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The Role of Information and Communication Technology in Women's Decision-Making on Reproductive Health and Household Expenditures

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Abstract

The study investigates whether the affordability and penetration of information and communication technology among women contribute to their empowerment in Pakistan, analyzing this relationship at both provincial and residential levels. It further examines how information and communication technology influences women's empowerment while facilitating progress towards achieving the Sustainable Development Goals. The study empirically examines the impact of information and communication technology on women's decision-making power within households across Pakistan's provinces, utilizing data from the Household Integrated Economic Survey 2018-19. The analysis employs a binary logit model and the classification and regression tree techniques. The findings reveal a significant and positive impact of information and communication technology on women's decision-making power, identifying it as the most important predictor for the women's decision regarding expenditures at household level and about her reproductive health. Furthermore, the classification and regression tree technique indicates that Punjab leads other provinces, while Balochistan furthest behind in achieving the Sustainable Development Goals Agenda 2030. While from other socioeconomic and demographic variables, the odds of number of son, women's age, education level, residence and region are more likely and significantly associate with the women's decision-making power. The findings of the study support the policies in favor of ICT penetration and improving women's access to education and employment opportunities to enhance women's autonomy in Pakistan.

Keywords

Women's Empowerment, Communication, Technology, Sustainable Development

1. Introduction

Information and Communication Technology (ICT) has unprecedentedly transformed our lives, influencing how we live, work, learn, and communicate with others. This transformation has been possible primarily due to the tremendous increase in the speed and scale of information and services transfer, facilitated by high-speed broadband connectivity, 5G technology, Artificial Intelligence (AI), and big data. These advancements have also enhanced women's decision-making

power at the household level, enable their participation in socio-economic development, and boosted economic productivity.

The 2030 Agenda for Sustainable Development emphasizes ICT as a crucial indicator for measuring women's empowerment and the achieving the Sustainable Development Goals. Seven ICT-related indicators align with six SDGs targets, five of which fall under the responsibility of International Telecommunication Union (ITU). These include, SDG 4 (Quality Education): indicators 4.4.1 *"proportion of youth and adults with ICT skills, by type of skills."* SDG 5 (Gender Equality): indicator 5.b.1 *"proportion of individuals who own a mobile phone, by sex."* SDG 9 (Industry, Innovation, and Infrastructure): indicator 9.c.1 *"proportion of the population covered by the mobile network, by technology"* and SDG 17 (Partnership) and its indicators 17.6.1 and 17.8.1 *"fixed internet broadband subscriptions per 100 inhabitants and proportion of individual using the internet"*. To ensure that no one is left behind, it is essential to identify and understand the socioeconomic and demographic characteristics of regions lagging in their access to and use of ICT.

Pakistan has been devoted to the SDGs agenda since its launch in 2015. In February 2016, Pakistan became the first country in the world to approve the SDGs as part of its National Development Agenda through a National Assembly Resolution. Drawing from its experience with the Millennium Development Goals (MDGs), Pakistan's national and provincial assemblies established SDG units. Improving ICT access and achieving gender equality remain key national priorities of Pakistan.

ICT holds the potential to create numerous opportunities for women in employment, education, access to information, and public service. However, unequal and inadequate access to ICT exacerbates inequalities in income and education.

The COVID-19 pandemic exposed disparities in ICT access and use across society [11]. Now, more than ever, easy access to ICT and ICT-related skills is critical for enhancing women's decision-making power. The COVID-19 pandemic highlighted the significance of this gap, which prevents about half of the world's population from accessing ICT [15]. ICT played a vital role during the pandemic in many countries, enabling online work and education while keeping people informed through easy access to relevant information. Yet the uneven access to and use of ICT among different countries and regions had never been recognized before the COVID-19 pandemic. As a result, those lacking easy access to ICT are at risk of falling further behind [11]. Ultimately, ensuring easy access to ICT and ICT-related skills is essential for empowering women and enhancing their decision-making power.

The provision of equal opportunities can empower women in education, employment, and asset ownership, and easy access to ICT plays a vital role in achieving this. The percentage of the female population in Pakistan is 48.76% [24]. However, the status of women in different socioeconomic dimensions has remained lower than that of the male population. Men continue to serve as the primary breadwinners and dominate major decision-making roles. Pakistani society is patriarchal, with male preference prevalent in most households. In Pakistan, less than 47% of adult women are literate, compared to 71% of adult men [24]. These figures underscores the urgent need for significant improvements in the status of women.

Urban regions in Pakistan fare better in women's access to and use of ICT, while small towns and rural areas lag behind. It is worth mentioning that 62.2% of Pakistan's total population resides in rural areas [23]. Rural women in Pakistan face significant discrimination in nearly every facet of life. However, recent years have seen progress in reducing the gender gap. For instance, women's ownership of mobile phones increased to 50% in 2021 from 38% in 2019. Additionally, 49% of women had Internet access in 2020 [15].

Previous studies [1, 10, 12, 13, 16, 18, 21] have explored various factors influencing decision-making including education, employment, and child health. SDG 5 emphasizes empowering women through ICT, aligning with the broader SDGs is leaving no one behind. Therefore, women's empowerment is essential for achieving SDGs such as quality education, poverty reduction, and economic productivity. ICT is a crucial enabler of women's empowerment women, and without its widespread penetration, the SDGs are unlikely to be achieved.

This study examines the role of ICT in women's empowerment concerning socioeconomic and demographic variables while incorporating SDG indicators to accelerate the achievement of the SDGs. It is specifically aims to explore how ICT can contribute to achieving the 2030 Agenda for Sustainable Development through classification and regression tree analysis. Additionally, the study identifies the characteristics and circumstances of individuals most likely to be left behind at the provincial level.

The main objective of the study is to measure inequalities in women's decision-making regarding having more children and household consumption expenditure, influenced by ICT penetration at provincial and regional levels. The study employs the Classification and Regression Trees (CART) technique and the Logistic Regression Model to analyze the impact of ICT on women's decision-making power concerning household expenditure and fertility decision, focusing on Pakistan as a case study.

The current study organized as follows. Section 2 is about literature review. The third section will give detailed information on variables and data sources, while the fourth section will discuss the methodology of the research study. The results of the study are shown in the fifth section. Section Six covers the conclusions and policy implications of the study.

2. Literature Review

The current study reviews the socioeconomic and demographic determinants of women's decision-making power. In

addition, the study examines other aspects of women's empowerment mentioned by previous studies conducted in Pakistan and other parts of the world.

Using the Pakistan Integrated Household Survey 1998-99, [21] analyzed various indicators that affect female decision-making regarding paid employment. The study applied Probit Model and found that income, education, and marital status positively and significantly influence female decision-making regarding paid employment. The study also found that the socio-economic status of the household is also an important factor in determining the women's status among households. It is noticed that the female-headed household will look after the equal rights of all family members regardless of gender [21].

The influence of household decision-making on women's maternal health in Pakistan was examined [13] by using data from 2Pakistan Social and Living Standards Measurement (PSLM) 2005-06. The study found that women's decision-making power positively and significantly correlated with women's maternal health. That is when women are empowered. They are most likely to use maternal and child healthcare services, and where men had the decision-making power in households, women were less likely to avail Maternal and Child Healthcare (MCH) services. Urban populations in large and small cities and rural populations in districts were considered separate strata using a two-stage stratified sample. By applying the logit model, the study found that the maternal health service uptake indicators have a positive association with women's decision-making power in Pakistan.

To analyze the association between education, employment, and decision-making in Pakistan [12] used, survey data from PSLM 2007-08. The study used the Linear Probability model to examine women's decisions regarding family planning and expenditure on food, clothing, medical cost, and recreation. The study found that education and employment positively associated with women's say in household decisions. Moreover, education and employment play a crucial role in intra-household decision-making.

The individual, household, and community-level determinants were analyzed to examine women's empowerment in Egypt [20]. The study used the 2006 and 2012 Egyptian Labour Market Panel Survey (ELMPS) to measure individual decision-making, household decision-making, mobility, and financial autonomy. The results are consistent with those [12, 19, 21], working women had greater decision-making power. The study found that wealth and region were positively associated with women's autonomy. Surprisingly, education had no association with women's decision-making power at the household level in Egypt and is contrary to expectations. The study analyzed that to empower women in society, it is first necessary to examine how women's community, social norms, and their families affect them. Applying the Ordered Logistic Model to primary data from a sample of 200 female college students in Lahore [7] found that female education, economic participation, and economic opportunities had a positive and significant impact on women's empowerment. However, it has also been observed that poverty is high where most households are illiterate, and women in those families face barriers to empowerment.

For addressing the determinants of women's empowerment in Pakistan, used women's decision-making about their education and women's decision-making about having more children [3]. Binary Logistic Regression was applied to the dataset taken from PSLM (2011-12). The study found that education level increases the decision-making capacity of women, and age, type of educational institution, and paid work were found to be positively and significantly correlated with empowerment. Moreover, there is hardly any women's decision-making power in rural areas of Pakistan households, and also, a large proportion of women are excluded from any level of participation in decision-making.

To analyze the socioeconomic, political, and demographic determinants of women's empowerment in Turkey [9], took a sample of more than 100,000 women and constructed an empowerment index. Empowerment was measured based on health, education, income, social life, and personal care. The study regressed multilevel analysis and found that women's empowerment was affected by individual attributes and the locality where women reside. Employment status, education level, income level, religiosity, and marital status had a positive association with women's empowerment.

By applying a multistage random sample technique on primary data from 500 households from four districts of Punjab, Pakistan, [1] measured the relationship between employment and women's empowerment. The primary determinants of women's empowerment (dependent variable) were decisions about health care and staying with the family, freedom of movement, access to and use of resources, and domestic abuse. In addition, a principal Component Analysis was conducted to guarantee the indicators' dependability. The outcomes of the multiple regression model demonstrated that working women were more empowered and able to fend off domestic abuse.

To measure household empowerment and poverty incidence with other socio-economic and demographic indicators [2] used, primary data from a survey of 600 household heads in rural southern Punjab, Pakistan. The study used the Probit model and found that HEMI, after controlling other variables like occupation, household size, remittance, and unemployment rate, are significantly associated with poverty incidence. In addition, the study revealed that HEMI had a negative association with rural household poverty incidence.

Women living in rural Pakistan face several issues, including a lack of access to high-quality education, low-income levels, and early marriage [16]. The study conducted a micro-survey of 480 women from six rural areas of Khyber Pakhtunkhwa, Pakistan. It analyzed that almost all selected women were participating only in household-level activities and were restricted to participating at even the

community level due to the rigid customs of their areas.

To measure women's empowerment in Punjab, Pakistan [18], indexed HIES 2013-14 dataset and applied the Logistic regression model. The study concluded that wage differential and other independent variables were positively associated with women's empowerment. However, it has also been discovered that empowerment is even worse in areas where education and other facilities are poor.

The literature review has uncovered several socio-economic and demographic factors that have a direct or indirect influence on women's decision-making power at the household level. These factors typically relate to family, women's education, age, household headship, paid employment, media, and the number of children. Moreover, from the series of reviews, it has been evident that education level and employment opportunities are essential for reducing the gender gap and empowering women. The present study helps to bridge the literature gap by focusing primarily on the access to and use of ICT by women of Pakistan at the provincial and regional level in the context of Goal 5 and Target 5b, specifically of the SDGs 2030 Agenda. The following section will explain the methodology used to develop relationships between these variables, and the next section will describe operational definitions of the variables.

3. Data and Definition of Variables

For empirical analysis, the study uses cross-sectional data from the Household Integrated Economic Survey (PSLM/HIES 2018-19) conducted by the Pakistan Bureau of Statistics 2020. The survey includes data at both the individual and household levels. The 2018-19 round of HIES covers 24,809 households and includes data on 24 SDG indicators. The PSLM/HIES provided comprehensive sample of households across Pakistan's provincial, district, and regional levels. The present study specifically focuses on currently married

women of reproductive age (15-49) living in Pakistan. The final sample consists of 23,087 observations for the empirical analysis.

The HIES dataset includes out of pocket expenditure on food, clothing and footwear, medical treatment, and travel and recreation. The study constructs an expenditure index by aggregating these four indicators. Responses to the question "Who in your family decides about expenditure at the household level?" are categorized as; woman herself=1, head/father decides alone=2, head/father in consultation with his/her spouse=3, head/father in consultation with women=4, head/father and spouse of the head in consultation with the women concerned=5, her spouse decides alone=6, women and her husband jointly decide=7.

Data from HIES 2018-19 include a which the interviewer asked respondent/woman the question, "Who in your family decides whether you should have more children?" is divided into eight categories which are 1=husband alone, 2=woman herself, 3=husband and woman jointly, 4=mother of woman or husband, 5=nobody, 6=menopausal/infertility, 7=other, 8= it is in the hands of God.

For analysis, the study recodes the variable into a dichotomous variable. The dichotomous variable is 1 if woman says yes to a decision regarding having more children and expenditures; this is category 2 and 3. While the dichotomous variable stands, is 0 if the woman not included in the decision-making process.

In the PSLM/HIES, the head of the household is defined as "If a person lives alone, that person is considered the head of the household. If a group of people lives and eats together as defined above, the head of the household is that person who is considered as the head of the household members. In practice, when husband, wife, married and unmarried children form a single household, the husband is generally reported as the "head." Detail of the variable and their definition is given in Table 1.

Table 1. Meta Data.

Variable	Definition of variable	Description of variable
Dependent Variable		
Women decision-making power index	Decision about having more children. Decision about consumption expenditure (food, clothing and footwear, medical treatment, recreation, and travel).	1= if decision is taken by woman or jointly with her husband and with other family member 0= Otherwise
Independent Variables		
Use internet	have used internet during last 12 months	1= if used internet 0= otherwise
mobile phone	Women has her own mobile phone	1= if she has mobile phone 0= otherwise
ICT index	Combine the variable internet user and mo-	1 = use internet or mobile phone

Variable	Definition of variable	Description of variable
	bile phone users	2 = use both
		0; Otherwise
		Study recode as 0 if not using ICT and 1 otherwise.
Education	Highest level of education attained	0= if below grade one
		1= primary
		2=secondary
		3=higher and professional degree
Employment	Job status of a woman	1= if she is working
		0= otherwise
Age	Age of a woman	It is a continuous variable, and we calculate the age of ever married women belonging to age group 15-49.
No. of boys	Number of alive boys	Number of boys of a woman is divided into three interval i.e zero for no boy, 1-4 and 5-9
Income	Income of the family	Income is a continuous variable to show the status of the household
No. of girls	No. of alive girls in family	number of girls also divided into three interval that is zero of no. girls then 1-4 and 5-9.
R/s with head	Relationship with household head	1= if herself; 2= spouse; 3= other family member
		1 = if respondent or husband is the head of house
		0; Otherwise
Region	Lived in urban or rural area	1= if lived in urban area
		0= otherwise
Province	Provinces of Pakistan.	Punjab, Sindh, Balochistan and Khyber Pakhtunkhwa.

4. Methodology

There is a strong possibility of causality in our model, as empowered women may have greater access to ICT. However, as noted in the theory and literature, cross-sectional data are collected at a single point in time and account for various characteristics of a population. Several authors highlight the primary limitation of cross-sectional data analysis: its lack of a time dimension, which prevents the demonstration of causal relationship. It does not measure cause and effect simultaneously (ICT and Women's Empowerment).

Therefore, while cross-sectional studies cannot establish causation, they are valuable for developing causal hypotheses [17, 22]. Literature also indicates that a major drawback of cross-sectional studies is their inability to separate cause and effect from simple association. Furthermore, while cross-sectional analysis can define community attributes, it is not designed to establish cause-and-effect relations between variables. This technique is frequently used to explore potential associations or gather preliminary data that can guide further investigation and experimentation.

Consequently, the current analysis examines the possible association between the dependent variable (women's empowerment) and the independent variable (ICT indicators) using univariate methods (descriptive statistics and graphical presentation) and multivariate analysis Binomial Logistic Model and the CART technique.

4.1. Logistic Model

The study identifies two key proxies for women's empowerment, (i) women's decision-making regarding household expenditure (food, clothing, medical costs, travel, and recreation) and (ii) women's decision about having more children. These proxies are analyzed as separate categories. To explore the influence of ICT, we construct two models based on important determinants identified in the literature and aligned with available data. The functional form of our model is given as:

WDP = (ICT index, province, region, education, employment, income, no. of boys, no. of girls age, relation with head)

The dependent variables in the study are dichotomous, taking the values 1 and 0. Therefore, we apply the Logistic Model and the CART technique.

Since the dependent variable is dichotomous, the logistic

equation is as:

$$Prob\ (WDP) = \frac{1}{1+e^{-WDP}}$$

$$WDP = \beta_0 + \beta_1 ICT + \beta_2 Pro + \beta_3 Reg + \beta_4 Edu + \beta_5 Emp + \beta_6 Inc + \beta_7 Boy + \beta_8 Girl + \beta_9 HHH + \mu$$

Each β_i represents the odds ratio, which is explained as:

Odds Ratio = p(women taking decision) /p(women not taking decision) = e^{-WDP}

The change is the log ratio with respect to an independent variable is expressed as

$$\frac{dlog(odds\ ratio)}{dx_i} = -\beta i$$

The study utilizes the HIES dataset for the year 2018–19. This dataset was chosen due to its extensive coverage of variables at the national, provincial, and district levels, ensuring comprehensive analysis.

4.2. CART Model

CART is visualized as a binary tree, with the partition of data into multiple subspaces, and is extensively used for its ease of interpretation. It is easily interpreted as the most important indicator given in the top node and the least significant indicator in the lowest branch of the tree. Furthermore, the classification tree shows the predictive power of each independent variable.
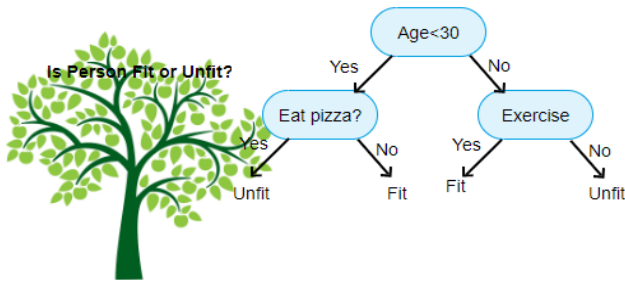

***Figure 1.** CART model.*

When the inference problem needs to make a discrete prediction about some variable given other details of the variable is easily handled with partitioning classifiers [6]. These classifiers split the space into partitions, CART uses classification trees to recursively partition the space. Tree algorithms-built trees are shown in Figure 1. This tree is called the decision tree as decisions are taken on leaves about yes or no. The left branch of the tree refers to yes as these trees have branches and leaves.

The study uses the CART [6] to explain the predictors by building the binary decision tree. CART generates the sub-tree sequence by growing a large tree and pruning it until

the root node is left. Therefore, CART first selects the variable and then selects its split node, the observation goes to the leaf node of the branch. CART is a useful nonparametric approach that interprets categorical dependent variables in terms of various independent variables. While explanatory variables could be categorical and independent in nature.

The categorical dependent variable has two attributes "yes" or "no". If the independent variables are good predictors move to the "yes": node and if not, then the node splits to the right side which is the "no" node. Moreover, in the CART technique, the partition is continuous till the end nodes and pruning where necessary. The decision tree starting from the variable with the top of the branch has the highest association with the dependent variable and variables are further split in the form of nodes and branches. The tree is in an upside-down position, meaning the roots are at the top and the leaves are at the bottom.

As we have categorical variables in our study, we use the Classification Tree technique instead of the Regression Tree. In regression, we measure the importance or significance level of variables by p-value, while in the CART approach, we measure which predictor is important by the stems of the tree. Therefore, in the CART approach, we draw an inverted tree. The variable nearer to the Stem of the tree is more significant and has a higher impact on the exogenous variable than other endogenous variables. The study uses the R software for applying the CART approach.

In the current study, the measure of opportunity is women's decision-making power regarding the household level consumption expenditure and having more children in the provinces of Pakistan. The outcomes could be used as the target variables for policymakers in the target policy tools. ICT penetration and selected variables in the data set are used to define women's decision-making power.

5. Results

Table 2 presents the percentage of women with decision-making power regarding household expenditure and the percentage of women involved in decision about having more children, measured at the provincial and regional levels. It also shows the percentage of women with access to ICT across provinces and regions.

From Table 2, it is evident that in Punjab, percentage of women who have a say in decision-making (decision-making=1) is higher in both urban and rural areas as compared to Sindh, Khyber Pakhtunkhwa, and Balochistan, particularly in decisions regarding household expenditures.

In urban Punjab, 65 percent of women participate in decision-making regarding expenditures, while the corresponding figures are 35 percent in Sindh and Khyber Pakhtunkhwa and only 9 percent in Balochistan.

Regarding women's decision-making power about more children, urban women in Khyber Pakhtunkhwa lead, with 75 percent of women having a say in such decisions, followed

closely by Punjab at 73 percent. In contrast, women live in Sindh and Balochistan have significantly lower participation, with 63 percent in Sindh and only 33 percent in Balochistan.

Table 2. Percentages of Women's Decision Making and ICT Penetration.

	Punjab Role in Decision Making		Sindh Role in Decision Making		Khyber Pakhtunkhwa Role in Decision Making		Balochistan Role in Decision Making	
	No	Yes	No	Yes	No	Yes	No	Yes
Women Decision Making Regarding Household Expenditure								
Urban	35	65	65	35	65	35	91	9
Rural	42	58	74	26	63	37	96	4
Women Decision Making Regarding Having More Children								
Urban	27	73	37	63	25	75	67	33
Rural	31	69	49	51	39	61	72	28
ICT Penetration								
Urban	43	57	43	57	45	55	63	37
Rural	66	34	89	11	61	39	86	14

Interestingly, Table 2 shows that ICT penetration is the same in urban areas of Punjab and Sindh, at 57 percent. However, in rural region of Punjab, 34 percent of women have access to ICT compared to 11 percent in rural Sindh. In urban regions of Khyber Pakhtunkhwa, 55 percent of women have access to and use of ICT, while in urban Balochistan, this figure stand at 37 percent.

Figures 2 and 3 provide a graphical representation of women's decision-making power regarding household expenditure and their decision-making power regarding having more children, with women's access to ICT at provincial level. In Figure 2, women's access to ICT is measured on the x-axis, and women's decision-making power regarding household consumption expenditure is measured on the y-axis. In Punjab, 63 percent of women with access to ICT have decision-making power regarding household expenditure, leading in decision-making power compared to the other provinces. In contrast, women in Balochistan who have the least access to ICT, exhibit only 7 percent decision-making power regarding household expenditure. The findings of the study highlighted that Baochistan is furthest behind in achieving the SDGs Agenda 2030 among all provinces.
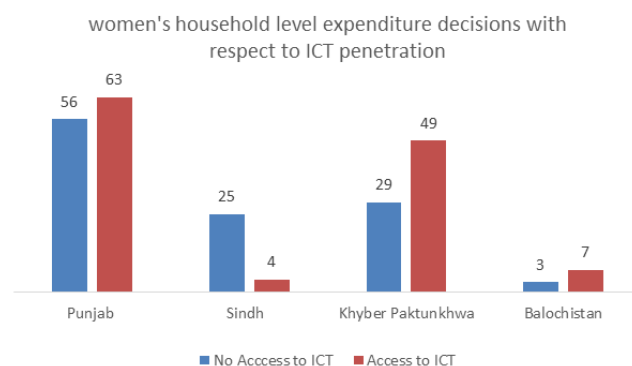

Figure 2. Percent of women's decision-making power regarding expenditures with access to ICT.

In Figure 3, the use of ICT is measured on x-axis while women's decision-making power regarding having more children is measured on the y-axis. The figure reveals that women from Punjab and Khyber Pakhtunkhwa have grater decision-making power regarding having more children, with 71 percent and 72 percent, respectively, when they have access to ICT. However, women from Sindh and Balochistan, who have less access to ICT exhibit the lowest decision-making power in decision about having more children.
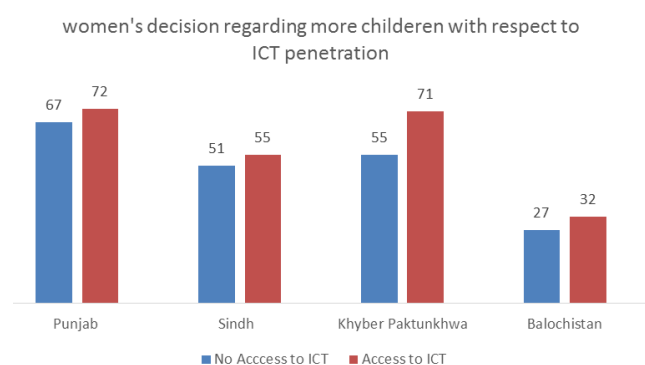
Figure 3. Percent of women's decision regarding having more children with reference to access to ICT.

The Odds Ratio represents the measurement of association between odds of the dependent variable and the independent variable. The study estimates the two models: Model I examines household expenditures, while Model-II assesses decision-making regarding having more children. The find-

ings indicate that the odds of having decision-making power are 1.4 times higher for women with access to ICT. This demonstrate a positive and significant association between the ICT index and women's decision-making power regarding the household expenditure, highlighting the robust effect of ICT on women's decision-making power regarding expenditure.

The analysis reveals that women in Punjab have three times higher odd of having decision-making power regarding household expenditure compared to women in Khyber Pakhtunkhwa, with a positive and significant association. In contrast, the odds for Sindh and Khyber Pakhtunkhwa are approximately equal to, with statistically insignificant results. However, women in Balochistan exhibits lower odds than Khyber Pakhtunkhwa, consistent with the findings from previous studies [13, 14].

Additionally, the estimated results highlight that education significantly enhanced women's decision-making power. Women with any level of education have considerably higher odds of being empowered compared to those with no education.

Table 3. Logistic Regression Model on Women's Decision-Making Power.

CONSUMPTION EXPENDITURE INDEX Model-I					HAVING MORE CHILDREN Model-II			
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
ICT index	1.41***	0.000	1.71***	0.000	1.31***	0.000	1.68***	0.000
Province								
Punjab	3.12***	0.000	4.01***	0.001	1.1	0.48	1.24*	0.068
Sindh	0.961	0.61	0.88	0.399	0.63***	0.001	0.7***	0.009
Balochistan	0.35***	0.001	0.17***	0.002	0.34***	0.001	0.28***	0.001
Province*ict								
Punjab*ict			0.67***	0.005			0.763*	0.087
Sindh*ict			1.13	0.7			0.86	0.423
Balochistan*ict			3.07***	0.005			1.17	0.592
Region								
Urban	1.11	0.14	1.11	0.201	1.14**	0.026	1.31***	0.003
Region*ict								
Urban*ict			0.99	0.503			1.34***	0.003
Education								
Primary	1.3**	0.044	1.131**	0.04	1.16	0.264	1.2	0.261
Secondary	1.44***	0.004	1.51***	0.004	1.31**	0.041	1.3**	0.044
Higher	1.31	0.1	1.33	0.093	1.35**	0.049	1.36**	0.047
relation with head								
Spouse	0.24***	0.001	0.241***	0.001	1.92***	0.003	1.9***	0.003

CONSUMPTION EXPENDITURE INDEX Model-I				HAVING MORE CHILDREN Model-II			
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Other	0.42***	0.001	0.414	0.001	1.61**	0.033	1.59**	0.037
Income	1	0.11	1*	0.09	1***	0.003	1***	0.002
employed								
Yes	1.11	0.13	1.11	0.18	1.2	0.937	1.17**	0.047
	CONSUMPTION EXPENDITURE INDEX				HAVING MORE CHILDREN			
number of boys								
1 –4	1.21**	0.023	1.71**	0.023	1.32***	0.000	1.32***	0.001
5 –9	1.23**	0.031	1.23**	0.028	1.52***	0.000	1.51***	0.001
number of girls								
1–4	0.95	0.454	0.95	0.473	1.41***	0.001	1.41***	0.001
5 –9	0.91	0.415	0.94	0.472	1.25	0.022	1.31**	0.023
Age								
25–34	1.1	0.556	1.05	0.563	1.23*	0.068	1.16*	0.075
35–44	1.3***	0.009	1.3**	0.01	0.89	0.264	0.89	0.246
45–54	1.34**	0.013	1.34**	0.01	0.488**	0.001	0.48***	0.000
Constant	0.84	0.52	0.74	0.3	0.64	0.118	0.561**	0.045

***if p-value <0.01, ** if p-value< 0.05, and * if p-value <0.1

Our findings are consistent with previous studies [7-9, 12]. It is observed that woman's relationship with the household head is positively and significantly associated with the household expenditure. Furthermore, the results also shows that if woman herself is the household head, the odds of her decision-making power regarding household expenditure increase, consistent with previous studies [2, 13, 21].

Moreover, having a male child significantly and positively impact on women's decision-making power, with odds are 1.2 to 1.3 times higher than for women who do not have a son. Similarly, the odds favors women in the age group 34 to 54 compared to those aged 15-24, indicating that older women are more empowered than younger women in a society like Pakistan, where the joint family system prevails [3, 14, 21].

From Table 3 (Model-II), it is evident that the odds ratio of the ICT index in favor of women's decision-making power regarding having more children is 1.68. It shows that access to and the use of ICT enhances women's decision-making power and contributes in fostering the process of achieving SDGs Agenda 2030, as the study taken the women's decision-making power on having more children is considered a proxy for women's empowerment. The ICT index shows a robust, positive, and highly significant association with women's decision-making power regarding having more children.

The results of Table 3 illustrate that when the response variable is women's decision-making power regarding household expenditure, if the husband and other family members head the household, the odds of women's decision-making power decrease by 0.24 and 0.42 times, respectively. This can be interpreted as each additional male head of household being associated with a 0.24 times decrease in the odds of women's having decision-making power regarding household expenditure. Conversely, in the case of women's decision-making power regarding having more children, the odds increase by 1.9 times and 1.6 times if the husband and other family members head the household.

At the provincial level, women in Punjab have 1.24 times higher odds of decision-making power regarding having more children compared to women in Khyber Pakhtunkhwa. Conversely, women Sindh and Balochistan exhibit lower odds compared to those in Khyber Pakhtunkhwa, highlighting significant provincial disparities, results are consistent with previous studies [4, 19, 21]. Additionally, regional differences play a significant role, with urban women having 1.3 times more odds than rural women in decision-making power regarding having more children. This indicates that urban women are more empowered than their rural counterparts [1, 3, 18].

Access to resources and control over income are considered

essential prerequisites for empowerment [2, 5, 20]. The analysis reveals that income has positive and significant impact on women's decision-making power regarding having more children.

Additionally, the number of boys and girls in the family a positively and significantly affects women's decision-making power about having more children. This suggest that family composition plays critical role in shaping women's autonomy, the findings are consistent with previous studies [2-4].

The model used in this study a discrete variable regression, where the goal is to predict a binary (0-1) outcome base on given predictors. While classification problems like this are often addressed using logit or probit models, these model may sometimes show that certain variables are only marginally significant, particularly when the variables are categorical, such as region, provinces, education, and employment. In such cases, CART model is helpful alternate as it identifies the most influential predictors compared to those located at the bottom branches.

Classification Tree for Consumption Punjab

Figure 5. CART model for decision regarding expenditure (Punjab).

Classification Tree for Consumption KhyberPakhtunKhwa

Figure 6. CART Model for Decision Regarding Expenditure (Khyber Pakhtunkhwa).

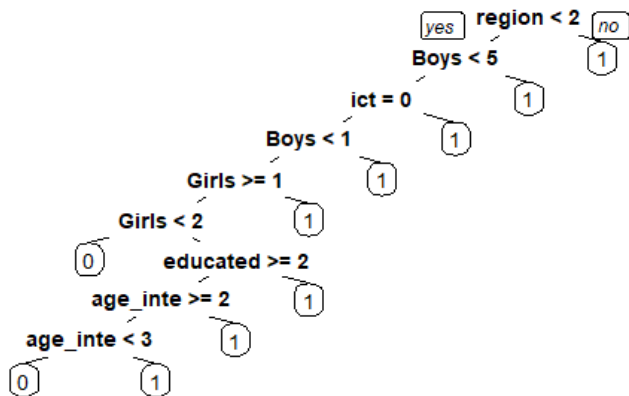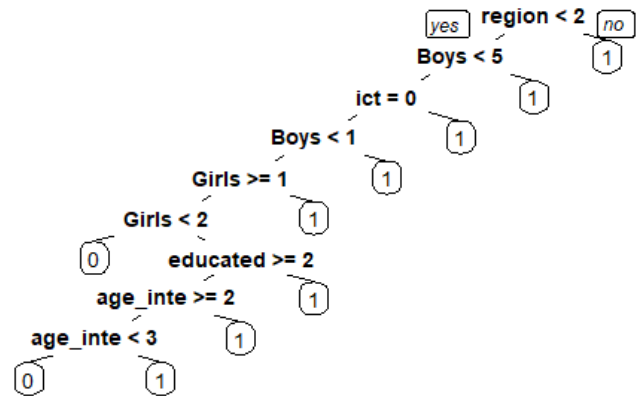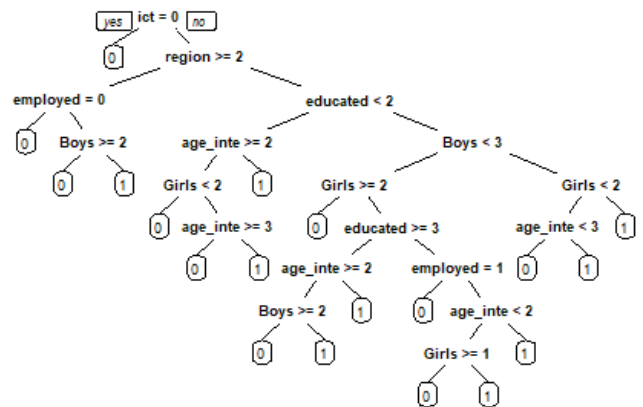## Classification Tree for Consumption Punjab

Figure 4. CART Model for Decision Regarding Expenditure (Punjab).

The classification tree for women's decision-making power regarding household expenditure in Punjab, illustrate in Figure 4, shows that region is the most important predictor. Urban women in Punjab are more empowered than rural women. The tree further splits based ib factors such as the number of boys in the family, access to ICT, the number of girls, education, and age.

Women in Punjab, who have sons, are educated and using ICT are further ahead than those who live in rural areas and do not have access to ICT. This indicated that rural women in Punjab are furthest behind in terms of empowerment and achieving the SDGs Agenda 2030.

Figure 6 illustrates women's decision-making power regarding the expenditure index for Khyber Pakhtunkhwa, as analyzed using the CART model. The results indicate that the ICT index is the most important and significant predictor for women who residing in urban area and those who employed. The subsequent splits in the decision tree are based on factors such as the level of education, the age of women, and the number of boys and girls in the family.

Figure 7 presents the classification tree for women decision-making power regarding household expenditure in Sindh. The analysis reveals that ICT index is the most important predictor for women decision-making power. Then the branches in the tree further split base on the number of girls and boys in the family and by the age of the women.
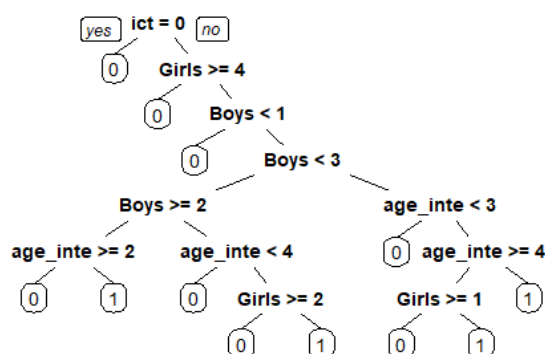
Classification Tree for Consumption Sindh

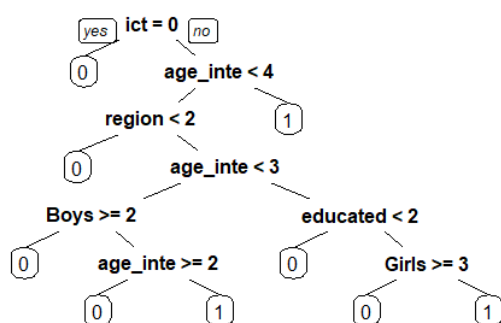*Figure 7. CART model for decision regarding expenditure (Sindh).*

Classification Tree for Consumption Balochistan

Figure 8. CART model for decision regarding expenditure (Balochistan).

Figure 8 indicates that in Balochistan, age and region are the most important predictors, after ICT, for whether women have a say in decisions about household-level expenditures. The branches of trees further split based on the number of girls, boys, and education level of women.
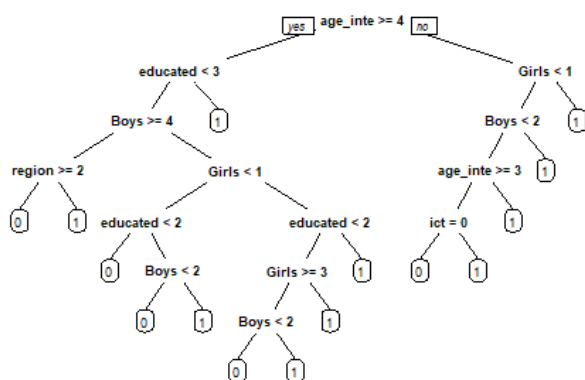
Classification Tree for Having Child for Punjab

Figure 9. CART Model desire for having more children (Punjab).

Figure 9 shows the classification tree for decisions regarding having children among women living in Punjab. From the branches of tree, it is predicted that older women have more decision-making power. The node further split based on the number of boys and girls in the family, with region being the fourth most important indicator predictor. Urban women have more say to yes for decisions regarding having more children.
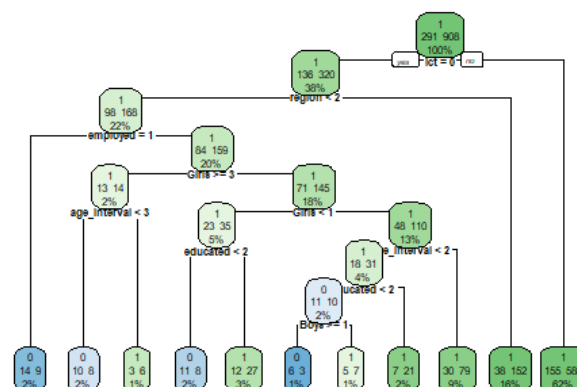
Classification Tree for having child for KP

Figure 10. CART Model desire for having more children (Khyber Pakhtunkhwa).

Figure 10 presents the classification tree for women's decision regarding having more children in Khyber Pakhtunkhwa. The ICT index, is the most significant predictor, follow by the region. The split node for the region. Women living in urban areas of KP with access to ICT and employment have more decision-making power. The second most important indicator is the number of girls in the family. If there are three or more girls are three or more then the next important node is the age interval which should be between 15 to 33 then women have decision-making power regarding having more children.

Classification Tree for Having Child for (Sind)

Figure 11. CART Model desire for having more children (Sindh).

Figure 11 presents the CART model for Sind, showing that the most significant predictor for women's decision to have more children is age, with women aged 30 having more decision-making power. The second most important predictor is the region, where urban women in Sindh are more empowered to make decisions regarding having more children.

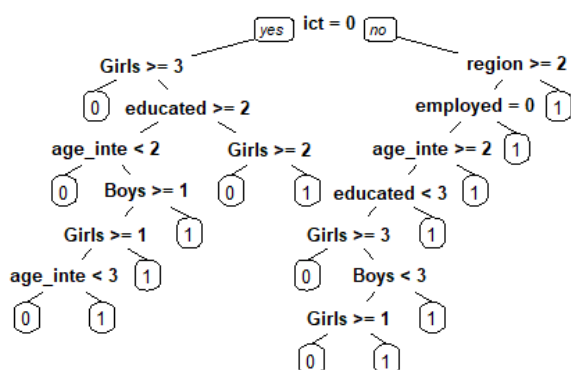**Classification Tree for Having Child (Balochistan)**

Figure 12. CART Model desire for having more children (Balochistan).

Figure 12 illustrates the decision-making tree for women living in Balochistan. The CART model depicts that ICT is the most important variable influencing women's decisions regarding having more children. The tree then split based on the number of girls in the family, with women who have three or more girls being more likely to make decisions about having more children. The tree further split based on education level, number of boys, and age. Women with secondary or higher education, more than one boy in the family, and aged between 30 to 50 are more likely to have decision making power regarding having more children.

6. Conclusion

The present study investigates the impact of ICT and other socio-demographic factors on women's decision-making power regarding household expenditure (food, clothing, health, travel, and recreation) and decision about having more children. The data from Household Integrated Economic Survey (HIES) for the year 2018-19 was analyzed using the CART technique and binary logistic regression analysis. For the analysis, two indices were constructed: the expenditure index and the ICT index.

From the study, it has been found that women in Punjab have more decision-making power and better access to ICT as compared to women in Khyber Pakhtunkhwa, Sindh, and Balochistan. The classification tree identifies ICT as the most predictive variable for decision-making power, followed by region, age, education and employment status. In

Sindh, ICT is the primary predictor for women's decision-making power regarding household expenditure, with further splits based on the number of children and then the age. Likewise, in Khyber Pakhtunkhwa, the most important predictor is ICT then employment status, and education, respectively. Therefore, in Khyber Pakhtunkhwa, women who use ICT, live in urban areas, are educated, and are employed having greater decision-making power. Surprisingly, also in Balochistan ICT is the most important and significant predictor of women's decision-making power regarding household expenditures.

The findings of the study support the policies in favor of ICT penetration and improving women's access to education and employment opportunities to enhance women's autonomy in Pakistan. Moreover, the study suggest that ICT access could serve as an effective indicator of women's empowerment in the country. Furthermore, from the findings, the study could suggest that ICT access for women may be a good measurement tool for women's empowerment in Pakistan.

Abbreviations

AI	Artificial Intelligence
CART	Classification and Regression Tree
ELMPS	Egyptian Labour Market Panel Survey
HIES	Household Integrated Economic Survey
ICT	Information Communication and Technology
ITU	International Telecommunication Union
MCH	Maternal and Child Health
MDGs	Millennium Development Goals
PSLM	Pakistan Social and Living Standards Measurement Survey
SDGs	Sustainable Development Goals

Author Contributions

Amna Noor Asim: Conceptualization, Formal Analysis, Methodology, Writing – original draft

Zahid Asghar: Investigation, Software, Supervision, Validation

Haroon Sarwar Awan: Data curation, Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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