Women in Tech Communities: challenges and risks

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Abstract

This work aims to present new results of ongoing doctoral research on female technology communities, initially published in the Annals of XV Women in Information Technology 2021. New debates on inclusion, empowerment and education in these groups will be related to new theoretical fields such as data feminism and platformization besides a framework based on Edgar Morin's Paradigm of Complexity to point out advances, risks and threats of this activism.

Keywords: Tech feminism, Communities, Social media, Activism, Data feminism

1 Introduction

In the last ten years, women in tech communities have been created and expanded all over the world. This can be confirmed in a simple conference on an information search engine like Google. On July 5th 2022, the words "women in tech groups" were typed, which yielded 1,020,000,000 results. When typing "girls in tech groups", Google referred to 392,000,000. When looking for "Brazilians in technology" 38,300,000 results appeared. When searching for "women groups in Portuguese technology", there were 21,600,000 results. These results mirror websites of private groups and governmental institutions, publicized by feminist social media and sites, books, for example.

The contexts in which these communities have developed are diverse and complex, from the 1980s in the USA to the present to promote the female presence in technology. This article aims to present the preliminary results of a research work started in 2018, which is part of a doctoral thesis about technological feminist activism (in Social Sciences, Communications Sciences, Information Science related to HCI and Social Computing), to point out solutions for inclusion, empowerment and education of women in technology. The organizational and communicational study of Brazilian and Portuguese groups will be considered in this work. The doctoral research[1] is framed in five strategic objectives of the UN 2030 Agenda for sustainable development: 4 (Quality Education), 5 (Gender Equality), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation and Infrastructure), 10 (Reduce Inequalities). It is intended to propose relevant scientific contributions in Information Technologies, Technological Feminism, Human-computational, Communication Sciences and Information Science.

This article intends to present an updated approach, with a new perspective on the work "Comunidades de mulheres em tecnologia: estudo comunicacional e organizacional"[2] ("Communities of women in technology: communication and organizational study"), published in the Proceedings of the XV Women in Information Technology, also title of scientific communication presented in 2021 at the Women in Information Technology congress (an initiative of the Brazilian Computer Society) in the same year.

The study of IT women's groups has a complex nature due to the superposition of layers and factors related to their emergence, development, advances and points to be improved. In this new approach, also resulting from an ongoing doctoral research, the Social Sciences are used to analyze, contextualize motivations and phenomena that occur in these communities and in STEM domains and careers, essentially related to the Exact Sciences, Computer Science, for example. As there is an intersection of perspectives and theoretical bases between sciences to configure these collectives in organizational and communicational terms, it was decided to expand the contextualization and debate around the work of technological women communities from theories and concepts which point to achievements that are being realized, threats to be faced in the activist exercise and actions to be improved in the collective interaction of members with technology.

Therefore, a large part of the data and debates of the work that gave rise to this one will be kept as base material for this scientific update, which will be deepened in a specific segment of this study. It is also intended to incorporate the Edgar Morin´s Complexity Paradigm with a brand new approach, as a framework with its specificities and relationships related to these women in tech groups and a dialogue with theories, concepts and even the consolidated and ongoing empirical work of my doctoral research.

There are aspects related to and within these communities that influence issues of female inclusion and diversity in technology, such as the advancement of artificial intelligence, the platform society (platformization) such as the metaverse, new activism, issues of security, privacy and use of data in a more current

[2] Frade, R. (2021). Comunidades de mulheres em tecnologia: estudo comunicacional e organizacional. In *Anais do XV Women in Information Technology*, (pp. 41-50). Porto Alegre: SBC. doi:10.5753/wit.2021.15840

vision of the concept of network society (Castells, 1996), surveillance capitalism that unfolds in issues of oppression, violence and algorithmic threat.

It is considered relevant to incorporate, once again, the research methods, female tech communities monitored organization and communication systems data, the analysis of the hierarchical structure of the groups, the flow of communication and information production through channels and environments with target audiences, such as events and digital platforms (DP). Castells' technological paradigm, concepts such as cyberfeminism, technofeminism and social computing, will be taken up in the discussion proposed in this work.

2   Research Methods

The ongoing doctoral research foresees the carrying out of communicational studies on digital platforms (DP) of twenty Brazilian and Portuguese female technology communities (examples: Facebook, Twitter, Instagram, Telegram, Whatsapp, YouTube, websites, Slack etc), with initial monitoring with behavior of users (community members and target audiences) observer participation.

This study, as well as the doctoral research in which it is enrolled, analyzes and relates social, economic and historical aspects of tech feminism, whose object of organizational, interactional and communicational analysis are women in technology and Brazilian and Portuguese women's IT communities. For this work, limited to a congress in the Brazilian scope, it was privileged to approach national and non-Portuguese collectives. However, it can be briefly mentioned that the Luso-Brazilian female groups in technology were chosen not only because they share the same language, but because they emerged and developed with greater emphasis in the same period, in the last twelve years, with communicational and similar organizational structures (such as the scope in terms of members), for what the preliminary results of the investigation point out.

Three communities out of twenty analyzed for one year were chosen as case studies with ethnographic methods (Kozinets, 2014). Among the criteria for the choices are the possibility of accessing at least one digital platform for exclusive internal use by the community, the need to deepen the ethnographic study from the profiles of different communities, the activities in the organizations and the projection growing with target audiences. The groups digital platforms and events were monitored and evaluated following ethnographic methods for four years (2019, 2020, 2021, 2022).

In order to profile these women in technology, 20 interviews have been carried out with leaders of these communities, as well as role models (successful models in the Academy and in the IT job market); it is intended to carry out at least another fifteen interviews by the end of the doctoral research. Part of the information collected in the fieldwork occurred via participant observation in more than 50 events held by these collectives and related to the theme "women in technology", such as WebSummit (in

Lisbon, editions 2018, 2019, 2020), Grace Hopper Celebration 2020 (AnitaB.Org, considered the largest women's technology event in the world); She's Tech 2020; monthly meetups of these communities. There was also my participation as a speaker and as a researcher in feminist and social action events such as Festival Feminista do Porto 2018 (Portugal) and We Colloquium (Lisbon School of Economics & Management).

This research is part of the interpretive paradigm, of a qualitative nature, but will use quantitative data, such as statistics. A bibliographic survey was carried out for three years to define the theoretical-conceptual field, objectives and hypotheses of the thesis (Coutinho, 2013). There are still plans to carry out a conceptual analysis model of a theoretical nature, focus groups with the Brazilian female tech community and test the hypotheses made (Coutinho, 2013).

During 2018, efforts were made to monitor 20 Brazilian and Portuguese women's technology communities digital platforms (DP). The choice of these collectives was carried out after a preliminary and initial research work, lasting about three months, focused on surveying about 70 groups and their respective communication structures (internal and external digital platforms). The preliminary objectives were to draw an overview of the current state of what these groups are and perform, in addition to understanding and configuring communication dynamics through analysis instruments: participatory observation in the DPs of these communities, face-to-face and online events; inquiries; interviews.

After the initial three months of the investigation, six months were dedicated to monitoring DP of Girls in Tech Brazil, WoMakersCode, Elas Programam, Reprograma, PrograMaria, MariaLab, PretaLab, programa Meninas Digitais, Minas Programam, São Paulo WiMLDS. Minas Programam and São Paulo WiMLDS were analyzed with ethnographic methods and chosen as Brazilian case studies of women's technology communities. The first was investigated during the time the community allowed access to the DP for internal use (two whatsapp groups) and platforms for external use (website, profiles on Twitter, Facebook, Instagram, Blog), around 10 months. The second community is still being monitored, but preliminary results were consolidated in March 2020 from the collection of data from internal DP (whatsapp group, institutional email) and external (website, LinkedIn profiles, Meetup, national YouTube and studies of external DP from the group's headquarters in the USA).

From the analysis of the manual collection of data published on DP (such as comments) and likes, it was possible to draw a profile about who commands these women's communities in technology, how the division of labor has been organized, who are the audiences-target, how they choose and structure the communication of their activities. The leaders and volunteers of Brazilian women's technology communities are geographically dispersed, but it is common for them to belong to the same country. The leaders are formed by women who have completed a

degree in a STEM career (Science, Technology, Engineering and Mathematics), or who have graduated in careers outside of computing and exact sciences and have sought a university education, or in courses offered by women's technological groups, companies and government institutions, for career transition in IT.

The ongoing doctoral research has 5 phases. Some activities planned and to be developed are described in Table 1. These actions are related to the scientific domains related to this article.

Table 1. Some of the activities and stages carried out and planned of the ongoing doctoral research that gave rise to this work:

Phase	Activity
Phase 1	- Mapping women in tech groups based digital platforms, such as Facebook and Instagram accounts. - Bibliographic survey. - Research methods definition. - Informal women in tech communities digital platforms monitoring
Phase 2	- Online and face-to-face events observer participation. - Case Studies planning and execution. - Case studies communities digital platforms monitoring with ethnographic method. - Case studies configuration: social, technological, communicational. - Case studies characterize communication strategies and organizational profile.
Phase 3	- Data collection and analysis with an ethnographic method on communities digital platforms. - Focus group with women from the target audience of the case study. - Interviews with target audiences and group leaders.
Phase 4	- Collected data analysis. - Communities communication model proposition.
Phase 5	- Thesis writing.

These leaders, young and old, also had relevant professional experiences and managed to occupy prominent positions in companies, not necessarily translated into the most important positions. They are also usually the only female representatives in teams and feel the need to help themselves and women who, like them, have suffered prejudice, resistance and difficulties to start and remain in studies and professional careers. The leaders are, in general, founders of groups and have established rules for coexistence and admission of volunteers and new members, the communication system and type of information to be produced, according to the profile of the collective and its objectives.

The volunteers of the women's technological collectives are, in general, women who participated in a series of face-to-face and online events of these groups, were benefited by their actions (from academic and professional updating, to scholarships, networking to enable projects and business, for example), sensitized by community work to the point of offering their professional labor. Most groups carry out this activism, or technological feminism, or professional activity on a voluntary basis. There are communities that, however, charge for courses, mentorships, sell objects in virtual stores to make the actions viable. The volunteers operationalize the demands

defined by the leaders, in the organizational and communicational scopes. They contact partner companies and participate in prospecting meetings to help with actions, create content for DP, act in mediating the entry of new volunteers, respond to target audiences, for instance. Members are the target audiences to be impacted by leaders and volunteers to engage in the cause of inclusion, empowerment and IT training.

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The author got in touch with most of the Brazilian women in tech communities cited in this work previously the PhD investigation work, when she had been a female tech community leader from 2015 to 2018 in Brazil. The communities chosen to be mentioned came from a bibliographic survey and a face-to-face survey (observer participation). Each community was, preferably, studied and monitored by the digital platforms used for its communication between members. Relevance communicational ecosystem, foundational and organizational background, success on achieving objectives were some of the criteria chosen to select three case studies.

All personal information is anonymous, ensuring the privacy of participants in interviews, focus groups and other investigation methods. In this sense, the data collected will be used for scientific purposes, in studies and academic publications, without ever compromising privacy issues and always guaranteeing the participant's anonymity.

3 Related Work

This investigation intends to map Portuguese and Brazilian technological female collective activism, based on the communicational and interactional study of digital platforms (DP) used by leaders, volunteers and target audiences. In the bibliographic survey, scientific databases such as Scielo, Scopus, Web of Science and RCAAP (Open Access Scientific Repositories in Portugal) were researched to find works with references to "Brazilian female communities in technology" and "Brazilian women in technology" in a bibliographic survey update in November 30, 2022. In Scopus and Web of Science, published works found were outside the geographic scope related to the doctoral research (Portuguese and Brazilian). In Scielo, the framed works related to the investigation areas of this work were similar to those of the RCAAP. In the RCAAP

database there were 1089 documents about women in technology, 157 of which were related to Brazilian academic works in the categories "ciências" (39), "saúde" (29), "gênero" (27), "mulheres" (26), "cnpq" (25), "sociais" (24), "tecnologia" (20), "educação" (16), "feminismo" (13), "women" (12), "gender" (12), "brasil" (11), "história" (11), "social" (10), "comunicação" (9), "health" (9), "informação" (9), "technology" (9), "análise" (8), "desenvolvimento" (8).

It was verified the presence of Brazilian research which analyze feminism in IT with an emphasis on the maker and hacker culture and free software (Araújo 2018; Paz 2015), theoretical relationship on cyberfeminism with feminist practices of technological empowerment, education and inclusion in the labor market, in communities and in the Academy (Nogueira, 2017; Peres and others, 2020; Schwartz et al., 2006; Souza, 2017; Vieira and others, 2017; Rodrigues, 2021; Oliveira and others, 2020; Lima and others, 2020).

Gender issues associated with women in technology (Incerti and others, 2021; Liberato and others, 2018; Lima and others, 2016; Lopes, 2016; Salvador, 2010) and case studies (Loch and others, 2021; Vasconcelos and others, 2018; Hayashi et al., 2007; Itani, 1992) were also found in the bibliographic survey.

The bibliographical survey was relevant for the analysis of academic references, as well as perceiving whether and how female communities in technology were the subject of studies.

4 Theoretical contributions to the technological female communities

In the last ten years, the emergence and growth of women in technology communities in Brazil and Portugal have been observed, as well as the expansion of the debate on women in technology in the press, digital platforms (DP), social media. Resulting not only from technological and informational inclusion, from the advent and expansion of the Web, but from a process of maturation of what represented online activism, or collective action in digital communities with the emergence and expansion of new networks and platforms. For this work, we intend to focus only on Brazilian female IT communities, as mentioned earlier. So far, the information circulating in ecosystems of DP (in some cases internal and in all external, open to the public) were studied in groups such as Mulheres na Tecnologia[3]; WomakersCode[4]; Elas Programam[5]; PrograMaria[6]; MariaLab[7]; PyLadies Brasil[8]; programa

Meninas Digitais[9]; PretaLab[10]; Brazilians in Tech[11]; Reprograma[12]. Two case studies with ethnographic methods with Minas Programam[13] and São Paulo WiMLDS[14] were developed.

Other relevant Brazilian women in tech communities evaluated and monitored in the doctoral research were: Women Up Games, Academia Lovelace, Ada.vc, AI Brasil Girls, Anitas, ByteGirl, Code Girl, Code Club Brasil, Chicas Poderosas, CloudGirls, Coding Rights, Developers Br, Django Girls, ElaLíder, Girl Lab, Girls in T ech, Inspirada na computação, High5Devs, JS4Girls (Javascript for Girls), LadyTalks, Juntos na TI, Mulheres de Produto, NerdGirlz, Node Girls, Peixe Babel, Rails Girls SP, RodAda Hacker, Women@Comp, Women Techmakers, Women Who Code, #includemeninasuff, Perifacode, PHPWomen, Projeto Devas, UPWIT (Unlocking the Power of Women for Innovation and Transformation), Shes´s Tech, She Sharp, TechLadies, Tecnogueto, Tutoras.

All the groups mentioned were monitored with observer participation at least once, either via DP (get to know them, understand the communication ecosystem and exchange of information between members), or presence in events of some of them, especially the communities that were chosen as case studies. Three communities of women in technology were chosen as case studies: two mentioned in the article because they are Brazilian and one Portuguese, which was not mentioned because it is not part of the scope of the objectives of this work nor of the national reality.

The advent and expansion of the Internet, in the mid-1990s, provoked a revolution in communication between people, in the formation of communities, in new ways of seeking information and education. Developments in hardware and software have brought women closer to technological artifacts (relegated for almost a century), such as smartphones, computers and games. The experimentation of technological devices that provide intense immersion and interaction of contents, continuously connected to the digital platforms that also emerged in that period, made the access of women to technologies inexorable.

Historically, the process of designing Technology (artifacts, objects of everyday use, computer programs, etc.) were dominated by men. The Internet democratization and the emergence of a network society, from the end of the 20th century, provoked an unprecedented technological and communication revolution. The greater awareness and struggle of women for equal rights with men, for control of their bodies and lives, especially in developed and industrialized countries, is, according to Manuel Castells (2018), an inexorable process due to four factors:

1. The transformation of the economy and the labor market related to opportunities for women in the field of education;

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[3] http://mulheresnatecnologia.org/
[4] https://womakerscode.org
[5] https://elasprogramam.com.br/#/
[6] https://www.programaria.org
[7] https://www.marialab.org
[8] https://brasil.pyladies.com/

[9] http://meninas.sbc.org.br
[10] https://www.pretalab.com
[11] https://braziliansintech.com
[12] https://reprograma.com.br
[13] https://minasprogramam.com
[14] http://wimlds.org/about-the-sao-paulo-team-2/

2. The collapse of patriarchy resulting from economic and technological transformations;

3. The extraordinary increase in the number of grassroots organizations, mostly created and led by women, in the metropolitan areas of developing countries, impacting policies and institutions, but also the emergence of a new collective identity, in the form of empowered women;

4. The self-construction of identity is an affirmation of power through which women mobilize themselves to become the way they want to be. Claiming an identity is building power.

In *The Network Society*, Manuel Castells (2002) highlights the importance of IT and the emergence and expansion of the Web for women and minority groups. In *O Poder da Identidade* (2018), he reveals new gains in female power and social representation, based on online interactions, connections and activism. According to the author, NGOs and women tend to express themselves more openly, in digital networks, because they feel more protected in electronic media. Virtual expressions would represent a great opportunity to reverse traditional power games in communication processes. These networks represent the true producers and cultural codes distributors. Not only through the network, but in its multiple forms of exchange and interaction.

The acceleration of IT (especially microelectronics, computers and telecommunications) ended up unfolding in a new paradigm, still influenced by the attempts of the old society to, through technology, establish other forms of exercise of power. Circumstances and instances of Culture and History bring together background contexts of a new technological paradigm emergence, marked by information as raw material for interactions between people and technologies, in the formation of networks of people that gradually gained the contours of communities (Castells 2002): "*The first characteristic of the new paradigm is that information is raw material. The second aspect refers to the penetrability of the new technology's effects. As information is an integral part of all human activity, all processes of our individual and collective existence are directly shaped (not determined) by the new technological medium. The third characteristic refers to the logic of networks in any system or set of relationships, using these new information technologies. The logic of networks is necessary to structure the unstructured, while preserving flexibility, as the unstructured is the driving force of innovation in human activity*".

The information circulating through DP was fundamental for the empowerment of women in society and in the transformation of gender relations: objects and artifacts are no longer seen as separate from society, but as part of the social fabric that holds society together; they are never merely technical or social (Wajcman, 2009).

Cyberfeminism is the result of the fourth feminist wave, marked by the emergence and expansion of the Web, the network society, the creation and democratization of access to new devices and computer programs, online communities and DP for interaction and communication

between people of different worldwide. It is a strand of technological feminism marked by optimism in the theoretical perspective about the impact of technology to empower women and transform gender relations.

Feminists of the post-colonialist feminism movement seek to investigate and contextualize realities of countries and groups to understand the contributions of women in Information and Communication Technologies and the impacts of technologies on them. With a bias in the analytical approach that is also ethnic, they emphasize the intersectionality of gender, point out how women constitute themselves as the main workforce of the technology industries in search of cheap labor, both in manufacturing and in services and programming. It is in cyberfeminism that one of the main concepts of technological feminism emerges, technofeminism. In it, technology is the source and consequence of gender relations. Masculinity and femininity acquire meaning in the integration with work machines. Politics is characteristic of the present moment of a network (any feminist politics is an extension of network analysis). The relationship between social analysis and projects of social transformation is what marks the fundamental difference between conventional studies of technoscience and technofeminism (Wajcman, 2006).

Social computing is related to systems that support the collection, processing and dissemination of information distributed among social collectives. Information is the main link between people, mirrors and represents common identities [Erickson 2013]. Social computing systems can generate value by integrating knowledge among diverse participants, by performing tasks based on human skills and by producing more legitimate results for a community, a collectivity.

It is not possible to define in time a specific point on the Web where these communication systems of women activists in Technology emerged. Created in 1987 by Anita Borg, the first female technology community launched in the world was called Systers (Abbate, 2012). The initial members were women working in operating systems research, in computer science, who built a collective sharing the same identity, advice and experiences. One of the goals was to allow women to feel free to share opinions. Systers also generated separate lists for subgroups of members, such as lesbian, gay, bisexual and transgender, who wanted their own safe spaces for discussion.

5   Preliminary results from community studies

The strength of the collectivity and the infocommunicational flow is a catalyst for personal development in IT for women in tech community members. There are operational and communicational operating rules common, or not, to each group. Defined by leaders, they are disseminated by volunteers. Impacted women who agree with organizational guidelines are accepted to participate as students and recipients of campaigns, events, courses, online and in person. Search engines (search tools

such as Google) and digital platforms (social media) are the main entry points for new members. They are nodes with similar and specific characteristics formed and inserted in a sea of nodes of other natures in this complex and multidimensional cybernetic flow space. Information (statistical data and courses, testimonials of engagement and empowerment) is produced and shared together via digital platforms.

The success of this activism can be measured by the significant number of in-person events, articulated internally by the communities and communicated to the public on digital platforms. It is increasingly common to find meetups (periodic meetings), awards and programming competitions (hackathons) filled with women of different ages and backgrounds. In addition to the dissemination of knowledge, there is networking (the expansion and strengthening of contact between all those present in search of professional or business exchanges). These groups coexist and can partner to carry out campaigns with other groups of similar women activists in Technology, or with government and private sector entities aligned with the cause. The reach of the groups' actions and initiatives transcends geographic and online barriers.

The preliminary results of the investigation allow us to define characteristics and purposes common to these communities of Brazilian women in technology:

1. Formation of the Maker Culture: teaching and qualifying women to use different languages and computer programs in the creation of their own technological products (initiation of young people and deepening for those who already work at an academic and professional level);

2. Educational: guiding and instructing teenagers in schools, namely in the transition phase from secondary to university, with the aim of considering IT as a career to embrace, as scientists or professionals;

3. Entrepreneurship: network promotion, with a view to creating businesses, startups, as well as innovative and competitive IT projects;

4. Political/Social: collective articulation in the search for the creation and consolidation of labor inclusion laws for women in IT; perspective of Information Technology being a field of identity affirmation (Feminist and Gender).

5. New scenarios and challenges for collective female activism in IT

The work of women in technology communities, especially in Brazil, is experiencing new challenges and achievements not only because of the unfolding of a new way of performing since the emergence of covid-19, which forced teleworking and the migration of group activities to platforms, but also the influence of new devices and systems of technological and computational interaction embedded in data integrated by artificial intelligence.

All the communities analyzed in this investigation needed to reassess organizational and communication processes based on the impact that the pandemic had on the leaders, volunteers and target audience lives. There was a deceleration and interruption of events, due to the number of sick people who also suffered material consequences such as unemployment, and also health consequences, such as mental ones. Through monitoring on digital platforms, it was noticed a resumption of activities with greater intensity from 2021, but still outside the intense pace of events and content productions seen, for example, in 2019.

In addition to the pandemic, there are contexts that help to explain positive and negative influences on the work of women's groups in IT. In a recent critical review of the release of his book *A Sociedade em Rede* (2002), originally released in 1996, Castells (2021) emphasizes that in the last ten years internet-based social networks have become a platform for virtually all types of social networking practices, sociability, and that behind all human activities there are digital networks that are connected, something that the sociologist confesses he did not foresee in his work. It highlights the speed in the volume of data exchange between these networks, now also under the influence and expansion of artificial intelligence. According to the theorist, AI has transformed the notion of data transfer and database: "*When we say data we say artificial intelligence at the same time and in terms of the communication in terms of the theory, it's not more speed or more volume more capacity more latency is qualitatively different, and the combination of both is what is truly transforming everything we do and so we know, social movements are transformed*".

In another critique and update of his work, Castells points to the growth of the construction of specific individual identities that fragment societies, which still coexist with collectively constructed identities. It highlights the influence of capitalism on social media networks that form a data capitalism, in which never before has there been so much freedom for free communication, which has become an instrument of immense accumulation of capital based on the destruction of privacy. He points out risks for social transformation movements (in which it is possible to frame female communities in technology) in these digital platforms which have also become deposits of racism, sexism, nazism, homophobia.

Castells' considerations resonate with the work of van Dijck, Poell & Waal (2018), authors of the concept "the platform society", who "*does not merely shift the focus from the economic to the social; the term also refers to a profound dispute about private gain versus public benefit in a where most interactions are carried out via the Internet. While platforms allegedly enhance personalized benefits and economic gain, they simultaneously put pressure on collective means and public services*".

The platforms allowed tech female communities to start their development, but they can compromise the activism with monitored interaction and restricted to the scope of its creators. As most of the platforms used by the groups are free, developed by Big Techs such as Meta (Facebook and Instagram) and YouTube, all members give their data to these companies and are limited in terms of interaction and communication to features established by these companies. In other words, engagement and activism are limited and

monitored, without the possibility of opening for customization according to the organizational characteristics of these groups.

"*The critical point of Zuboff's diagnosis lies in the detection of a form of capitalism that captures human actions both online and offline, to facilitate the modification and commercial exploitation of future behaviors. Based on the predictive analytics of AI algorithms, the raw material of human experience, translated into behavioral data, is designed for future behaviors. As a result, the algorithms shape our behaviors in an anticipatory way, for commercial purposes.*" (Santaella, 2021)

Still in the universe around data capitalism, it is worth highlighting the increasingly sophisticated aspect of surveillance by Big Techs, which jeopardizes democracy and also the exercise of citizen and activist practices, such as those carried out by female communities in technology, which are also influenced in the navigation and suggestion of content and people to be connected in interfaces by the algorithms. These companies do not always mirror the interests of the users, but of the advertisers of these social digital platforms and themselves. There are also exclusions of content and user profiles deliberated by companies without completely clear rules, profiles that may be from the communities themselves and discarded posts developed by them, without any control over them. Beiguelman (2021) presents this dynamic clearly and broadly:

"*I prefer to understand the algorithmic surveillance model as a new surveillance model, whose emphasis is on the relationship between individuals. (...) This is because this intimacy is the 'behavioral surprise' with which corporations, such as Google and Facebook, work, giving concreteness to 'surveillance capitalism', as economist Shoshana Zuboff called it. Its pillars are the extraction and analysis of data, which underlie the main asset of this economy: the ability to predict user actions. A complex and sophisticated artificial intelligence system is mobilized, so that it is possible – through the provision of translation resources, storage services, voice command, maps and image searches – to infer, assume and deduce the consumption potential, addressing products in a personalized way users, in order to remunerate their true customers: the advertisers*".

The danger of the influence of algorithms in suggesting content and connections, and the surveillance of interactions on platforms, can also amplify social problems whose causes are also fought by many female communities in technology, with gender equality. Problems caused by algorithms also related to prejudice against women and black people, which exacerbate the racist and sexist discrimination of pre-existing social life online, called by Noble (2018) algorithms of oppression.

According to Benjamin (2019), algorithmic oppression biases arise in the design of products and services (one can also consider digital platforms): "*Human toolmaking is not limited to the stone instruments of our early ancestors or to the sleek gadgets produced by the modern tech industry.*

Human cultures also create symbolic devices that structure society. Race, to be sure, is one of our most powerful tools – developed over hundreds of years, varying across time and place, codified in law and refined through custom, and, tragically, still considered by many people to reflect immutable differences between groups".

The advent and daily spread of artificial intelligence has been challenging for the work of these female communities in technology for the reasons explained above, with emphasis on the lack of data mastery and control over interactions.

Data processing, with automation behind interfaces of digital platforms, and the creation of new devices and computer programs involve algorithms that can reinforce gender/sex stereotypes, or the segregation of the labor market. Data feminism is a way of thinking about data in both its uses and limits, related to direct experience and commitment to action and intersectional feminist thinking. The starting point for data feminism is something that is not recognized in data science: power is not evenly distributed in the world (D'Ignazio, Klein, 2020). Those who wield power are elite, heterosexual, white, sane, cisgender men from the Global North. The work of data feminism is the first to tune in to how standard practices in data science serve to reinforce these existing inequalities and to use data science to challenge and change the distribution of power. Data can consist of words or stories, colors or sounds, or any type of information that is systematically collected, organized and analyzed.

The seven principles of data feminism are (D'Ignazio, Klein, 2020): Examining Power; Challenging power; Elevate emotion and personification; Rethinking binaries and hierarchies; Embracing Pluralism; Consider the context;

Make the work visible.

There are challenges for women in technology communities from the questions and conclusions of the cited authors and from the doctoral research that gave rise to this work. For this, a framework based on the classic Complexity Paradigm by Edgar Morin (2011, 2005) will be proposed. The Complexity Paradigm governs Communication and Information Sciences, was accelerated by Technology and brings together an expressive variety of disciplines. The introduction of a systemic theory of complexity, proposed by Edgar Morin, is fundamental in the analysis of the organizational and communicational systems of these groups. System, understood by the sociologist, as an idea of organized heterogeneity.

Information is a living and fundamental element in the Technological and Complexity paradigms. Morin's work introduces us to the complex thinking described by the multidimensional character of any reality. Edgar Morin focuses on the foundation of a science of "man" (as a social and biological being), in a theoretical and epistemological perspective of the complexity of the social – in a largely anticipatory view.

The field of Social Sciences is fundamental for the debate and understanding of the multidimensional factors

and motivations that increasingly provoke the creation and development of groups of empowered women and IT activists entrepreneurs, in addition to the adhesion of volunteers or, simply, new members in these groups. Complexity is a "fabric of events, actions and interactions, retroactions, determinations that constitute our phenomonic world" (Morin, 2011, p. 13). It places the paradox of the one and the multiple in the same fabric of inseparably associated heterogeneous constituents.

The Complexity Paradigm must respect trans and interdisciplinary disciplines. There are principles and fundamentals that govern it, which, in this work, will be exposed in the form of a Framework applied to the reality of women's technological communities, based on data collected and analyzed on digital social platforms:

A. Systemic: Morin resumes the General Systems Theory, created by the biologist Ludwig Von Bertalanffy in the 50's, developed from Biology. The sum of the parts is greater than the whole. It is situated on a transdisciplinary level that conceives the unity and, at the same time, the differentiation of the sciences, following not only the material nature of its object, but the types and phenomena of association and organization. Systems Theory extends to all knowledge beyond cybernetics. There is the idea of organized heterogeneity. The members of women's IT groups (leaders, volunteers and impacted) share similar goals, but their motivations, knowledge/education levels, age and origins are heterogeneous. The definition of operational and communicational rules is fundamental for the cohesion and maintenance of groups as systems, but these organizations and members are not isolated on the Web and in the physical world. The knowledge shared in women's technology communities takes place on digital platforms, in a universe marked by unlimited networks of profiles connected by recognized similarities between members.

However, according to the dangers of surveillance capitalism guided by the algorithms manipulated by the companies that create these platforms, this heterogeneous, diverse nature can be at risk due to the lack of transparency of mechanisms for suggesting information and interaction.

B. Holographic: the whole is in each part, that is, it is not possible to dissociate the part from the whole. Present in the biological and sociological world. These groups coexist and can partner to carry out campaigns with other groups of similar women activists in Technology, or with government and private sector entities aligned with the cause. The scope of the groups' actions and initiatives are greater than their totality, transcending geographic and online barriers. Not even as an organization they constitute a closed system, as they are influenced by the reuse of information propagated by the impacted women, in addition to the action of other groups and the local and global social, economic, political dynamism. It can be said that the activist, citizen and communicational exercise of these groups is practically impossible without social digital platforms and their respective networks.

C. Dialogical: order and disorder collaborate and produce organization and complexity and, at the same time, suppress each other. A point of disorder in the communication and information system of women's IT groups can be attributed to the unpredictability of information reuse by the impacted women, based on the order, regiment and organizational and communicational functioning determined by the leaders of the online communities. The new demands for information generated by the target audiences are evaluated internally by the leaders, seeking to improve and renew the organizational and communication arrangements established as initial parameters.

Elements extrinsic to the activities of women's communities in technology can generate order and disorder in the organizational and communicational rules established in the foundations of these groups, such as deliberate actions by the companies that develop digital social platforms around access to accounts, publications, sharing mechanisms, actions of communicational, educational and marketing promotion. These elements may or may not be perceived by the members of these collectives. Decision making and consequences of actions chosen by leaders and volunteers can be influenced by these external elements in a dialectic that is not so clear.

D. Organizational Recursion: process in which products and effects are, at the same time, causes and producers of what produces them. Society is produced from interactions between individuals. Once produced, society retroacts on individuals and produces them. Individuals produce the society that produces individuals. They are products and producers.

Complexity explains an information system, information being a living element in the system and not a simple finished informational object, ready and immutable in the exchange between human actions. The groups of women in IT that develop online activism are still a social, political, economic, cultural product of an era, or a result of the expansion of the creation of devices and computer programs for everyday use. Each online community configures a communication and information system that goes beyond the purposes for which they are intended, mentioned above. They are women of heterogeneous origins, who bring together heterogeneous knowledge (from different disciplines) and similarities around these explicit objectives, others not so evident or confidential with the target audiences. These purposes are materialized in a digital and face-to-face environment based on operating guidelines, codes and internal operating regulations among leaders and in their relationship with volunteers and the external public.

Technology is accessible to women who are digitally included and, above all, to those who have a degree of information literacy which allows leaders and volunteers from the alignment of objectives and tangible and intangible information (such as statistical data, programming knowledge, etc.) of digital platforms, whose operational functions fulfill the role of efficient and wide

dissemination of technological, ideological, professional, educational information in a complex, multiple communication chain connected to the digital platforms of the impacted women. These groups are living systems of multidimensional communication, adaptable to the emergence of new technologies, digital platforms and social dynamics in a macro perspective.

The advent of data capitalism and the ubiquity of artificial intelligence can destabilize the communication ecosystem as well as the organizational statutes defined by these collectives as defining their identities. The Complexity Paradigm can be an important bridge and path for the evaluation of phenomena related to Gender and Technology. According to Edgar Morin, everyone is a subject. Being a subject is putting yourself at the center of your world and taking the place of the "I" beyond the singularities of subjectivities, integrated into a metasystem. What represents the feminine today transcends the original sex. Gender Choices and Technology has been a field of discovery and identity affirmations.

6   Conclusion

Based on the preliminary results of the doctoral research, it is possible to point out characteristics common to Brazilian technological female collectives:

1. Mentor and educate young women in IT, transitioning to university and with the aim of considering a career as scientists or professionals;

2. Increase female representation in the professional field, through the exchange of knowledge between group members (active in the community, in the articulation and promotion of events, lectures, congresses, for example), in order to increase female competitiveness in a field that is still predominantly male;

3. Promote networking, with a view to creating businesses, startups, as well as innovative and competitive IT projects.

The groups of women in IT that develop online activism are still a social, political, economic, cultural product of an era, or an expansion and creation of devices and computer programs for everyday use. Each online community configures a communication and information system that goes beyond the purposes for which they are intended, mentioned above. They are women of heterogeneous origins, who bring together heterogeneous knowledge (from different disciplines) and similarities around these explicit objectives, others not so evident or confidential with the target audiences. These purposes are materialized in a digital and face-to-face environment based on operating guidelines, codes and internal operating regulations among leaders and in their relationship with volunteers and the external public.

Technology is accessible to women who are digitally included, especially to those who have a degree of information literacy that allows leaders and volunteers to align objectives and tangible and intangible information (such as statistical data, programming knowledge, etc.), to choose digital platforms, whose operational functions fulfill the role of efficient and wide dissemination of technological, ideological, professional, educational information in a complex, multiple communication chain connected to digital platforms of the impacted women. These groups are living communication systems, adaptable to the emergence of new technologies, digital platforms and social dynamics in a macro perspective. Until the conclusion of this doctoral research, it is intended to follow the routine of women in technology communities selected via digital platforms (DP) to confirm the preliminary conclusions, as well as the development of a theoretical model applied to the study of women in technology.

It is fundamental not only for the cause of female inclusion in technology, but for the emergence and growth of collectives that represent it, that theoretical reflections on technological feminism such as data feminism continue to be developed at the Academy. It is also vital that these theoretical works become increasingly accessible to these collectives to raise awareness around the topics covered in this work, such as the manipulation and control of data in the social digital platforms chosen for engagement and communication. Most of the communities analyzed in this investigation are voluntary and, therefore, there is a lot of work to be done, in general, by fewer people necessary to fulfill objectives and tasks. It is necessary to point out to activists and members that their policies and practices can also be contaminated by biases of prejudice and commercial interests in a very subtle way.

References

Abbate, J. (2012). *Recoding Gender: Women's Changing Participation in Computing*. Cambridge, Massachusetts; London, England: The MIT Press.

Araújo, D. (2018). *Feminismo e cultura hacker: intersecções entre política, gênero e tecnologia*. Tese de doutorado. Campinas: Universidade Estadual de Campinas.

Beiguelman, G. Dadosfera. In: *Políticas da imagem: vigilância e resistência na dadosfera*. São Paulo: Editora Ubu. p. 47-77.

Benjamin, R. (2019). *Race after technology: Abolitionist tools for the new Jim code*. Oxford: Polity.

Castells, M. (1996). *The Rise of the Network Society (Vol.1)*. Oxford; Malden, MA: Blackwell.

Castells, M. (2002). *A sociedade em rede*. São Paulo: Editora Paz e Terra.

Castells, M. (2018). *O poder da identidade*. São Paulo: Editora Paz e Terra.

Castells, M. (2021). "The Network Society Today: (Revisiting) the Information Age Trilogy". Available at

https://www.youtube.com/watch?time_continue=3&v=07K PiVpymAM&feature=emb_logo

Coutinho, C. (2013). *Metodologia de investigação em ciências sociais e humanas: Teoria e prática*. Coimbra: Almedina.

D'Ignazio, C., Klein, L. (2020). *Data Feminism*. Cambridge, MA: MIT Press.

Erickson, T. (2013). Social Computing. In: Soegaard, M. and Dam, R. (eds.). *The Encyclopedia of Human-Computer Interaction*. Aarhus: The Interaction Design Foundation.

Frade, R. (2021). Comunidades de mulheres em tecnologia: estudo comunicacional e organizacional. In *Anais do XV Women in Information Technology*, (pp. 41-50). Porto Alegre: SBC. https://doi.org/10.5753/wit.2021.15840

Hayashi, M. et al. (2007). Indicadores da participação feminina em Ciência e Tecnologia. Transinformação, v. 19, n. 2, pp. 169-187. Epub 12 Set 2014. ISSN 2318-0889.

Incerti, T.; Casagrande, L. (2021). Discutindo gênero na educação profissional e tecnológica: conquistas, desafios, tabus e preconceitos. Cadernos Pagu [online]. 2021, n. 61 e216117. Epub 04 Jun 2021. ISSN 1809-4449. https://doi.org/10.1590/18094449202100610017.

Itani, A. (1992). TRABALHO FEMININO E TECNOLOGIA: A Imagem da Alteridade. Tempo Social [online], v. 4, n. 1-2, pp. 133-154. ISSN 1809-4554. https://doi.org/10.1590/ts.v4i1/2.84932.

Kozinets, R. (2014). *Netnografia: Realizando pesquisa etnográfica online*. Porto Alegre: Penso.

Liberato, T.; Andrade, T. (2018). Relações de gênero e inovação: atuação de mulheres nos NITs paulistas. Revista Estudos Feministas [online]. 2018, v. 26, n. 2, e41763. Epub 11 Jun 2018. ISSN 1806-9584. https://doi.org/10.1590/1806-9584-2018v26n241763.

Lima, B.; Costa, M. (2016). Gênero, ciências e tecnologias: caminhos percorridos e novos desafios. Cadernos Pagu [online]. 2016, n. 48, e164805. ISSN 1809-4449. https://doi.org/10.1590/18094449201600480005.

Lima, D.; Oliveira, T. (2020). Negras in tech: apropriação de tecnologias por mulheres negras como estratégias de resistência*. Cadernos Pagu [online]. 2020, n. 59, e205906. Epub 15 Jan 2021. ISSN 1809-4449. https://doi.org/10.1590/18094449202000590006.

Loch, R.; Torres, K.; Costa, C (2021). "Mulher, esposa e mãe na ciência e tecnologia". *Revista Estudos Feministas*, Florianópolis, v. 29, n. 1, e61470.

Lopes, M. (2016). As grandes ausentes das inovações em Ciência e Tecnologia. *Cadernos Pagu*, (19), 315–318. Available at https://periodicos.sbu.unicamp.br/ojs/index.php/cadpagu/article/view/8644588

Lucca, G., Raiol, J., Araújo, N., Sousa, R., Guedes, E. (2019). PyLadies Manaus: Experiências no Empoderamento Feminino na Comunidade Python. In: Anais do 13° Women in Information Technology (WIT2019). SBC, 2019.

Morin, E. (2011). *Introdução ao pensamento complexo*. Porto Alegre: Sulina.

Morin, E. (2005). *Ciência com consciência*. Rio de Janeiro: Bertrand.

Noble, S. (2018). *Algorithms of Oppression*. New York: New York University Press

Nogueira, E. (2017). *Empoderamento feminino através das tecnologias da informação. Rio de Janeiro*. Dissertação de Mestrado. Rio de Janeiro: Universidade Federal do Rio de Janeiro.

Nunes, M, Louzada, C., Salgueiro, E., Andrade, B., De Lima, P., Figueiredo, R. (2016). Mapeamento de iniciativas estrangeiras em língua inglesa que fomentam a entrada de mulheres na Computação. In: Anais do 10° Women in Information Technology (WIT2016). SBC, 2016.

Oliveira, J.; Mello, L.; Rigolin, C. (2020). Participação feminina na pesquisa sobre tecnologia da informação no Brasil: grupos de pesquisa e produção científica de teses e dissertações*. Cadernos Pagu [online]. 2020, n. 58, e205804. Epub 03 Ago 2020. ISSN 1809-4449. https://doi.org/10.1590/18094449202000580004.

Organização das Nações Unidas (2015). Objetivos do Desenvolvimento Sustentável. Available at https://unric.org/pt/objetivos-de-desenvolvimento-sustentavel/ Accessed in 10/03/2021.

Paz, M. (2015). Mulheres e tecnologia: hackeando as relações de gênero na comunidade software livre do Brasil. Universidade Federal da Bahia, Salvador.

Peres, S., Gomes, E. (2020). Estudo sobre o empoderamento feminino através de comunidades de tecnologia. In: Anais do 14° Women in Information Technology (WIT2020). SBC, 2020.

Rodrigues, S. (2021). "{reprograma}: gênero e tecnologia em um estudo de caso preliminar". *Revista Estudos Feministas*, Florianópolis, v. 29, n. 1, e67314.

Salvador, S. (2010). Gênero na engenharia: o corpo docente em Curitiba/PR. Dissertação (Mestrado em Tecnologia) - Universidade Tecnológica Federal do Paraná, Curitiba.

Santaella, L. (2021). *Humanos Hiper-Híbridos*. São Paulo: Paulus Editora.

Schwartz, J., Casagrande, L., Leszczynski, S., Carvalho, M. (2006). Mulheres na informática: quais foram as pioneiras?. In *Cad. Pagu*, 27, pp.255-278.

Souza, A. et al (2017). Relato Tech Ladies: redes de colaboração entre mulheres na tecnologia. In: Anais do 11°.

Women in Information Technology (WIT2017). SBC, 2017.

van Dijck, J., Poell, T., & Waal, M.: *The platform society: Public values in a connective world*. Oxford University Press, New York (2018).

Vasconcelos, I.; Irigaray, H. (2018). Novas formas de tecnologia e trabalho e uma maior igualdade para as mulheres em sua vida profissional. Cadernos EBAPE.BR [online]. 2018, v. 16, n. 3, pp. 1-4. 2018. ISSN 1679-3951. https://doi.org/10.1590/1679-395174821.

Vieira, C., Soares, A., Ribeiro, S. (2017). Incentivos à igualdade de gênero: estudo de caso de uma comunidade formada somente por mulheres da área de tecnologia. In:

Anais do 11° Women in Information Technology (WIT2017). SBC, 2017.

Wajcman, J. (2006). *El tecnofeminismo*. Madrid: Ediciones Cátedra.

Wajcman, J. (2007). From women and technology to gendered technoscience. In *Information, Communication and Society*, 10 (3), p. 287-298.

Wajcman, J. (2009). Feminist theories of technology. In *Cambridge Journal of Economics, 34*, p. 143–152.