



Women as Innovators, Decision-Makers and Co-Designers of Technology: From Representation to Recognition, Influence and Inclusive Development: An SDG-9 Focused Study with Exploratory Survey Evidence from Peshawar, Pakistan

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ABSTRACT

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Access to technology, work, and education are often mentioned as barriers to women's involvement in innovation. However, it takes more than just being there to lead, create a product, earn attention for an idea, or make a difference. The article reimagines women's inclusion as a path to agency, including access to technological opportunities and resources, involvement in innovation, influence over organizational decisions, acknowledgment and ownership of contributions, and the creation of technologies that cater to the needs of all social groups. According to the poll results, 83.9% of participants believed that women could make good decisions, 67.7% believed that women were underrepresented in senior decision-making positions, 80.6% agreed that the trend was changing, and 64.5% said that women's efforts were not always acknowledged. These results are only descriptive perceptions of a small geographic sample of the province and are not intended to be representative of perceptions throughout Pakistan. Recent data from throughout the globe further supports the question's continued significance: While the GSMA has identified a narrowing but continuing gender imbalance in Pakistani mobile-internet leadership, UNESCO has documented significant gender discrepancies in scientific research and STEM leadership. An integrated framework of "Access – Agency – Authority – Attribution – Impact," which links digital inclusion with decision-making authority, acknowledgment, and results of inclusive innovation, is the proposed addition to the article. The framework offers a foundation for future empirical research and institutional action in line with Sustainable Development Goal 9, which emphasizes equitable technology development and innovative capacity.

Introduction

Innovation can go beyond the creation of a new product or device or beyond the design of a technical product. This involves also enhancing services, processes, organizational approaches and problem-solving in communities. The involvement of who in the

design of innovation has a significant impact on innovation, productivity, public services, infrastructure and economic opportunity. A system that is limited to a specific part of the population may fail to capture needs, experiences and constraints of the entire population. So, the issue of inclusion of gender is not only about being fair, it's also about quality, access and public value of innovation [1-5].

In spite of the advances in education and employment, there is a lack of balance in the participation of women in all areas of scientific research, technology professions and leadership. UNESCO's 2024 Call to Action highlights that women make up approximately one-third of global researchers, and that women's participation in advanced scientific positions is lower and there is significant disparity across countries and disciplines. It's not about women going into a sector. It's also whether or not they have the resources, authority, professional networks, safety, and recognition to influence its direction [6-8].

Digital Access is the central issue in the conversation in Pakistan. According to GSMA, mobile-internet gender gap decreased from 38% in 2023 to 25% in 2024 and the proportion of women using mobile internet has increased from 33% to 45%. It is very positive, but it is not sufficient to achieve equal access. But merely having connectivity does not guarantee that women are able to use digital tools without any support, develop technical competence, create products, participate in technology policy or improve their financial lives as they engage [9-10].

This is an article that further develops the original paper on women as innovators, strategic decision makers and actors in technology. It retains the original exploratory survey of 62 respondents of Peshawar and presents the findings in a contemporary literature-based discussion. The survey is not intended to be an indicator of women's innovation performance, but rather to answer questions about their perception of women's role in innovation in terms of leadership, participation, and recognition.

Research problem

Plans and action for gender inclusion might prioritize recruitment, training, or access to digital devices and not as much on actions that occur after women join an institution or innovation ecosystem. Women can be there but not involved in decision making positions, opportunities are not given to them for the design or governance, they don't get the credit for the work or they are not visible. This leaves a divide between representation and participation. The gap is conceptualized here in the present study by connecting access, agency, authority, attribution and impact.

Research gap

The original article deals with gender bias in innovation, glass ceiling and lack of women in management and technology. It also sheds light on women's attitude towards the power of decision making and recognition of women's work. The changed framing unites these strands in one pathway model and is used to discuss Pakistan. There is no statistical measure of these relationships in the surveys, and these relationships are therefore only recommended for testing in the future, but may not be a validated causal model.

Aim and objectives

- To analyze the role of gendered organizational and social issues in reducing women's involvement in innovation and technological development.
- To summarize the original survey respondents' perceptions of women's decision-making capacity, representation and recognition.
- To link women's digital access to meaningful participation, leadership, attribution and inclusive innovation outcomes.
- To suggest a feasible model and suggestions to institutions, teachers, tech developers and policymakers.

Literature Review

From gender-blind innovation to gender-responsive innovation

In some cases, the concept of innovation is regarded as gender neutral because the outputs of the technical performance are evaluated based on performance, efficiency or novelty. Where ideas are conceived, financed, chosen for and commercialized, though, are social institutions. Informal networks, stereotyping, and unequal access to ideas and resources of whom or what is technically

savvy can influence the flow of ideas heard and developed. Ranga and Etzkowitz argue that there is a need to recognize the gender dimension of technology, innovation and entrepreneurship not as an afterthought of the innovators [11].

A gender responsive approach addresses the question of whose needs are being met, who is involved in defining the problem, researching and designing, who has control of the resources, and who would benefit from the innovation that comes from it. It's not about making certain assumptions about being the same or doing the same for all women.

Women as innovators: participation and attribution

Women are able to innovate as a researcher, engineer, entrepreneur, designer, manager, user and community problem solver. But their work can never be less visible when it is in support role, when the leadership of projects is given to others, or when the professional networks establish who will remember who's work. Recognition is crucial because it can result in promotion, funding, patents, authorship, reputation and opportunities for future opportunities. Women's participation has been less when invited to a system but not fairly rewarded. Therefore, attribution should be viewed more as of an institutional process and less an award to a person. By clarifying authorship, inventorship, project leadership, and assessment of authorship and inventions, ambiguity can be minimized. There should also be a review of whether tasks are disproportionately delegated to women and men are assigned a public face for the actual, technical control of such tasks or a public credit for such work [12-13].

Women and strategic decision-making

Leadership shapes priorities, allocation of resources, risk appetite and organizational culture. A glass ceiling is when there doesn't seem to be a level playing field, but the opportunity to move up is blocked by something. Research also indicates the difficulties of those who are significantly outnumbered in a group (tokenism). Torchia, Calabrò and Huse (2011) explored the link between women directors, critical mass and innovation and contributed to the research question of representation on boards [14]. Nevertheless, the concept of a critical mass shouldn't become the fixed benchmark for any organisation that would rule it out as having influence. Formal authority, meeting practices, organizational culture and accountability are among the other factors. Mentoring and sponsoring women, as well as having transparent promotion criteria and equal access to high-visibility assignments and fair evaluation, can be helpful to increase their influence on decisions. However, this change in knowledge and skills will not occur if the rules of the organisation and behaviours of the colleagues are not changed. Good interventions: individual support and institutional responsibility, including training for managers and clear procedures for reporting discrimination/harassment.

Women, digital access and technology design

Digital inclusion is more about access to a phone, and access to the internet, than anything else. It includes affordability, digital literacy, control of devices, privacy, safety, accessible interfaces, relevant content, and uses technology for education, labor, entrepreneurship and civic engagement. Women's participation in the design of digital products is also important because biases in data, assumptions about the users, choices of interfaces, and safety can also be reinforced by digital products. UN Women's work on technology and innovation for gender equality highlights three key areas: connecting the dots on digital access and skills gap; enabling inclusive innovation ecosystems; and using technology to combat gender-based violence. Therefore it is important to engage women in problem definition, product design, testing, governance and evaluation, as well as their use as end users [15-17].

Contemporary evidence and the Pakistan context

UNESCO 2024 Call to Action highlights the gender gaps that continue to exist in science careers and invites governments, schools and colleges, industry and civil society to take action. GSMA's Pakistan data provide a more detailed view of digital access: In 2024, 45% of women were mobile-internet adopters, down from 33% in 2023 with a gender gap narrowing from 38% to 25%. These measures are related to access and use and not to women's representation in research leadership positions, or access to credit for innovation. They are definitely related but not the same dimensions and require other indicators [18].

Conceptual contribution: the Access-Agency-Authority-Attribution-Impact framework

The article suggests a five-stage analysis of inclusive innovation. It is a conceptual synthesis that has been created for this manuscript and not empirically tested by the current survey.

Access: Are there affordable, reliable, safe access to devices, connectivity, education, finance, tools and professional opportunities for women?

Agency: Do women have the agency to use these resources freely, solve problems, offer suggestions, try things out and engage in innovation?

Authority: Do women have any sway over priorities, budgets, hiring, product decisions, research agendas and organizational strategy?

Attribution: Do women get a fair share of credit for their contributions in terms of authorship, inventorship, leadership credit, pay, promotion and ownership?

Impact: Are the products, services and institutions which have resulted to the need that they meet and do they give inclusive social and economic benefits?

At the heart of the framework is its core idea that “inclusion can unravel at any turn.” Access without agency may result in passivity; agency without authority may result in ideas going unrealized; authority without attribution may mean that the ideas are picked up and used by someone else; and recognition without inclusive impact may mean that the ideas are rewarded while the technology itself is inaccessible and/or unsafe. Each dimension can be translated into operational measures and the relationships between the dimensions can be assessed in future studies.

Methodology

Research design

The first study was done using a literature research and a short internet survey. The article is still exploratory and descriptive in nature. The literature review provides background concepts while the survey provides a summary of the respondents' views on the concepts of women's role in decisions, representation, changing opportunities, recognition in innovation. There is no intent to draw causal inference or make prevalence estimates of workplace discrimination in Pakistan in the study.

Study context and respondents

Respondents to the original manuscript from Peshawar, PAKISTAN include 62 students. It says the respondents were selected "at random," but it does not say what the sampling frame was, how the respondents were recruited, the response rate, a breakdown of the respondents, or the date(s) of the survey or the level dataset of the respondents. Accordingly, the sample should be viewed as a small exploratory one and the random sampling cannot be verified independently of the information provided in the original manuscript.

Instrument and variables

Is there a strong correlation between the question of women's good decision-making ability and the percentage of women who believe that women can be good decision-makers? (b) Do women have a lower proportion of representation for the highest-ranking decision making positions? (c) What are the reasons behind the trend? (d) Is there a need for gender diversity in the most important decisions? (e) Do women contribute to innovation and are they credited? Questionnaires and answer alternatives and raw data were not submitted. The results below are therefore only indicative of the reported data and not the missing data.

Analysis

The survey results are briefly summarized descriptively, as reported in the original manuscript, in terms of percentages. There are no group comparisons made, nor are any inferences drawn. The percentages were not independently recalculated as the raw response data were not available. There is one figure reported and needs to be substantiated: 83.2% (yes/no) is not directly compatible when rounded to one decimal place with a denominator of 62. Original response sheet should be reviewed for submission/publishing.

Ethical considerations

No details are given in the original manuscript of informed consent, anonymity, informing the participants of the use of the data or institutional ethics approval. This information will NOT be posted until confirmed. There is no ethics approval/consent statement in this revision.

Results

The numbers presented below are those given in the original article. They are self-reported perceptions and not actual measurements of workplace representation or women's innovation performance, from 62 respondents in Peshawar.

Survey theme	Reported result	Interpretation / data note
Women can be good decision-makers	83.9%	Reported agreement
Women do not often obtain senior decision-making positions	67.7%	Perceived underrepresentation
The trend toward women reaching higher positions is changing	80.6%	Perceived change
Gender diversity matters in major decisions	83.2%	Reported agreement; percentage requires verification
Women are not given credit for their work	64.5%	Perceived recognition gap
Women are not often included in innovation processes	9.7%	Reported response to final item

Perceptions of women's decision-making capacity

83.9% of those surveyed said women can be good decision makers, according to the original article. This indicates that there is a general acceptance of the leadership ability of women within this sample. But the measure targets respondents' beliefs, and not the actual performance of men and women in leadership positions.

Perceived barriers to senior representation

67.7% reported that women do not often get to senior jobs in which important decisions are made at the workplace. This perception is in keeping with what has been found in the literature on advancement barriers; however, the survey did not consider which barriers respondents perceived nor did it determine whether they knew them from personal experience or through the media, education or social beliefs.

Perceived change in women's opportunities

According to the original article, 80.6% felt that the trend was shifting and more women were moving toward senior positions within an organization. This 'progress' can exist alongside persistent structural barriers. The assumption that improvements are underway does not create equality or an equal increase in the authority and recognition of women and their access.

Gender diversity in decision-making

83.2% of the manuscript respondents agree that gender diversity is important when making major decisions and impacts the outcome. This percentage should be checked against the original survey data as it does not translate easily to 62 respondents in a simple binary response question. It is recommended to be considered as a provisional reported figure until confirmed.

Recognition and visibility of women's contributions

According to the original manuscript, the share of people who said that women are not recognised for their efforts is 64.5%, with 9.7% saying that women are seldom part of the innovation process. The analytic point is important, and it's that the problem of not being included in the process and the problem of not being recognized afterwards are different. Restriction in participation,

and weakening of attribution, career growth, future resource access. The original article also reports that some respondents believed that recognition was related to the organization.

Results summary

The reported findings indicate a paradox of perceived capability and perceived opportunity. The respondents generally agreed that women's decision-making ability and their view of the change were positive. They also raised the issue of the representation of senior women and the question of credit. The results support the notion that it is not enough to have access to the other party, but that one's influence must also be meaningful, but they cannot prove that one factor leads to the other.

Discussion

Representation is not the same as influence

Based on the pattern reported in the survey, recognizing the ability of women does not imply that people feel that institutions are offering equal opportunities. This is a key contribution of the article. While targets can increase the number of women joining a profession, substantive inclusion also means having control over decision-making, having access to resources, and being fairly recognised for contribution. Institutions should assess these results independently of the number of students in their halls.

Recognition is an innovation-system issue

The expressed worry over credit is a less visible aspect of inequality. But innovation is not individual, it is cumulative and collaborative, and therefore, who gets the reputation, funding and promotion for successful work are influenced by the attribution systems. Organizations can do this by documentation of project roles, clear criteria for authorship and inventorship, public recognition protocols, fair access to patent and grant assistance, regular review of promotion and compensation, and others. These mechanisms are more practical than awareness raising.

Digital access must lead to meaningful use

While Pakistan's strides in women's mobile-internet adoption offer a positive sign, access indicators need to be correlated to mobile-internet use and impacts. A woman might be connected but not in control of a device, have privacy, not have confidence or advanced skills, and have no safe opportunity to participate online. Therefore, digital-inclusion programmes need to be evaluated beyond enrolment, connectivity, to course completion, independent use, income generation, product development, leadership, online safety and continued participation.

Inclusive technology requires women's participation across the lifecycle

Meaningful participation should be from problem definition to testing, deployment and evaluation. Women must be included in research teams, designers, entrepreneurs, decision-making and evaluation groups. Women's involvement in the consultation process is important, but it cannot replace women's decision-making power in technical and governance positions. This is especially important if technologies have an impact on access to finance, education, employment, health information or personal safety, public services.

Implications for Pakistan and Peshawar

The local survey is not a nationally representative diagnosis, but is a starting point for future research in Peshawar. To build a better follow-up study, students, women entrepreneurs, technology workers, managers, and university researchers and public-sector decision makers should be sampled across urban and rural areas. It should gather disaggregated data by gender, and if ethically feasible, opportunity to access personal tools, disability, place, income and education. These dimensions can both interact with gender and help to form those who benefit from Digital Transformation.

Proposed Practical Model for Inclusive Innovation

To translate the framework into practice, institutions can adopt a five-part audit. The purpose is to identify where women's participation is interrupted and assign responsibility for improvement.

Access audit: Track access to devices, connectivity, training, funding, facilities, mentors and high-value assignments.

Agency audit: Assess whether women can propose ideas, lead experiments, join technical teams and influence problem definition.

Authority audit: Review who controls budgets, approves projects, sets research priorities, leads teams and participates in governance.

Attribution audit: Review authorship, inventorship, patents, awards, project visibility, promotion, pay and ownership of outputs.

Impact audit: Test whether products and services are safe, affordable, accessible and useful to diverse groups of women and men.

This model can be implemented through annual reporting, staff and user surveys, project-level documentation, confidential feedback channels and independent review. Targets should be adapted to institutional context and accompanied by clear accountability; numerical representation alone should not be presented as proof of inclusion.

Policy and Institutional Recommendations

For educational institutions

Integrate women's contributions to science, technology, engineering, entrepreneurship and social innovation into curricula and teaching materials.

Provide equitable access to devices, connectivity, labs, internships, research supervision and career guidance.

Create mentoring and sponsorship pathways that connect students with women researchers, engineers, entrepreneurs and leaders.

Teach digital safety, privacy, critical AI literacy and responsible technology use alongside technical skills.

For employers and innovation organizations

Publish transparent criteria for recruitment, promotion, project leadership, authorship, inventorship and awards.

Track women's participation in high-value technical assignments, decision-making bodies, funding decisions and leadership pipelines.

Provide flexible and family-supportive work practices without penalizing employees for using them.

Train all staff and managers on bias, respectful collaboration and fair evaluation; pair training with enforceable organizational procedures.

Establish confidential reporting and response systems for discrimination, harassment and technology-facilitated abuse.

For technology developers and funders

Include women in problem definition, design, testing, governance and evaluation—not only as end users.

Assess datasets, interfaces, safety features and performance across relevant user groups.

Make funding and procurement criteria transparent and monitor whether women-led teams can access opportunities.

Document contributions across collaborative projects and recognize technical, research, design and implementation work fairly.

For policymakers

Improve the availability of gender-disaggregated data on digital access, STEM education, research careers, entrepreneurship and leadership.

Support affordable connectivity and digital-skills programmes that address barriers such as cost, device control, safety and mobility.

Encourage public-private-university partnerships that connect women's skills training to paid work, entrepreneurship and applied innovation.

Evaluate programs by sustained outcomes employment, earnings, leadership, ownership, innovation outputs and user benefit not attendance alone.

Limitations and Future Research

There are a number of caveats to note. First of all, the sample size is small and restricted to geographically Peshawar, so the results cannot be generalized to the whole of Pakistan. Second, the original manuscript does not include the complete questionnaire, sampling frame, response rate, demographic information and raw data. Thirdly, percentages have not been calculated on their own and have been carried from the original document; the figure of 83.2% should be checked. Fourth, the survey does not measure workplace practices, innovation output or career outcomes of the enterprises, but perceptions. Fifth, the study is cross-sectional and descriptive and thus cannot determine causal relationships. Finally, the literature review has been updated with selected contemporary sources, but is not systematic review and does not claim to include all the literature.

Future research should gather the raw data and questionnaire and check all percentages and report counts as well as percentages. A larger mixed-methods study could integrate a stratified survey with interviews or focus groups with women in science and technology jobs, entrepreneurship and management. Researchers can independently measure each proposed dimension of framework and determine whether access is related to agency, agency is related to decision making authority, and authority is related to recognition and inclusive innovation outcomes. Longitudinal study would be useful in establishing if institutional intervention brings about a lasting change.

Conclusion

The level of women's involvement in innovation cannot be measured solely by their entry into education, the labour market or technology use. It also relies on whether they can come up with ideas, help formulate strategic decisions, be fairly acknowledged and have a voice in the technologies and services that impact their lives. The overall findings of the initial survey conducted in Peshawar are that most of the respondents acknowledged the decision-making capacity of women, but they also noticed the barriers for their inclusion in higher positions and their recognition. Due to the exploratory nature of the study, and because the raw data were not provided, these results should be taken with a grain of salt and confirmed prior to formal publication.

The "Access-Agency-Authority-Attribution-Impact" framework that the article suggests could help shift the discussion from representation to something more authentic and from representation to an outcome. It links digital inclusion to access organizational conditions for women to become innovators and decision makers. Inclusive innovation is using systems to not only bring technology within reach of people, but to enable different individuals to be involved in the design, governance and benefits of that technology. Empirical validation of the framework with transparent data and measurable indicators in the educational, entrepreneurial and technological environments in Pakistan is the next step.

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