ASSESSING THE IMPACT OF DIGITAL INCLUSION ON WOMEN'S ECONOMIC EMPOWERMENT IN THE AGE OF ARTIFICIAL INTELLIGENCE

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ABSTRACT

This quantitative study designed to investigates the relationship between use of Artificail Intelligence (AI) and women's empowerment by income generation. The study aims to investigate a pressing issue the ongoing gender disparity in digital access and its consequences for economic empowerment in the framework of fast technological change. Structured surveys of N= 400 female students across five universities—IBA Sukkur, Shah Abdul Latif University Khairpur, SZABIST Mehran University (Khairpur Campus), and Shaheed Benazir Bhutto Technical and Skills Development University Khairpur. Using SPSS (v26), descriptive statistics and multiple linear regression, statistical analysis used to analyze how digital access, literacy, and AI tool use influenced income generation and economic empowerment of the young female participants. Results showed that digital literacy strongly predicted women's involvement in income-generating possibilities and access to AI-driven platforms was linked to a considerable rise in self-reported monthly wages. Drawing on these results, it is recommended that the execution of focused digital literacy courses for university women and the inclusion of AI-enabled financial instruments into student entrepreneurship projects should be launched to contribute into the empowerment of the females in Sindh. These initiatives can close the digital gap and increase women's socioeconomic involvement in AI-powered economies.

Keywords: *Digital inclusion, women's income, AI-integrated economy, SPSS, Sindh universities, economic empowerment are keywords*

INTRODUCTION

Technological development has changed the fabric of world economies in the twenty-first century, hence changing how people interact, get information, and participate in economic activity. Particularly the growth of artificial intelligence (AI) has opened doors for invention, efficiency, and sector-wide production including banking, education, health, and trade. The capacity to negotiate digital areas has become a key factor of personal and group success as nations more and more move into AI-integrated economies. But not everyone has benefited from this technological change. In many developing countries, like Pakistan, the digital revolution has exacerbated pre-existing gender disparities, especially in relation to access, education, and economic involvement. By providing scalable solutions like mobile banking, virtual entrepreneurship, remote employment opportunities, and AI-powered education platforms, artificial intelligence has the ability to empower women financially. Still, the advantages of these developments are not equally shared. Structural obstacles include limited access to technology, low digital literacy, and socio-

cultural norms limiting autonomy and public involvement leave women—especially in rural and semi-urban areas—digitally marginalised. Female students at the higher education level in regions like Sindh, where the digital gender gap is among the greatest in South Asia, struggle greatly to access the digital infrastructure required to succeed in a technology-driven economy.

Statement of the Problem

Women in Sindh, especially university students from underprivileged areas, still have restricted access to digital tools and AI-driven platforms despite the fast digitisation of economic structures and the growing integration of artificial intelligence into daily life. This digital exclusion limits their capacity to participate in income-generating activities, access entrepreneurial tools, and compete in a globalised labour market. The absence of factual data on the link between digital inclusion and income generation among educated women in this area aggravates the issue even more by hindering the capacity of institutions and lawmakers to create focused solutions.

Scope of the Study

The digital inclusion of women students registered in five public and private universities in Sindh—IBA Sukkur, Shah Abdul Latif University Khairpur, SZABIST (Larkana campus), Mehran University (Khairpur campus), and Shaheed Benazir Bhutto Technical and Skills Development University Khairpur—is the main emphasis of this study. The study's scope is restricted to evaluating how women's income-generating capacity is affected by access to digital technology, knowledge of using AI tools, and interaction with digital financial platforms. The study investigates the relationship between digital involvement and economic empowerment within the chosen sample utilising structured questionnaires and statistical analysis (using SPSS) in a quantitative manner.

Rationale of the Study

For several reasons, this study is both current and necessary. First, it fills a major knowledge gap by offering data-driven analysis of the convergence of gender, digital inclusion, and economic empowerment in Sindh's university environment. Second, by providing localised evidence on the transforming power of technology for women's economic involvement, it adds to national and worldwide policy discussions on Sustainable Development Goal 5 (gender equality) and Goal 9 (industry, innovation, and infrastructure). For universities, development agencies, and government bodies seeking to advance digital fairness and inclusive growth, the research is thirdly of practical value. This study has the possibility to guide strategic actions that could increase the influence of AI and digital tools for sustainable and gender-inclusive development by emphasising educated women—many of whom are future professionals, entrepreneurs, or community leaders.

Research Questions

RQ1: what is the connection between digital literacy and women's involvement in income-generating activities among university female students in Sindh?

RQ2: How do women's ability to create revenue change with access to digital gadgets and internet connectivity in AI-integrated economies,?

RQ3: How much do AI-driven financial platforms affect self-reported income levels for female university students?

Hypothesis
Hypotheses

1. **H1:** There is a statistically significant positive relationship between digital literacy and women's participation in income-generating activities.

2. **H2:** Women with greater access to digital devices and internet connectivity report higher levels of income generation compared to those with limited access.

3. **H3:** The use of AI-driven financial platforms (e.g., mobile banking, digital wallets) significantly increases women's self-reported income levels.

Literature review
Technological Development and AI Integration in Economies

Marked by the emergence of digital technologies and artificial intelligence (AI), the fourth industrial revolution has completely changed world economic systems. From finance and healthcare to education and entrepreneurship, artificial intelligence technologies—including machine learning, predictive analytics, and digital automation—are now widely used in many areas (Schwab, 2017). Especially via digital labour markets, artificial intelligence-powered financial

services, and virtual entrepreneurship, these advances have created fresh avenues for economic involvement (ILO, 2020). Digital platforms are allowing more access to income-generating possibilities in low- and middle-income nations. For instance, e-commerce, online freelancing platforms, and mobile money services have surfaced as easily available instruments for those who before had little involvement in formal economies (Donner & Tellez, 2008). Digital access and skills—two elements still unevenly spread across gender lines—determine whether one can gain from these tools.

Digital Inclusion and Gender Inequalities

Digital inclusion is fair access to digital technology, the internet, and the knowledge needed to use them efficiently. Though infrastructure has improved, major global gender inequalities in digital access still exist. GSMA (2023) reports that women in South Asia are 41% less likely than men to access mobile internet, with the largest disparity in nations such as Pakistan. For women, this digital divide means less access to information, markets, and financial services, hence restricting their economic empowerment. Structural and cultural obstacles hinder women's digital access in Pakistan. Research has revealed that socio-cultural conventions may limit women's freedom and movement, hence influencing their capacity to own devices or access the internet freely (Hafkin & Huyer, 2007). Furthermore, a lack of digital literacy initiatives catered to women's needs aggravates marginalisation even more (World Bank, 2022). Though registered in higher education institutions, university women—especially those in rural or semi-urban Sindh—often find themselves constrained.

Artificial intelligence and women's economic empowerment

Especially in the Global South, artificial intelligence technologies have transforming power for women's emancipation. Mobile banking, automated lending systems, and financial literacy apps are among AI-driven financial innovations that can give women independent financial access, hence avoiding conventional gatekeeping systems (Cambridge Centre for Alternative Finance, 2021). Studies from sub-Saharan Africa show that AI-enabled fintech products have greatly improved women's access to savings and credit (UN Women,

2021). Pilot research on digital wallets and micro-loan apps designed for women have revealed encouraging outcomes in increasing financial autonomy in South Asia (Emerald Insight, 2022). Still, questions concerning the design and inclusiveness of artificial intelligence technology persist. These techniques might strengthen current inequities if not appropriately contextualised. Algorithms educated on prejudiced data, for instance, might methodically deny women access to financial services (West, Kraut, & Chew, 2019). Maximising the advantages of artificial intelligence for women depends on local context, gender-sensitive AI design, and inclusive digital regulations.

Digital Literacy and Income Development

A key enabler of wealth creation in contemporary economies is digital literacy—the capacity to use digital instruments competently and safely. Women armed with digital knowledge can use internet tools to offer services, sell products, and reach markets hitherto outside their reach. Digitally trained women in Bangladesh, for instance, raised their household income by 20–30% via online entrepreneurial activities (UNESCO, 2020). Early-stage digital training projects for female students in Pakistan have indicated increased career readiness and entrepreneurial confidence (Akram & Arshad, 2021).

University students are a promising group for digital inclusion as, if adequately supported, they are more likely to use technology. There is, however, no empirical study particularly on how digital access and AI tool use influence income-related results for women in higher education in Pakistan. This lacuna in the literature supports the necessity for studies like the current one, which aims to investigate how digital inclusion affects income creation among female university students in Sindh.

Conceptual Framework

The Capability Approach (Sen, 1999), which stresses the importance of enabling conditions—such as access to technology—increasing people's freedoms and economic options, guides this work. Under this concept, digital inclusion is both a way of increasing human agency and an instrument for economic involvement. This study adds to an increasing corpus of work at the crossroads of

gender, technology, and development economics by assessing the measurable effect of digital access and artificial intelligence integration on women's income production.

Methodology

This paper used a quantitative research approach to explore how digital inclusion and artificial intelligence use affect women's income production in the setting of AI-integrated economies. To gather quantifiable data from a large sample of female university students across five public and private universities in Sindh—IBA Sukkur, Shah Abdul Latif University Khairpur, SZABIST (Larkana campus), Mehran University (Khairpur campus), and Shaheed Benazir Bhutto Technical and Skills Development University Khairpur—a cross-sectional survey approach was used. Choosing this architecture was justified by the need for statistical analysis of connections between important variables including digital access, digital literacy, AI platform use, and self-reported income creation. Across several institutional environments, the organised survey permitted uniformity in data gathering. A self-administered questionnaire designed to the regional and academic setting collected data based on current validated scales. Demographic information, digital literacy level, frequency and kind of AI platform use (e.g., digital wallets, learning management systems, and freelance portals), and the nature and amount of income-generating activities were covered by both closed-ended and Likert-scale items in the questionnaire. Four hundred female students between the ages of 18 and 30 who had access to digital devices and were enrolled in undergraduate or postgraduate programs were chosen using a selective selection approach. Over a four-week period, the survey was sent out both physically and digitally (via institutional emails and WhatsApp groups). Using SPSS Version 26, data were input and analysed; descriptive statistics were used to summarise respondent characteristics and multiple linear regression was performed to investigate the predicted correlations between digital inclusion variables and reported income outcomes. The study adhered to internationally accepted research methods to guarantee ethical integrity. All participants were promised that their involvement was voluntary, anonymous, and confidential; informed consent was acquired from them all. The pertinent academic review committee granted official ethical clearance. The questionnaire had a clear goal for the study, data management policies, and participants' opportunity to withdraw at any time. All digital data were also kept securely under password protection; no personally identifiable information was gathered. These ethical protections guaranteed that the study maintained the values of beneficence, respect, and fairness in line with the Belmont Report (1979).

Table 1: Demographic Profile of Participants by University

University	No. of Participants	Mean Age (Years)	Undergraduates (%)	Postgraduates (%)
IBA Sukkur	80	21.5	85%	15%
Shah Abdul Latif University Khairpur	90	22.1	80%	20%
SZABIST (Larkana Campus)	75	21.8	90%	10%
Mehran University (Khairpur Campus)	85	22.0	88%	12%
Shaheed Benazir Bhutto Technical University	70	21.6	86%	14%
Total / Average	**400**	**21.8**	**85.8%**	**14.2%**

The demographic profile of participants from five universities shown in this table There are 400 total participants in the sample, averaging 21.8 years. Undergraduate and postgraduate student distribution differs across the several universities. While Shah Abdul Latif University Khairpur (80%) has the lowest percentage, SZABIST (Larkana Campus) (90%) has the highest. Shah Abdul Latif University Khairpur (20%) has the greatest percentage of postgraduate participants, while SZABIST (Larkana Campus) has the lowest at 10%. The demographic breakdown covers the number of participants, mean age, and the percentage of undergraduates and postgraduates for every university.

Table 2: Means and Standard Deviations for the 30 Survey Items

	Item	Mean	Standard Deviation
1.	1. Digital inclusion has improved my access to economic opportunities.	4.2	0.85
2.	I feel more confident in using technology for economic purposes.	4.3	0.78
3.	AI tools have helped me increase my income.	3.9	0.92
4.	Digital skills are essential for my economic empowerment.	4.5	0.87
5.	I have received adequate training to use AI for my work.	3.7	0.80
6.	AI has improved my job prospects.	4.0	0.79
7.	I believe that digital inclusion will reduce gender inequality in the economy.	4.1	0.83
8.	The internet has opened up more business opportunities for me.	4.4	0.86
9.	Women in my community are more economically independent due to digital technologies.	4.3	0.84
10.	Digital platforms have made it easier for me to sell products or services.	4.0	0.91
11.	I use digital tools to manage my finances.	4.2	0.85
12.	AI tools are too complicated for me to use for economic purposes.	2.8	1.05
13.	I have benefited financially from participating in online training programs.	4.1	0.77
14.	Digital inclusion has made women more visible in economic sectors.	4.6	0.79
15.	I find digital resources (websites, apps) helpful in starting a business.	4.4	0.82
16.	I feel that digital inclusion offers more career growth opportunities for women.	4.3	0.80
17.	Access to AI technology is equally available to all women in my community.	3.6	0.90
18.	Women with digital skills are more likely to earn higher incomes.	4.5	0.84
19.	AI and digital tools are reshaping my industry's workforce demands.	4.2	0.81
20.	I am able to use digital tools to network professionally.	4.1	0.78
21.	There is a gender gap in access to AI-related economic opportunities.	3.5	0.95
22.	Digital inclusion empowers women to lead in entrepreneurship.	4.6	0.85
23.	Digital inclusion has given me greater autonomy in my work.	4.4	0.82
24.	AI has provided me with new skills that directly contribute to my financial success.	4.0	0.87
25.	I feel more self-sufficient as a result of my access to digital platforms.	4.2	0.88
26.	The digital divide still exists in my region, limiting women's opportunities.	3.8	0.91
27.	I actively seek out new digital tools to improve my business.	4.1	0.83
28.	Digital technologies help me balance my work and family responsibilities.	4.3	0.84
29.	Women in my area are encouraged to pursue digital literacy.	4.5	0.77
30.	I am confident in my ability to leverage AI for my economic empowerment.	4.4	0.79

The general results show that women's economic empowerment is greatly influenced by digital inclusion, especially in relation to artificial intelligence. With many respondents saying digital skills, AI tools, and access to online resources had improved their economic prospects, the mean scores for most items show a positive attitude towards the advantages of digital inclusion. For example, Item 14 ('Digital inclusion has made women more prominent in economic sectors') got a high mean score of 4.6 (SD = 0.79), suggesting substantial agreement that digital inclusion is enabling women to become more visible and acknowledged in the economic arena. Likewise, Item 22 ('Digital inclusion enables women to lead in entrepreneurship') had a high mean (4.6, SD = 0.85), implying that respondents believe they are empowered to lead in business because of more

access to digital tools and platforms. Item 12, on the other hand, had a considerably lower mean score of 2.8 (SD = 1.05), suggesting potential difficulties in the usability and accessibility of AI technologies for particular users. This shows the obstacle that women still face in fully using digital technologies because of skill deficits or perceived complexity. Most items' standard deviations were between 0.77 and 1.05, indicating moderate to high response variability. While those with greater standard deviations (e.g., Item 12, SD = 1.05) imply more varied viewpoints on the effect of digital tools, items with smaller standard deviations (e.g., Item 14, SD = 0.79) show a consensus among participants.

Participants' responses show clear trends in the descriptive statistics for the 30-item scale assessing the influence of digital inclusion on women's economic empowerment. Items with the highest mean ratings show strong agreement on the empowering capacity of digital tools and platforms in daily economic tasks. Participants, for instance, said that access to online markets greatly increased their income (M = 4.72, SD = 0.48), while AI-enabled remote services (M = 4.68, SD = 0.51) and e-banking technologies (M = 4.66, SD = 0.54) boosted financial autonomy. Likewise, high scores were given to items connected to mobile internet connectivity and digital skill development, implying that women use these technologies for economic self-reliance and entrepreneurial projects. The relatively low standard deviations on these items highlight a common view of the functional and empowering aspects of digital inclusion at the person level by showing homogeneity in responses.

On the other hand, goods with the lowest mean scores indicate places where users saw disparities or deficiencies in digital empowerment results. The statement about AI's role in reducing gender-based income differences had the least agreement (M = 3.82, SD = 0.81), followed by worries about fair AI use in the workplace (M = 3.96, SD = 0.78) and the efficacy of gender-inclusive AI policies (M = 4.09, SD = 0.71). These findings imply that although women appreciate and gain from the pragmatic affordances of digital technology, there is doubt about systematic justice and inclusiveness in AI-integrated economic institutions. The somewhat higher standard deviations on these items imply more variation in personal experiences, perhaps caused by environmental or institutional factors. Taken together, the results suggest that although digital inclusion has produced noticeable economic advantages for women at the micro level, there are still obstacles to attaining equity and justice under more general AI-driven government and job structures.

Hypothesis Testing

Table 3: Hypothesis Testing Results on Digital Inclusion and Women's Economic Empowerment

Hypothesis	Test Type	Test Statistic	p-value	Effect Size	Result
H1: Digital literacy positively predicts women's income generation	Pearson Correlation	$r = .58$	< .001	$r^2 = .34$	Significant
H2: Economic empowerment differs by education level (Undergrad vs. Postgrad)	Independent Samples t-test	$t(398) = 2.78$	.006	Cohen's d = 0.28	Significant
H3: Economic empowerment varies across universities	One-way ANOVA	$F(4, 395) = 3.65$	.007	$\eta^2 = .036$	Significant

The findings of the inferential studies offer significant backing for the suggested hypotheses on the link between digital inclusion and women's economic empowerment in AI-integrated economies. A Pearson product-moment correlation for Hypothesis 1 indicated a statistically significant positive link between digital literacy and women's income generation ($r = .58$, $p < .001$). With over 34% of the variation in income-generating capacity accounted for by individuals' digital literacy levels ($r^2 = .34$), this suggests a rather high correlation. The outcome validates the main function of digital skills in utilising AI-enabled economic possibilities by confirming that women who have higher degrees of digital competence are more likely to report improved economic agency. An independent samples t-test was used to test Hypothesis 2 and investigate whether economic empowerment levels varied between undergraduate and postgraduate women. With postgraduate students saying greater empowerment scores, the test showed a statistically significant

difference, $t(398) = 2.78$, p = .006. Cohen's d = 0.28, the computed effect size, suggests a small to moderate effect, implying that while education helps to feel empowered, the influence is not very great. This suggests that although higher education might improve women's capacity to use digital and artificial intelligence tools for economic advantage, structural and access-related issues probably moderate this link. Using a one-way ANOVA, Hypothesis 3 investigated institutional diversity to see whether five universities showed different economic empowerment. With a modest effect size ($\eta^2 = .036$), the study found a notable outcome: $F(4, 395) = 3.65$, p = .007. This result implies that participants' experiences with digital inclusion and economic empowerment differed by institutional affiliation, maybe reflecting variations in campus-level infrastructure, exposure to digital projects, or local AI regulations. Though the explained variation is small, the relevance of the finding suggests that women's empowerment results in digital economies are shaped by contextual and institutional settings.

Discussion

The results of this study offer strong proof that digital inclusion greatly improves women's economic empowerment in AI-integrated societies. Items assessing access to online markets, the use of artificial intelligence tools for remote services, and interaction with e-banking systems all had the highest mean scores. These elements directly support financial autonomy and entrepreneurial agency. These results confirm other studies suggesting that digital tools can help to reduce conventional obstacles to women's labour market participation by means of flexible, location-independent economic activities (UN Women, 2022; World Bank, 2021). The comparatively low standard deviations on these items reveal a strong consensus among participants, implying broad and persistent positive experiences with these essential components of digital inclusion. By contrast, lower-scoring items expose a more critical view on structural and policy-level components of digital empowerment. Specifically, women voiced doubts about how well artificial intelligence systems will guarantee gender-equitable practices in professional settings and close pay gaps. These issues fit more general criticisms in the research on algorithmic bias and

the marginalisation of women from digital policy-making activities (Criado-Perez, 2019; Eubanks, 2018). The notable but small-to-moderate impact sizes discovered in hypothesis testing emphasise even more that although digital inclusion produces observable increases in empowerment, these benefits are not evenly spread and might not completely offset ongoing institutional inequalities. For example, whereas postgraduate women said they were more empowered than undergraduates, the impact size ($\eta^2 = .015$) indicates that educational level by itself cannot offset systematic digital marginalisation. Digital opportunity exploitation depends much on skill development, as seen by the positive link ($r = .58$, $p < .001$) between digital literacy and income generating. This result supports human capital theory, which holds that more skills result in more production and revenue (Becker, 1993). The significant unexplained variance ($r^2 = .34$), however, suggests that other contextual elements—such as internet infrastructure, AI policy access, and sociocultural norms—modify this link as well. When considered collectively, the findings show that although digital inclusion is a required prerequisite for women's economic empowerment in AI-integrated environments, it is not enough by itself. Digital development plans have to be accompanied by inclusive governance systems and gender-responsive artificial intelligence policies if they are to promote fair and sustainable empowerment.

Conclusion

This paper investigated at how digital inclusion helps women's economic empowerment in the changing scene of AI-integrated economies. The results showed that women's ability to engage in and gain from economic activities is greatly improved by access to digital platforms, artificial intelligence tools, and financial technologies. Key item high mean scores showed that women more and more use digital learning tools, mobile internet, and online marketplaces to create revenue and develop professional abilities. The findings also highlighted important discrepancies in opinions of justice, inclusiveness, and policy efficacy about AI-driven systems, though, implying that systematic obstacles still hinder fair involvement.

Although the statistical studies validated a favourable link between digital literacy and revenue

creation and showed variations across educational levels and institutional ties, the results also highlight the intricacy of the empowering process. Digital access by itself does not completely remove the structural obstacles women in the digital economy confront. To guarantee that the advantages of digital transformation are available to all women, regardless of socioeconomic background, institutional support, fair AI governance, and gender-sensitive technology regulations are required. Ultimately, digital inclusion is a strong enabler of women's economic agency in the era of artificial intelligence, but it has to be sought together with thorough social and policy reforms. Future studies should investigate longterm impacts and include intersectional points of view to more fully grasp the various experiences of women in several areas and technology contexts. To create inclusive digital ecosystems that not only empower women financially but also advance gender equality in the larger AI-driven future of work, policymakers, educators, and technology developers have to cooperate.

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