

### 3. METHODOLOGY

Studying the relationship between women and ICT requires the integration of the following components: facts (statistical indicators), trends (considering time-evolution), and attitudes and opinions (expectations, empowerment, etc.). In this sense, we have identified the following research needs:

- The compilation of systematic and comparable data.
- The creation of a homogenous body of indicators on gender and ICT issues
- The use of an interdisciplinary research perspective
- The application of suitable and multiple methodological approaches

Our research project was developed in three steps:

- A database gathering information about ICT research groups in order to identify them and to map women's presence and position in public institutions involved in ICT research activities.
- Survey with primary respondents (heads of research groups and women holding the highest positions) to investigate the type of research activity and cultural and institutional barriers to gender equality.
- Cases study, interviews and biographies in public research institutions as a mean to know more about masculine and feminine models, gender policies and good practices in the search for talent and excellence in research.

In this paper we will show some relevant results about women's participation in public research institutions in Spain. Our research is inspired in the statement mentioned by Nancy Hafkin and Nancy Taggart (2005) in their book entitled *Cinderella or Cyberella*: "Without data there is no visibility. Without visibility there is not priority".

## 4. RESULTS

### 4.1. Database

A database was elaborated in order to map the presence and position of women as well as to facilitate a 'census' of research groups in ICT-related fields with contact information necessary to continue the investigation. Our sample includes only those research groups with at least one ongoing funded project in any area of the ICT-related field (telecommunications and computer science). This database comprises global information about location of research groups, contact information with leaders and

members of the group, presence and position of women and type of research activity carried out by the groups.

A total of 672 research groups (with at least one ongoing funded project) were identified in our database; women represent 19.2% (1.714) of the total researchers identified by means of websites and public information provided by the research groups (confirmed by telephonic calls); only 10.6% of women are team leaders. Regarding their academic category, 40.3% and 48.4% of the team leaders belonged respectively to the highest academic categories, but only 7.9% of full professors in the field were women.

In regards to the area within the ICT field, 248 women (14.5%) are doing research in Telecommunications and 456 (26.6%) in Computer Science. The remaining percentage of women (58.99%) is concentrated in other ICT-related activities.

### 4.2. Survey

The survey was comprised of a group of 44 closed questions oriented to analyze the position of women in ICT-related research groups, the work-life balance and the equality measures implemented by the Spanish public research institutions. The survey attempts to cover the following research topics:

-General questions (geographic location, type of research: basic, applied, etc.), ICT area (electronics, theory and signal of communications, etc.)

-Presence and position of female researchers and scientific relevance of the research groups (number of PhD holders, occupation of the women in the research groups; female participation in scientific committees, scope of scientific networks, type of research projects, publications and diverse research outputs, etc).

-Specific measures aimed at attracting and retaining talent and talented researchers

-Barriers to female leadership in the ICT field

-Measures to facilitate work and family balance

-Specific institutional measures oriented to achieve gender equality in different stages of the research activity (recruitment, training and promotion of research personnel)

### Presence of women in ICT research groups

228 research groups (33.93%) out of 672 (comprised of 3021 members) completed the survey, where women represented 21% of the sample. The majority of research groups were located in the most populated regions of Spain (Madrid, Cataluña, Andalucía, Valencia and the Basque Country), which also have a higher rate of female presence within the research groups; 93% of the research groups are located in universities, 4% in CSIC (Spanish National Research Council) and 3% in other research

institutes; 68% are technical schools, 16% faculties, 8% research institutes and 8% other research centers.

#### Position of women in ICT research groups

71% of the respondents were men holding posts of responsibility within the research groups; 9% of the respondents were female heads of research groups; 12% of the respondents were female contacts and 8% of the respondents were male contacts. The majority of the respondents to the survey had between 5-11 years of research experience.

The majority of the research groups report carrying out basic research to a greater extent than applied research and technological development

Concerning the type of occupation, women represented 21% of technical and support personnel, 22% of researchers with less than 5 years of experience (mostly scholarship holders); 20% of heads of research projects and other researchers with more than 5 years of experience; and 19% of heads of research programs or areas. Regarding the ratio of female occupation, 12% of women hold a technical or a support post; 47% are researchers with more than 5 years of research experience; 33% are head of research projects or researchers with more than 5 years of experience and, finally, only 9% are head of a research program or area. In terms of occupations of doctorate researchers, women represent 19% of the heads of a research program or area, 20% of the heads of projects 24% of the researchers with less than 5 years of experience and 17% of the technical or support personnel.

The differences in research outcomes, between research groups with a critical mass of women and masculinized groups are analyzed in the next section.

In order to carry out the data analysis on the presence of women in the research groups, we dichotomized the sample by the median of female presence in all participant research groups. The median resulted in 3 women per research group (a critical mass of 20% women per research group). Following this logic, those research groups with a percentage of women above the median are considered feminized and those groups under the median are considered masculinized.

Among the ICT-related research area, those research groups with a critical mass of women seem to be more represented in the fields of Telematic Engineering, Language and Computing Systems, Electronics and Computer Science and Artificial Intelligence. On the other hand, masculinized groups are more represented in

the fields of Systems Engineering, Electronic Technology and Architecture and Computer Technology.

Concerning the achievement of the most outstanding scientific outputs (technical reports, publications, patents, register of products, spin-off or independent business or prototypes), we have observed that those groups with a critical mass of women attain good scientific outputs, even better than the ones obtained by masculinized groups. More feminized research groups report obtaining more technical reports (60.4%), spin-off or independent business (59.2%), prototypes (50.7%), specific publications (58.1%) and the register of products (57.8%) than masculinized groups. On the other hand, masculinized groups obtain more patents (51.5%) than feminized groups.

Those research groups with a critical mass of women participate in European research projects (57%), National projects (56%) and in contracts with private institutions (54%) more frequently than masculinized groups; 55% of the research groups with publications in international journals are feminized groups, and 57% of the research groups publishing in journals with a high impact factor are feminized.

#### Women in top positions

Concerning posts of scientific responsibility, 61% of women in top positions hold them (as head or coordinators of research projects) instead of posts of management (managers or directors of departments or institutions). Most women in top positions don't belong to the highest academic category (only 9.1% are full professors), but on the contrary are associate professors and contract professors (47.2%) or just researchers (34.1%).

In terms of participation of women in scientific committees, women represent 20% of the holders of research prizes or other acknowledgements; 18% of participants in commission of personnel evaluations and hiring; 17% of participants in research activities evaluation agencies; 29% of participants in scientific committees; and 29% of directors of doctoral thesis are women.

#### Searching for talent

Concerning the endorsement of talent in the research groups, feminized groups report to carry out more measures to promote talent in general, together with measures oriented specifically to search for talented women, mentoring initiatives directed at young women and initiatives for female mentors.

#### Perceived barriers to female leadership

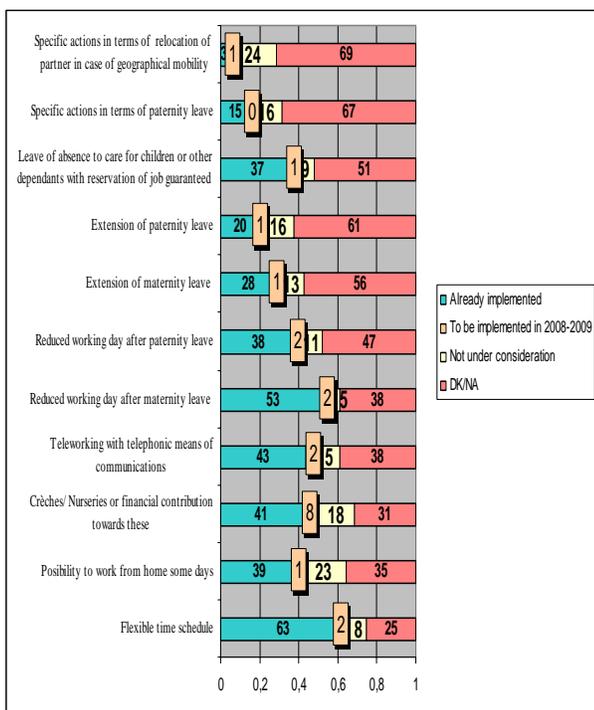
When respondents were asked about the barriers to female leadership, feminized groups allude more

frequently to problems to achieve work and life balance (67% of the 52 research groups), to difficulties associated with the academic career (62% of 8 research groups), to the discrimination women face in the ICT field, and to cultural stereotypes about the lack of competence of women to master technologies (60% of the 10 respondents). On the contrary, masculinized groups talk about the dearth of a critical mass of women in the ICT field (64% of the 45 respondents) and a lack of interest of women in holding posts of responsibility in the ICT-field (67% of the 12 respondents). Nevertheless, few research groups (just 4 feminized groups) mention the existence of institutional barriers to female leadership. It is also remarkable how out of 42 respondents 63% of them are feminized.

Measures oriented to work-life balance and reconciliation

Most respondents to the survey (91%) state that their institutions have implemented work-life balance measures, but only 45% of them (95 respondents) answer the 11 specific measures implemented in this regard or to be implemented by their institutions (graphic 1). Among the measures already implemented, it is worth-mentioning the flexible time schedule and reduced working day after maternity leave. Only 41 (out of 98) respondents acknowledge the implementation of baby or child care or financial contribution towards these services; 39 (out of 98) account for the possibility to work from home some days; 38 (out of 98) for reduced working day after paternity leave and 37 (out of 98) for leave of absence to care for children or other dependents with guaranteed reservation of job post. Only 3 research groups (out of 98) report that their institutions have implemented specific actions in terms of relocation of the partner in case of geographical mobility and 15 (out of 98) specific actions in terms of paternity leave.

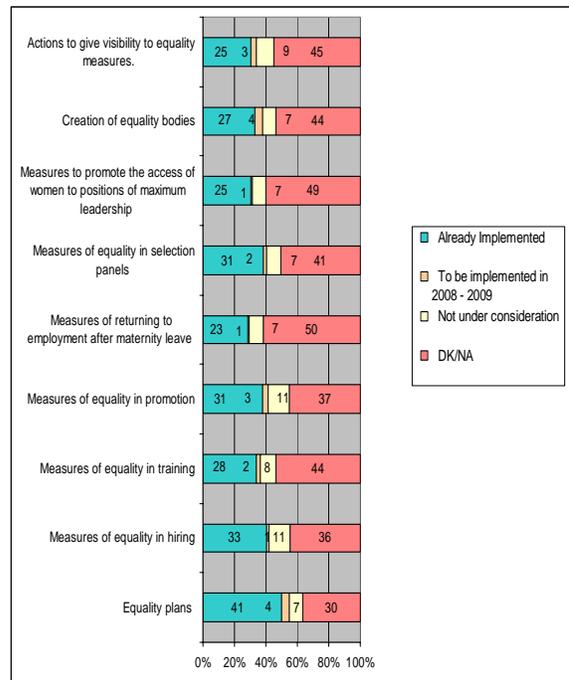
Graphic 1. Work and life measures



Concerning the implementation of gender equality measures, the majority of the respondents (89%) report that the institutions they are working for have already implemented these measures.

Nevertheless, only 41% of the respondents (82 respondents) answer the 9 questions concerning the implementation of specific equality measures (graphic 2). In this sense, 33 (out of 82) of those who answered all questions state that their institutions have implemented specific measures of gender equality in hiring, 28 in training and 31 in career promotion; 31 respondents (out of 82) report to have implemented measures of equality in selection panels, 25 (out of 82) report to develop actions to give visibility to equality measures (publicity; advertising; specially devoted meeting sessions) and 27 (out of 82) affirm that their institutions have created equality bodies. But it is astonishing that the majority of respondents select the don't know or don't answer option in regards to the implementation of most equality measures considered in the survey.

Graphic 2. Type of equality measures promoted in research institutions



4.3. Qualitative analysis

All of the in-depth interviews conducted explored the reasons why women decided to pursue ICT-related studies and a research career in the field of ICT and also the barriers encountered to achieve different positions in academia and reconciling work and family. Interviews with top researchers were held to analyze their career paths, the current status of women in science and also their opinion about the policy measures being

implemented in order to guarantee equal opportunities for men and women in this field.

The qualitative analysis consisted of 6 study cases and a total of 40 in-depth interviews in 6 public research institutions located in the regions with more prestigious and numerous research groups. The methodology used to carry out the interviews followed a triangular perspective: the head of the research group (preferably a woman) and then a female and a male subordinate.

The main findings of the qualitative research have to do with the paradoxical scenario for the achievement of reconciliation and of the gender/equality/diversity approach around the following dilemmas that research groups must face:

The dilemma between basic research (mostly assessed by scientific publications,) versus applied research (research contracts with private companies) developed by the research groups.

The dilemma of a university culture focused to a high degree on the individual (the professor/researcher and his/her academic freedom or *libertad de cátedra*), which entails that the research group is less valued than the individual.

The fact that the scientific career of the individual is based on meritocracy, but the research groups must develop a strategy for attracting and retaining the most talented researchers performing strategies of cooperation.

Specifically on the issue of gender equality, the university culture faces a double standard discourse:

-The predominant discourse supports the idea of the absence of gender segregation in scientific careers; on the contrary, the decision making process in Spanish universities is based on *corps* quotas by different academic categories (full professors, associate professors, contract professors, etc).

-The presence of women is scarce, but this is considered normal or natural.

-There still persists a gender segregation discourse: ambition is negative in women but positive in men; age is always problematic for women's careers (youth means risk of maternity and maturity is considered synonymous of lack of scientific interest); the natural place for women is still considered to be the home, whilst for men it is the workplace.

The design of the scientific career is still an obstacle in terms of a career with no breaks, focused on continuity. The scientific value is located into the individual, not in the research group; the merits are based on publications not on the applicability of the research findings

Other relevant elements of the scientific career are less valued elements, as for example the teaching experience; the creation of research groups and the practice of team

work; the applicability of scientific findings; the search for talent; creating multi disciplinary groups; diverse experiences and trajectories (from Mathematics or Linguistics to Computer Science).

This conception of the scientific career is translated into the following effects: the reinforcement of atomization (small groups are more valued than medium or large); research groups created "*ad hoc*" in terms of assessment criteria; high risk of losing scientific ground when performing innovation in teaching, applied research or management tasks. In this context, taking a maternity break can involve the end of a career for women.

In this very traditional and paradoxical environment, the creation of research groups is innovative, although many old barriers persist:

-Research groups are created for specific projects, but also around individual leaders (professors).

-Participation in research groups is optional (due to the autonomy of the professor).

-Differences between those research groups carrying out basic or applied research.

The groups developing applied research in the ICT field have the following features:

-Well-established research groups, with a large trajectory of applied research

-Organized around professors with long experience of cooperation with private firms oriented to develop applied research.

-Male dominated research groups with few women.

-The type of research they perform is considered as consultancy, so doesn't fulfill the scientific evaluation criteria.

The research groups developing basic research, show very different features, as the following shows:

-Recently established research groups.

-Oriented to meet the scientific evaluation criteria and compete for scientific excellence.

Among them, there are transition groups from applied to basic research that try to renovate their activities and members bring in young researchers

The women who participated in our qualitative analysis mentioned positive and negative aspects related to academic life. Among the factors that seem to attract women into academia, it is worth mentioning the following: passion for research and for technology (to find solutions to real problems); intellectual challenge; flexible working schedule; autonomy (the possibility of being their own boss). Among the negative aspects, we

can notice: Low wages; long delays; uncertainty about the career progression; lack of reconciliation measures (work-life balance and reconciliation uses are not formal, but informal and subject to continuous bargaining with colleagues) and barriers to promotion.

The scarce presence of women is interpreted as being the result of causes that are external to the university or research group and it is considered something natural (the same trend as in the past decades).

Some relevant questions remain open:

-The flexibility and autonomy in the organization of scientific work, the individual management of time and projects, (do these really help to achieve work and life balance?).

-The selection and promotion processes based on “merit and capacity”, - is this the appropriate approach to gender equality or, on the contrary, does this approach mean equal opportunities irrespective of gender equality?

The accreditation of merits follows an objective process or is it gender biased?

## 5. CONCLUSIONS

As our research has proved, the research field of ICT is male dominated and, although more females are entering the field, women hold positions of less responsibility than men.

Women are less represented in some areas of the ICT field, such as Electronic Technology, Systems Engineering and Architecture of Computer Technology. The scarce presence of women in the most technical branches of computer science and telecommunications reinforces gender stereotyping and discrimination in this field.

Research groups with a critical mass of women obtain better research inputs and outputs (European research projects; prototypes; international publications and journals with a high impact factor) than masculinized research groups.

Despite being a male dominated field, 55% of research groups have a critical mass of women (20% or at least 3 women). Feminized research groups consider that work-family balance is a handicap to women’s achievements and leadership in ICT-related research groups.

Most of the respondents report the lack of implementation of work and life balance measures in their universities or research centers, but the issue seems to be completely absent in the university environment, due to the fact that some of the groups cannot even distinguish between work and life measures and equality measures.

The persistence of gender stereotypes about computer scientists and telecommunications engineers, together with the masculine image of computer science and

engineering, seem to discourage women from pursuing ICT-related careers.

Some women report their conformity in not attaining a higher academic position or greater responsibilities because of the difficulties and barriers they have had to face.

Some research groups still find it difficult to respond to questions related to the implementation of institutional equality measures, which shows that the academic environment is not familiar with these issues.

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