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Multidimensional Poverty of Housing Quality: A Spatial Analysis for Districts of Pakistan

***Dr. Muhammad Jamil**

Abstract: An increase in living standards and housing quality is impossible without improving the housing quality. Housing quality provides many aspects of shelter and peace of mind. The present study used the quality of housing as an indicator of living standards and explored the deprivation in housing quality based on internal and external dimensions. These dimensions include indicators representing internal and external conditions, public provisions of the housing facilities available to the community, and users' perceptions of these facilities. For all this, we aim to create an index of multidimensional poverty for the quality of housing using the Alkire and Foster methodology (AF). The analysis is carried out for the Pakistan Social and Living Standards Measurement (PSLM) data, 2019-20. Regional decomposition of the index with spatial analysis is another study contribution. Regional decomposition of the index is the strength of the study.

1. Introduction

The global population is living in a shelter called a "flat" or "house". The shelter is also important for living, along with clothing and food requirements. The wellbeing of the individuals is subject to improvements in these. In addition to providing shelter, housing has an important bearing on work performance, educational attainment, national health, and the upbringing of the children (Bielestein, 1973). In developing countries like Pakistan, the unavailability of housing facilities for a low-income population group is an issue that is becoming swear with the addition of shortfall every year. According to Hussain (2007), Pakistan experienced an increase of 400,000 urban units' shortfall in Pakistan every year.

Similarly, the Human Rights Commission of Pakistan (2005) stated that over 60,000 people slept out in the open sky throughout the year in Lahore (the second largest city in Pakistan). According to the report, similar numbers are observed in other big cities in Pakistan. Along with the

*Professor of Economics, Ghulam Ishaq Khan Memorial Chair (SBP), Kashmir Institute of Economics, The University of Azad Jammu & Kashmir, Muzaffarabad. email: m.jamil@ajku.edu.pk

shortage of housing facilities, the quality of living standards in the existing houses is another issue.

Providing adequate housing facilities is an integral part of any meaningful economic development program. In recent years, different private housing authorities have provided quality housing in Pakistan. However, Cowasjee (2004) reported that the building control authorities violated the bylaws of private and cooperative building societies. Continuous violations of bylaws have contributed to the gradual transformation of cities into a jungle of low-quality housing without considering the negative effects on the environment and the citizens of the city. Many studies reported that low housing quality is associated with many stresses, deprivations, and infectious diseases (Loring, 1964; Martin, 1967; Mitchel, 1971; Bashir, 2002; Krieger & Higgins, 2002; Cattaneo et al., 2009; Irfan et al., 2017; Bah et al., 2018).

Studies have revealed that Pakistan, in general, and big cities, in particular, are experiencing problems related to low governance for housing policy, old housing standards, and no special consideration for housing quality. The quality of a house can be measured through the house's structure, facilities available in the house, and locality. Another factor contributing to the low quality of housing in the urban region is rapid urbanization. United Nations-Habitat (2007) reported that due to this high urbanization rate, the developing world's urban population will reach approximately six billion people by the end of 2050. This increase in population will put pressure on the existing housing supply, which may result in expensive and compromised housing facilities.

The term 'housing deficit' is repeatedly used in policy papers, academic papers, and newspaper articles. In academic literature, housing deficit can be divided into two categories: quantitative and qualitative. A quantitative housing deficit refers to a numerical shortfall in housing units. On the other hand, qualitative housing deficit refers to households living in sub-standard houses based on the locality of the houses, access to basic services, and condition of housing units (Bouillon, 2012; Bah *et al*., 2018; World Bank, 2020, Saiz et al., 2022). The present study intends to estimate the qualitative housing deficit.

Physical housing features, like the type of construction, location, habitation density level, and services available in the house, are significantly important. The study considers problems related to housing quality in different regions of Pakistan. The study measures an index for housing quality through deprivation scores related to the house's structure, deprivation scores related to facilities available in the house, and deprivation scores related to the locality of the house. Along with this, the study aims to estimate the determinants of high-quality housing.

Following the section of the introduction, section 2 presents the reviewed literature, section 3 presents the issues related to data and methodology and discusses in detail the construction of a multidimensional poverty index for housing, section 4 presents the results and their discussion, and section 5 presents the conclusion of the study.

2. Review of Literature

The standards for the definition of qualitative housing deficit vary significantly. Many studies used population density, deficiencies in infrastructure, and houses built with inadequate materials. Along with these aspects, studies extended the definition by adding other aspects such as telephone coverage (Lora et al., 2000), insecurity of tenure (UN-Habitat and UN-OHCHR, 2019), location and accessibility to markets (Acolin & Green, 2017). Table 1 presents indicators used by various studies for qualitative housing deficit.

Another way to estimate the qualitative housing deficit is through the households' satisfaction with their homes. A perception-based survey is conducted by Gallup (2021). The results based on the survey highlighted differences across countries regarding satisfaction levels. This indicates that the housing market varies across the world.

The estimates of the quality of housing very much depend upon the definition chosen for the analysis. A recent study analyzing the qualitative housing deficit in Peru (World Bank et al., 2021) shows that the housing deficit is equivalent to 23 percent of Peru's existing housing stock. The deficit could rise to 68 percent when a stricter definition of housing

adequacy is used for the analysis. Tusting et al. (2019) analyzed the improvement in housing quality between 2000 and 2015 in Sub-Saharan Africa. The authors reported an improvement in housing quality from 11 to 23 percent. On the other hand, in a recent study, Brown et al. (2020) assessed the home environments for protection from COVID-19 in developing countries. The study shows that to protect from the virus, 90 percent of the global poor are unable to comply with recommendation by the WHO fully.

The literature indicates that housing quality significantly affects socioeconomic outcomes, including education, health, social belonging, emotional wellbeing, political participation, job creation, and economical attainment (Thomson et al., 2009; World Health Organisation, 2018). Studies established a positive link between piped water and life satisfaction and improvements in overall wellbeing (Kremer et al., 2011; Devoto et al., 2012). Studies indicate that piped water helped to reduce diarrhea prevalence and mortality in young children (Jamison et al., 1993; Jalan & Ravallion, 2003; Galiani et al., 2005; Nabassaga et al., 2019).

Table 1: Indicators for the qualitative housing deficit

Reference	Indicators
Abdul-Rahman et al. (1998)	1. Layout of the flat (living area, kitchen, bathroom, bedrooms, balcony). 2. Workmanship (installation of ceiling, door, window, tiling, painting, plumbing work, electric wiring) 3. Garbage Collection System. 3. Environmental Conditions (air quality, noise traffic congestion). 4. Appearance/design 5. Internal Conditions (lighting, ventilation, and temperature). 6. Accessibility (shops, school, market, parking plots, playground/park).
Department of Housing and Urban Development (2004)	1. Sanitary facilities; 2. Food preparation and refuse disposal; 3. Space and security; 4. Thermal environment; 5. Illumination and electricity; 6. Structure and materials; 7. Interior air quality; 8. Water supply; 9. Lead-based paint; 10. Access; 11. Site and neighborhood; 12. Sanitary conditions; 13. Smoke detectors
Scotland Housing Quality Standards (2007)	1. Above the tolerable standard; 2. Free from serious disrepair; 3. Energy efficient; 4. Modern facilities; 5. Healthy, safe, and secure.
Housing Corporation England (2007)	1. Internal environment (size, layout, service provision); 2. Sustainability; 3. External environment (building for life)

Building Research Establishment, London (2007)	1. Exterior architecture; 2. Internal fabric finishes; 3. Electrical design systems; 4. Summertime overheating; 5. Sustainability; 6. Site planning; 7. Outer material; 8. Sourcing of repairable items; 9. Visual environment; 10. Maintainability; 11. Interior design; 12. External and internal details; 13. Air quality; 14. Space planning; 15. Junction detail; 16. Heating comfort
Chohan et al. (2015)	1. Architecture and site planning; 2. Structure; 3. Construction; 4. Building Services 5. Health safety & security; 6. Users' comfort; 7. Maintenance; 8. Sustainability
UN-Habitat (2016)	1. Access to improved water; 2. Access to improved sanitation facilities, 3. Sufficient living area, 4. Structural quality/durability of the housing unit, 5. Security of tenure
Tusting et al. (2019)	1. Quality of water and sanitation; 2. Sufficient living area; 3. Durable construction
World Bank (2021)	1. Access to improved water; 2. Access to improved sanitation; 3. Adequate living space; 4. Durable material and good structural quality; 5. Security of Tenure; 6. Access to electricity; 7. Access to clean cooking

Similarly, other studies established the positive impact of improved sanitation and health outcomes, especially in children (Duflo et al., 2015). Durable structure quality has positively affected overall health and adult welfare and negatively affected child mortality (Cattaneo et al., 2009; Bah et al., 2018). Studies reported the negative effects of overcrowding on health (Bashir, 2002; Krieger & Higgins, 2002; Cattaneo et al., 2009; Irfan et al., 2017). The overcrowding also causes the underdevelopment of children because of a lack of privacy (Goux & Maurin, 2005; Evans, 2006).

Several studies tried to estimate housing poverty or housing inadequacy, or housing quality in Pakistan (Sandhu, 1972; Ashfaq, 1974; Chhattari, 1978; Farooq, 1978; Zaki, 1981; Cowasjee, 2004; Hussain, 2007; Chohan et al., 2015; Ijaz & Rashid, 2015). These studies used one or a few indicators for the deprivation in housing quality. None of these studies tried to estimate housing quality at the district level. Based on the reviewed literature, several gaps emerge. The present study contributes to the existing literature in several ways. First, it provides a detailed review of existing literature on methods of estimating poverty in housing quality. Second, the study proposes a new method to estimate multidimensional poverty in housing quality. Third, it adds to the literature that estimates multidimensional poverty for Pakistan, its provinces, rural and urban regions, and its districts.

Fourth, the study decomposes the multidimensional poverty in housing in Pakistan to determine the contribution of different regions and dimensions. Fifth, mapping of the estimates of multidimensional poverty is carried out in the paper for spatial analysis.

3. Methodology

The term standard of living is observed in the scientific and common language. Because of its use in multiple disciplines, there are many definitions of standards of living. According to Czeslaw and Leszek (1999), the standard of living is represented by the degree to which human needs are satisfied, which results from the consumption of material goods and services and from using the amenities of both the natural and social environment.

The present study analyzed the multidimensional poverty for housing quality in districts of Pakistan by measuring, decomposing, and representing on a geographical map to conduct the spatial analysis. Section 3.1 presents the steps involved in measuring multidimensional poverty for housing quality. Section 3.2 discusses the procedure for decomposing the multidimensional poverty index of housing quality.

3.1. Measure of Multidimensional Poverty for Housing Quality

Various studies used aggregation of different adequacy dimensions to measure housing quality (see Table 1). The present study used ten dimensions to measure multidimensional poverty in housing quality. The Alkire-Foster method developed by Alkire and Foster (2011) measures the multidimensional poverty index for housing quality. Steps, based on the Alkire-Foster method, for the estimation of MPI for the quality of housing in Pakistan and its districts are as under:

Step 1 - Unit of Analysis: The present study used household as the unit of analysis to estimate the multidimensional poverty in housing quality for the district of Pakistan.

Step 2 & 3 - Dimensions & Indicators: Based on the literature on housing quality, the present study used ten dimensions to calculate the MPI for

housing quality. Overall, twenty indicators are used for these dimensions. Detail of these dimensions and indicators is presented below:

- **D_1 – own:** Ownership of the house;
- **D_2 – den:** Population Density (ratio of HHS and number of rooms); The study used overcrowding (more than three people occupying a room; UN-Habitat, 2007)
- **D_3 – inf:** Structure of the house (material used in floor, walls, and roof);
- **D_4 – ene:** Modern energy sources availability (fuel for cooking, heating, lighting);
- **D_5 – dwa:** Drinking Water Availability (Drinking water source, Time takes to get the water, the distance of the water source, Sufficient availability of water);
- **D_6 – wcw:** Water for Cooking and Washing (Water source for cooking and washing);
- **D_7 – toa:** Toilet Availability (Flush Available, Sharing toilet with a non-member of the household);
- **D_8 – gco:** Garbage Collection System (Garbage collection facility at home, Time required to dispose of the garbage);
- **D_9 – mcs:** Availability of Modern Communication Services (Availability of internet or landline at home);
- **D_{10} – cln:** Cleanliness inside the home (Place for hand washing in the house)

$$x_{ij} \subset \mathbb{R} \quad \forall \quad i = 1,2,\dots,n \quad \& \quad j = 1,2,\dots,d \tag{1}$$

Where x_{ij} represents indicator x in dimension j for household i.

Step 4 & 5 – Deprivation Cutoffs & Calculate deprivation in each dimension: For the identification, if the household is poor or not poor, we set the threshold, also called as "poverty line" or "deprivation cutoff (Z_j). A household is said to be poor or deprived in any indicator if $x_{ij} < Z_j$, otherwise, they are categorized as non-poor or not deprived. The deprivation cutoffs are summarized in vector Z. We assign a "deprivation status score" g_{ij} to each household in each dimension based on their deprivation status. Here, g_{ij} is equal to 1 if household i is deprived in

dimension j. If household i is not deprived in dimension j then g_{ij} is equal to 0.

$$g_{ij} = \begin{cases} 1 & x_{ij} < Z_j \\ 0 & otherwise \end{cases} \quad (2)$$

Figure 1 presents the deprivation of the household in case of the availability of a toilet in the house. Figure 2 presents the deprivation of the household in case of the availability of a clean water facility. The household is considered non-poor in this dimension if the government does not provide water or it is not accessible within a short time or distance. Similarly, deprivation in other dimensions is determined, and a value of 1 is assigned if deprived and 0 otherwise. Likewise,

Step 6 – Weights to each dimension: Normalized weights w_j to each dimension of housing quality d_j is assigned.

$$w_j > 0 \qquad \sum_{j=1}^{d} w_j = 1 \quad (3)$$

Step 7 – Weighted sum of deprivation status scores: Weighted sum of deprivation status scores of each household in all dimensions d are used to identify whether the household is poor or not poor. An overall "deprivation score" for each household i is computed by adding the deprivation status scores of all dimensions, each multiplied by their corresponding weights.

$$c_i = \sum_{j=1}^{d} w_j \, g_{ij} \qquad c_i \in [0,1] \quad (4)$$

To calculate the MPI for housing quality, the present study used equal weights for each of its ten dimensions.

Step 8 – Poverty cut–off and identification of poor: The poverty cutoff "k" reflects the minimum deprivation score a household must be suffering simultaneously to be considered poor. In the literature, there are three approaches to setting the poverty cutoff. The union approach identifies

people as multidimensionally poor if they experience at least one measured deprivation. For the union approach, according to Atkinson (2003), poverty cutoff "$0 < k \leq \min\{w_1, w_2, \ldots, w_d\}$" The intersection approach identifies as poor only those households who are deprived in all the indicators simultaneously. For the intersection approach, the poverty cutoff is $k = 1$. The Alkire-Foster method uses a dual cutoff approach, which sets a poverty line 'k' that can range between 1 and a total number of indicators included in the measure. Poverty cutoff k is set to identify the poor. A household is said to be poor if $c_i \geq k$. Otherwise, the household is identified as non-poor. Like Alkire and Foster (2011), the present study used conventional cutoffs of 33.33% and 66.66% to identify the poor.

$$P_i = \begin{cases} 1 & c_i \geq k \\ 0 & otherwise \end{cases} \quad (5)$$

Where, P_i represents the poverty of a household i having a value of 1 if the household is multidimensionally poor and 0 otherwise.

Step 9 – Head Count Index for housing quality (H): Head Count Index for housing quality (H) is obtained by dividing the number of poor people (n_P) with the total population (N).

$$H = \frac{n_P}{N} \quad (6)$$

H is a useful measure, but it does not increase if a household becomes more deprived in any dimension, nor can dimensions break it down to analyze how poverty differs among groups. For this reason, we used an adjusted multidimensional poverty index.

Step 10 – Average Poverty Gap (A): According to the focus Axiom, while measuring poverty, the focus should remain only on those identified as poor. The average poverty gap is the average number of deprivations a poor household suffers in terms of housing quality. It is calculated by adding the proportion to each person's total deprivations and dividing it by the total number of poor persons. Simply put, it is the average of the deprivation

scores among the poor only. This also reflects the intensity of poverty. Technically, this enables us to obtain the censored deprivation score vector $c(k)$ from c, such that $c_i(k) = c_i$ if $c_i \geq k$. Otherwise, $c_i(k) = 0$.

$$A = \frac{1}{n_P}\sum_{i=1}^{n} c_i(k) \quad (7)$$

Step 11 – Adjusted Multidimensional Poverty Index for Housing Quality (M_0): Adjusted Multidimensional Poverty Index M_0 for housing, quality is calculated as the product of two components: the share of the population who are multidimensionally poor or multidimensional headcount ratio (H), and the average of the deprivation scores among the poor only, or the intensity of poverty (A).[1] Technically, this can be written as:

$$M_0 = MPI = H \times A = \frac{n_P}{N} \times \frac{1}{n_P}\sum_{i=1}^{n} c_i(k) \quad (8)$$

Equation (8) indicates that a reduction in M_0 for housing quality is possible either by reducing H or by reducing A. If the reduction in M_0 occurs simply by reducing the number of people who are marginally poor in living standards, then H decreases and A may not. On the other hand, if a reduction in M_0 occurs by reducing the deprivation of the poorest of the poor, then A decreases, but H may not. M_0 can also be obtained as the average of censored deprivation scores.

$$M_0 = \frac{1}{n}\sum_{i=1}^{n} c_i(k) \quad (9)$$

[1] Adjusted Head Count Ratio (M_0) can be calculated with ordinal as well as cardinal data. However, cardinal data are required to calculate Adjusted Poverty Gap (M_1) and Adjusted Squared Poverty Gap (M_1). In the present study, we have only ordinal data for indicators of the housing quality.

The present used the above-stated procedure to calculate the multidimensional poverty in housing quality for overall Pakistan, provinces of Pakistan, rural-urban regions of Pakistan, and districts of Pakistan.

3.2. Decomposition of M_0

Adjusted Multidimensional Poverty index for housing quality can be decomposed into different regions. This is possible because the entire population can be divided into m mutually exclusive and collectively exhaustive groups. In this case, M_0 can be expressed as the weighted average of the M_0 values of m subgroups, where weights are their respective population shares. We denote the population, achievement matrix, and the adjusted headcount ratio of subgroup s by n^s, X^s, and $M_0(X^s)$, respectively. Consequently, the overall M_0 can be expressed as:

$$M_0 = MPI = \sum_{s=1}^{m} \frac{n^s}{n} M_0(X^s) \quad (10)$$

This subgroup decomposability helps us to understand the contribution of different subgroups to overall poverty (contribution of provinces to overall multidimensional housing poverty of Pakistan, contribution of rural and urban regions to overall multidimensional housing poverty of Pakistan, contribution of districts to overall multidimensional housing poverty of Pakistan). Here, we can observe that the contribution of a subgroup to overall multidimensional poverty of housing quality depends on the poverty level of the subgroup and its population share.

Further, we can decompose the multidimensional poverty in housing to see the contribution of each indicator to overall poverty. For this, first, the censored headcount ratio of an indicator (h_j) is obtained as the proportion of the population which is multidimensionally poor and is simultaneously deprived in the indicator in question. By property, M_0 can be expressed as an average of the censored headcount ratios of indicators according to their relative weights.

$$M_0 = MPI = \sum_{j=1}^{d} W_j \, h_j = \sum_{j=1}^{d} W_j \left[\frac{1}{n} \sum_{i=1}^{n} g_{ij}(k) \right] \quad (11)$$

Where, $g_{ij}(k) = g_{ij}$ if $c_i \geq k$. Otherwise, $g_{ij}(k) = 0$. Then the contribution of indicator j (ϕ_j) to M_0 can be written as:

$$\phi_j = W_j \frac{h_j}{MPI} = W_j \frac{h_j}{M_0} \quad (12)$$

The present study decomposed the contribution of each dimension in the overall multidimensional housing poverty of Pakistan, the overall multidimensional housing poverty of rural and urban regions, and the overall multidimensional housing poverty of districts of Pakistan.

Data from the Pakistan Social and Living Standard Measurement (PSLM) survey for 2019-20 issued by the Pakistan Bureau of Statistics (PBS) is used for empirical analysis. The PSLM survey is district representative and contains data from 160654 households.[2] Figure 3 presents the geographical boundaries of the provinces and districts of Pakistan. Gilgit-Baltistan, Azad Kashmir, and India-administered Kashmir are not part of the analysis because of the unavailability of the data.

Figure 4 presents the population share of each district of Pakistan. Districts shaded with light yellow indicate a low level of population share, whereas districts shaded with dark green indicate a high level of population share. Districts of Punjab relatively have more population share compared to districts of Khyber Pakhtunkhwa (KP), Sindh, and Balochistan. According to PSLM 2019-20, 53.4 percent of the households are from Punjab, 26.5 percent are from Sindh, 14.6 percent are from KP, and 5.5 percent are from Balochistan.

4. Results

Households' decision about housing is not about the shelter but also about providing comfort to them and their family members. For this, a house should have some basic level of facilities. The availability of these facilities

[2] List of the districts is provided in Appendix A.

defines the quality of housing. The housing quality across all Pakistan regions is not the same. The present study calculated the multidimensional poverty index for housing quality across different regions of Pakistan.

Figure 4 presents the MPI for housing quality in Pakistan and its provinces. Multidimensional poverty in housing is highest in Balochistan, followed by KPK, Punjab, and Sindh. Likewise, the adjusted multidimensional poverty index is highest for Balochistan, followed by KPK, Sindh, and Punjab. The ranking of deprivation in housing across provinces is the same as the estimates of income poverty across these provinces (In 2018-19, poverty at the national level stood at 21.5%, whereas in Balochistan, it was estimated at 40.7%, KPK 27%, Sindh 24.6%, and Punjab 16.3%).

On the other hand, looking at the contribution of the provinces to national poverty, the contribution is highest for Punjab, followed by Sindh, KPK, and Balochistan. This is because of the high population shares of Punjab and Sindh in the overall population of Pakistan. The ranking of these provinces for multidimensional poverty is the same when a cutoff of 0.6666 is used. This indicates that multidimensional poverty is highest for Balochistan, but its contribution to the multidimensional poverty of Pakistan is very low. On the other hand, multidimensional poverty is lowest for Punjab, while its contribution to Pakistan's multidimensional poverty is highest compared to other provinces.

Comparing multidimensional poverty in the housing of rural and urban regions of Pakistan, more than 80% of the households are multidimensionally poor in rural regions, and 38% of the urban regions are multidimensionally poor. The ranking for rural and urban regions of Pakistan is the same for the adjusted multidimensional poverty index. Looking at the contribution of these regions in multidimensional poverty for housing quality in Pakistan, the contribution is highest for rural regions, whereas it is lowest for urban regions. The results reveal that infrastructure development and availability of services in houses are highest for urban regions and lowest for rural regions.

Looking at the contribution of various dimensions in the multidimensional poverty of housing, the structure of the house (inf), along with the

availability of modern energy (ene) and modern communication services (mcs), contributes the highest in the multidimensional poverty. On the other hand, ownership of the house (own) and water for cooking and washing (wcw) contributes less to the multidimensional poverty of housing. The ranking of contributions of these dimensions is the same for all the provinces. This indicates that contributors to multidimensional energy poverty across provinces of Pakistan are more or less the same. Likewise, if we see the contributions of these dimensions in multidimensional poverty of housing for rural and urban regions, the results are the same except for the availability of modern energy resources and ownership of the house. The availability of modern energy resources is better in urban areas than in rural areas. So, this dimension contributes less to adjusted multidimensional housing poverty in urban areas than in rural areas. On the other hand, in rural areas, most households have their own houses. So, this dimension contributes less to adjusted multidimensional housing poverty in rural areas than in urban areas.

In the end, the study presents the results of MPI for housing at district levels. Most of Balochistan and Southern Punjab districts showed a high level of MPI for housing. With the infrastructure development in recent years, Gwadar showed a low level of MPI for housing. Districts of central and upper Punjab and some districts of KPK showed a low level of MPI for housing. Districts of KPK having a border with Afghanistan showed a high level of MPI for housing. The federal capital of Pakistan and all the provincial capitals showed better housing quality standards measured through MPI for housing. Districts with high population share also appeared as high contributors to MPI for housing in Pakistan.

Conclusion:

Improving housing living standards in Pakistan is a complex and multifaceted issue that requires a comprehensive approach. The provision of services by the government, like modern energy resources, water for cleaning and cooking, and modern communication services, add to the quality of housing. The present study highlighted some of the housing

challenges confronted by districts of Pakistan. The study provided an estimate of deficiencies in housing quality through the MPI for housing.

The study concludes that housing conditions in crowded cities of Pakistan are not proper, and there are weak housing policies. Among provinces, Balochistan faced a high level of deficiency in housing quality. As expected, housing quality in rural regions is worse than in urban regions. Further, housing quality is not the same across all the districts of Pakistan, and each dimension contributes differently to MPI for different districts. This indicates that the Pakistan Housing Authority should make policies that can assure the quality of housing in each dimension. Rather than focusing on housing ownership, the authority should also pay attention to the availability of the services like sources of modern energy, water for drinking, washing, and cleaning, toilet facility, garbage collection system, and availability of modern communication systems. The provision of these housing facilities will not only improve living standards but also improve environmental quality and help make economic growth sustainable.

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Figure 1: Deprivation in Toilet Facility

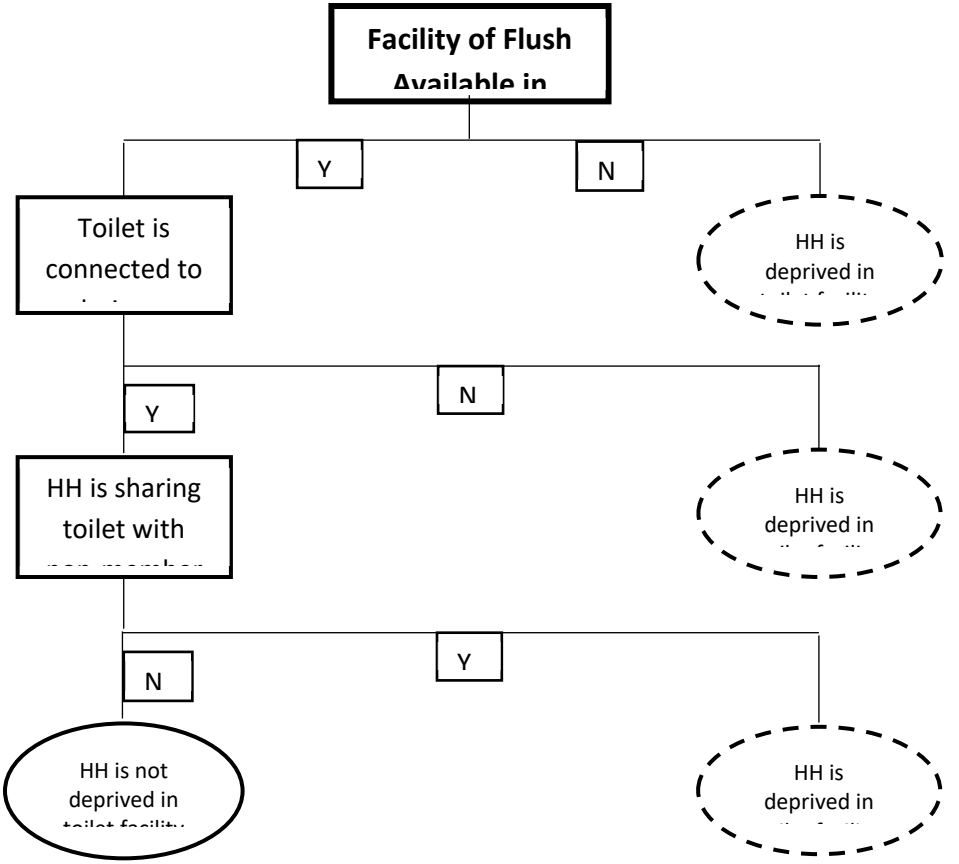


Figure 2: Deprivation in Drinking Water Facility

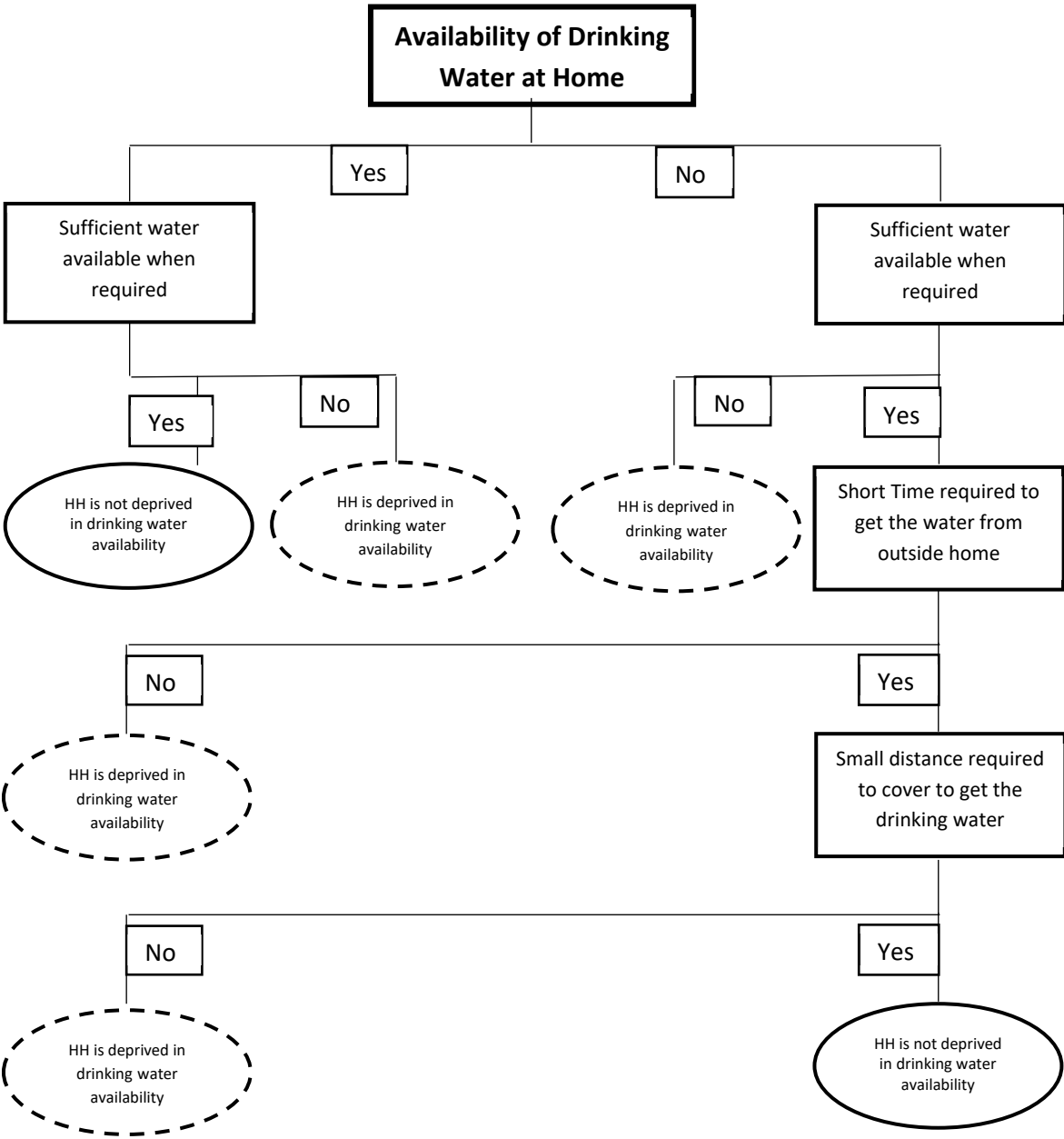

Availability of Drinking Water at Home
Yes
No
Sufficient water available when required
Sufficient water available when required
Yes
No
No
Yes
HH is not deprived in drinking water availability
HH is deprived in drinking water availability
HH is deprived in drinking water availability
Short Time required to get the water from outside home
No
Yes
HH is deprived in drinking water availability
Small distance required to cover to get the drinking water
No
Yes
HH is deprived in drinking water availability
HH is not deprived in drinking water availability

Figure 3: Boundaries of Districts and Provinces of Pakistan

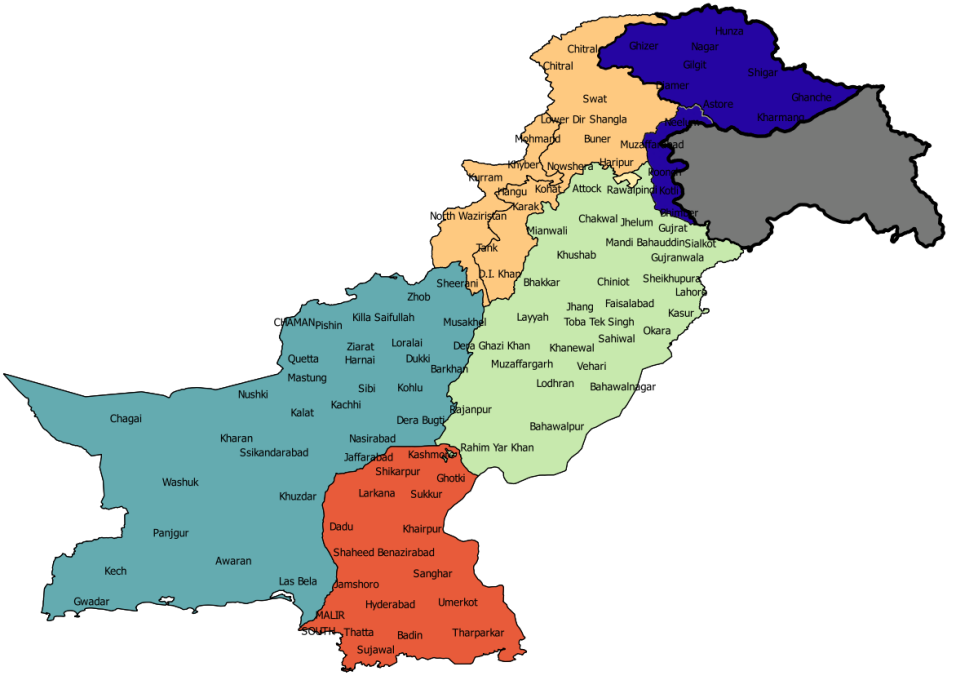


Figure 4: Population Share (PS) of Districts of Pakistan

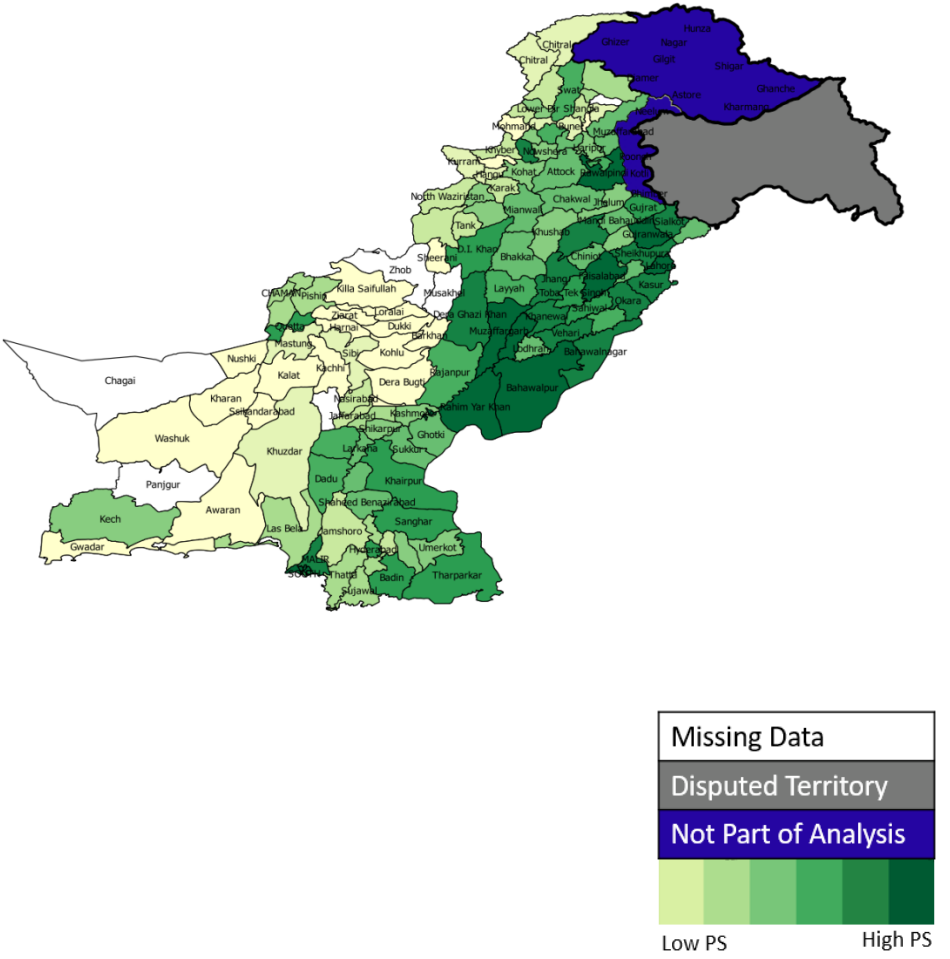


Figure 4: MPI for quality of housing for Pakistan and its provinces

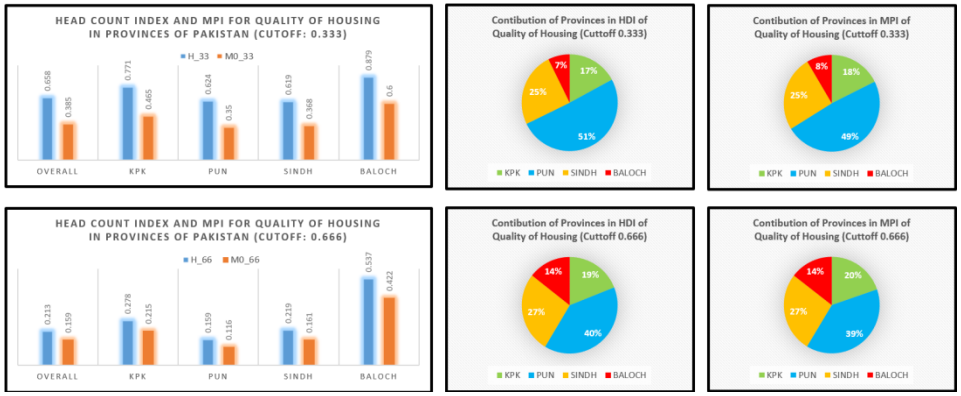


Figure 5: MPI for Quality of Housing for Pakistan and its rural-urban regions

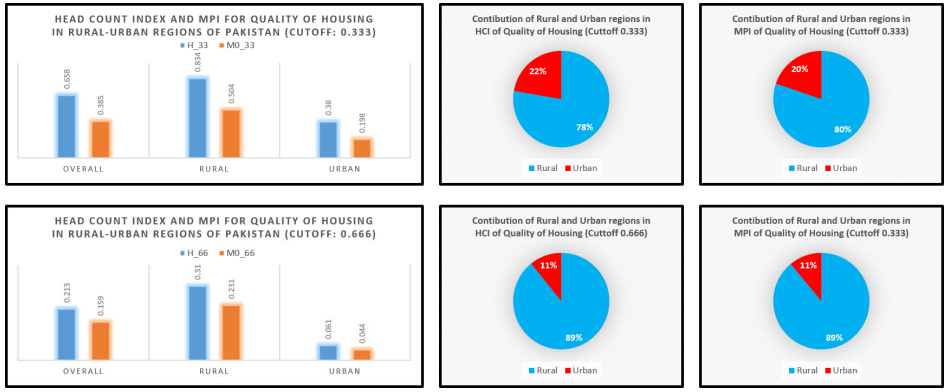


Figure 6: Contribution to MPI for Quality of Housing by each dimension

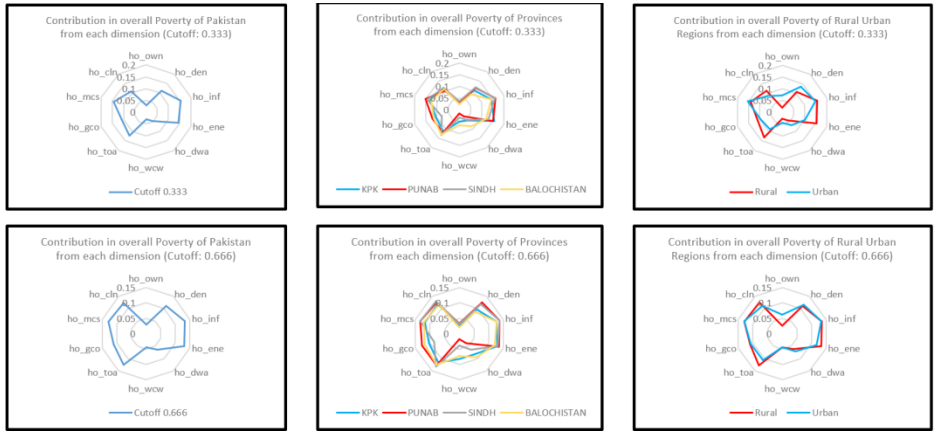
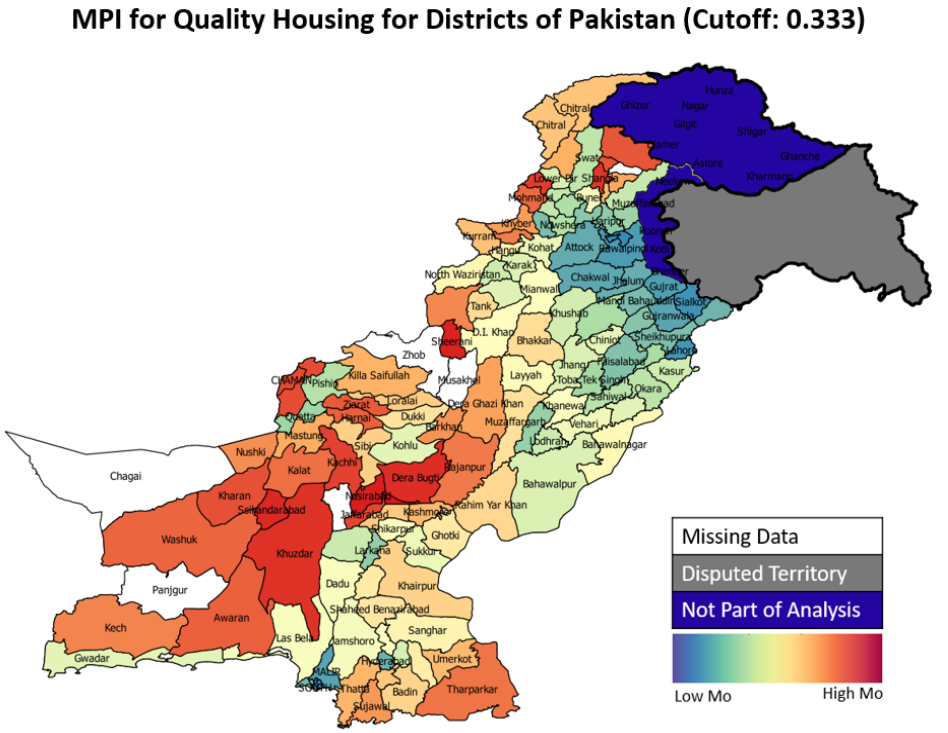
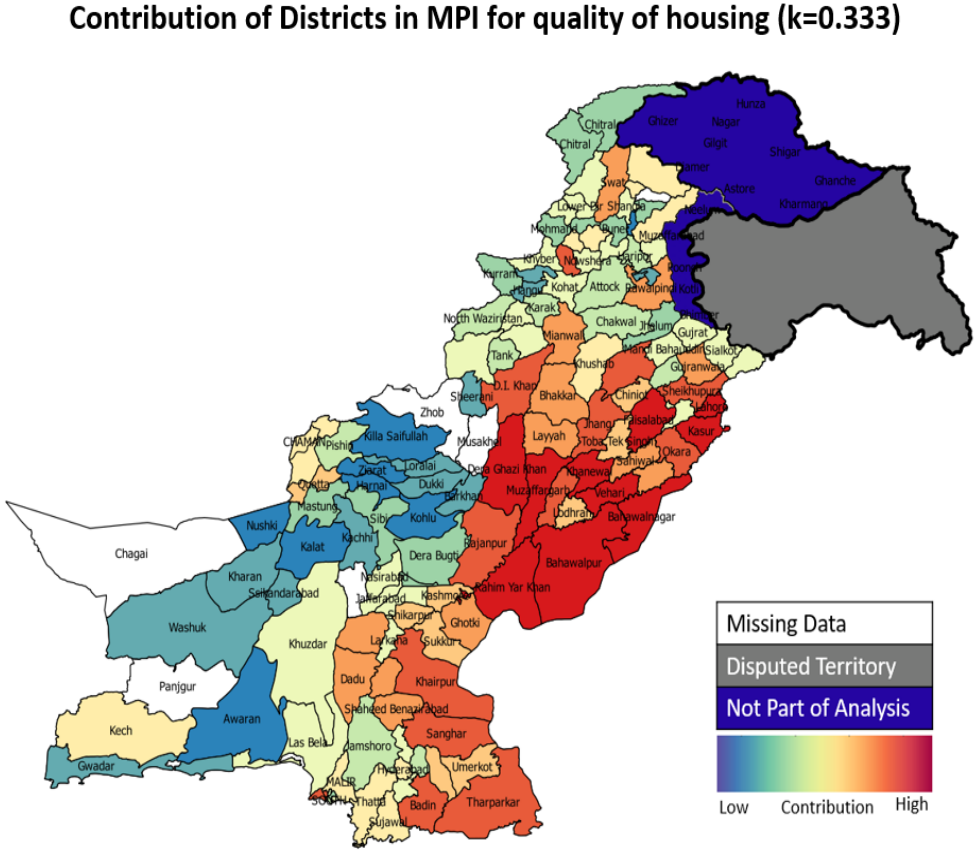


Figure 7: MPI for Quality of Housing for Districts of Pakistan using cutoffs 33.33%



*Professor of Economics, Ghulam Ishaq Khan Memorial Chair (SBP), Kashmir Institute of Economics, The University of Azad Jammu & Kashmir, Muzaffarabad. email: m.jamil@ajku.edu.pk



Appendix A: List of Districts

1	Islamabad				
Punjab					
2	Attock	14	Sialkot	26	Vehari
3	Rawalpindi	15	Gujranwala	27	Sahiwal
4	Jhelum	16	Sheikhupura	28	Bahawalnagar
5	Chakwal	17	Lahore	29	Bahawalpur
6	Gujrat	18	Kasur	30	Rahim Yar Khan
7	Mianwali	19	Okara	31	Pakpattan
8	Bhakar	20	Rajanpur	32	Narowal
9	Sargodha	21	Dera Ghazi Khan	33	Lodhran
10	Khushab	22	Layyah	34	Mandi Bahauddin
11	Faisalabad	23	Muzaffargarh	35	Hafizabad

12	Toba Tek Singh	24	Multan	36	Nankana Sahib
13	Jhang	25	Khanewal	37	Chiniot
Sindh					
38	Jacobabad	46	Badin	54	Kambar
39	Sukkur	47	Sanghar	55	Jamshoro
40	Shikarpur	48	Tharparkar	56	Kashmore
41	Larkana	49	Thatta	57	Matiari
42	Shaheed Benazirabad	50	Naushahro Feroze	58	Tando Allah Yar
43	Khairpur	51	Mirpur Khas	59	Tando Muhammad Khan
44	Dadu	52	Ghotki	60	Sujawal
45	Hyderabad	53	Umerkot	61	Karachi (Central)
Khyber Pakhtunkhwa					
62	Chitral	71	Kohat	80	Lakki Marwat
63	Lower Dir	72	Karak	81	Tank
64	Swat	73	Bannu	82	Batagram
65	Malakand	74	Dera Ismail Khan	83	Shangla
66	Kohistan	75	Nowshera	84	Hangu
67	Mansehra	76	Charsadda	85	Upper Dir
68	Abbottabad	77	Swabi	86	Tor Ghar
69	Mardan	78	Haripur		
70	Peshawar	79	Buner		
Balochistan					
87	Quetta	97	Khuzdar	107	Dera Bugti
88	Pishin	98	Kharan	108	Mastung
89	Loralai	99	Lasbela	109	Awaran
90	Zhob	100	Gwadar	110	Ziarat
91	Chagai	101	Panjgur	111	Sharani
92	Sibi	102	Jhal Magsi	112	Jaffarabad
93	Nasirabad	103	Killa Saifullah	113	Kech
94	Bolan	104	Killa Abdullah	114	Harnai
95	Kohlu	105	Musakhel	115	Washuk
96	Kalat	106	Barkhan	116	Noshki

*Corresponding Author, Department of Accounting & Finance, Kinnaird College for Women, Naila.sadiq@kinnaird.edu.pk
**Department of Accounting & Finance, Kinnaird College for Women
***Department of Accounting & Finance, Kinnaird College for Women

Intellectual Capital in Action: Unleashing Sustainable Growth in Non-Financial Companies of Pakistan

***Naila Sadiq,** Laiba Khawaja & ***Syeda Fizza Abbas**

Abstract: In contemporary competitive markets, firms must have sustainable profits and potential for long-term growth. This research focuses on how intellectual capital efficiency can assist in attaining sustainable growth rate of firms. The research develops a theoretical model that connects components of intellectual capital such as Human, Structural, Relational, Process, and employed capital for corporate sustainable growth in Pakistan's non-financial firms. Six years data of non-financial firms of KSE-100 from the period 2015 to 2020 was collected. Fixed effects panel data regression was used for the testing. The findings of regression output showed strong evidence that two of the intellectual capital components, the Human capital, and Process capital along with basic capital employed measures significantly resulting in the ability to grow sustainably of corporations. However, the results suggested that relational capital is having a weak link with corporate sustainable growth which highlights the doubt that whether Pakistani firms are contributing sufficiently toward the customer, supplier relationships, and marketing. Structural capital is also having a very weak connection with sustainable growth rate. The study conducted adds to the existing literature on intellectual capital and corporate sustainable growth by utilizing more components of IC in the context of Pakistan, a developing economy.
Keywords: Intellectual capital efficiency, Corporate sustainable growth, non-financial firms, Human capital, Process capital

1. Introduction

The creation of knowledge is the outcome of increased investment and prominence in science, research, technology, and innovation, as well as the use of computers and the internet to develop, share, and apply knowledge in an increasingly competitive world (Si et al., 2020). Pakistan's innovation and intellectual capital usage abilities are lacking in comparison to other emerging countries, necessitating Pakistani businesses to constantly access the capability of intellectual capital by innovating products, processes, and

management systems. (Fan & Hossain, 2018)Comparing Pakistan's ability to innovate and utilize intellectual capital with its neighbors indicates varied degrees of development. In terms of global innovation indexes, India, Pakistan's closest neighbor, scores higher and has a booming IT sector. Another massive neighbor, China, has made significant investments in R&D, emerging as a global leader in a number of technological fields. Moreover, another neighboring country Iran has made major strides in science and technology (Asiaei, Barani, Bontis, & Arabahmadi, 2020). Despite not being a close neighbor, Bangladesh has made progress in industries like textiles and agriculture (Dhar, Mutalib, & Subhani, 2019).

The way of accomplishing long-term growth determines a company's dynamic trend of development, which not only represents the company's survival and development capacity but also influences its future financial performance. Therefore, in contemporary competitive markets, it is required of firms to have sustainable profits and potential long-term growth (Xu & Wang, 2018). Therefore, to maintain sustainable growth firms should not only focus on the capital employed but also on intellectual capital which is quickly becoming the new norm of dynamic capability. The balance sheet of a company may be used to evaluate all a firm's physical assets.[i]

Rashid et al. (2018) found IC is critical for companies since their human capital (workers) is well-versed with the company, its procedures, their jobs, and the many internal and external circumstances in which the business finds itself. Present knowledge serves as a foundation for future information and capturing and sharing existing workers' knowledge with new hires is a cumulative process for growing the IC base. The assessment of corporate sustainable boom no longer only reflects the historic overall performance of establishments but additionally are expecting the income enlargement of firms within the future. If businesses want to own an efficient performance of sustainable boom, they need to make use of intangible sources (intellectual capital) to hold aggressive gain, and alter the funding in intellectual capital with dynamic adjustments of the internal and external running surroundings (Si et al., 2020).

The past literature has provided some effective models for measuring intellectual capital. For example, (Pulic) has proposed a model in 1998

referred to as the value-added intellectual-coefficient model denoted as (VAIC). It comprises two elements known as capital employed efficiency (CEE) and intellectual capital efficiency (ICE). The efficiency of potential resources of the company concerning value creation is determined by the VAIC framework (Khalique et al., 2019). This framework applies a definite process for the computation of the required coefficients and has commonly been seen in the past literature. However, this model has always been criticised by the previous scholars, for example, the greatest criticism reported for the VAIC model is that the model does not focus on the role served by external relational capital in value creation for the companies (Poh et al., 2018; RASHID et al., 2020)

Ulum and Syam (2017) have modified this model to overcome the issues in their existing model. This framework involves relational capital as a vital tool in creating value for companies (Tarigan et al., 2019). Structural capital in this model is also focused as an individual part of intellectual capital that does not base on human capital (Sharma et al., 2017). Hence, this modified model overcame the deficiencies of the previous VAIC model emphasizing the components that were avoided by the past model. With every passing day, upgrades in technology are forcing firms to work harder towards gaining or continuing to achieve a competitive advantage. It has now become insufficient for an enterprise to assess its performance based on only short-term financial measures. It is inevitable now to be able to evaluate a firm's long-term development potential and operational prospects.

Only constant innovation is a way for a company to maintain its exuberance and competitive advantage. Without this innovation factor, an enterprise puts itself at risk of becoming obsolete. Therefore, this sustainable growth or value-creating continuity can be achieved through investments in intangible resources known as intellectual capital to meet effective alterations in internal and external operational conditions.

This study is hoped to assist in identifying if a notable relationship between the efficiency of IC of a firm and its sustainable growth within the non-financial companies exists or not. In developing countries like Pakistan, corporate growth management is a major challenge for a firm's management in today's competitive business environment. The goal of this

study is to determine the empirical link between intellectual capital efficiency and corporate sustainable growth in Pakistani enterprises to examine the impact of human capital, relational capital, structural capital, and process capital on corporate sustainable growth rates.

Chief research questions of the study devised are given below.

- Is there a significant link between M-VAIC and CSG?
- Is there a significant link between the human capital, structural capital, Relational capital, Process capital, and CSG?

2. Theoretical Background

The concept of intellectual capital has developed from the strategic management perspectives such as the resource-based view, which is related to internal resources, and the knowledge-based view which focuses on knowledge (Ulum & Syam, 2017). Before the origin of the resource-based view, it was considered by the professionals that a company can achieve its competitive advantage by bringing changes as per the dynamic changes in the environment within which the organizations are operating respectively (Emadzadeh et al., 2013). This view was previously referred to as the industrial-organizational view. In contrast, the resource-based view is a modern view that is focused on the internal resources being scarce, inimitable, and rare (Xu & Wang, 2018). The notion of the resource-based view was that a company can achieve its competitive advantage over others if its internal resources are managed effectively. Tarigan et al. (2019) noted that the resource-based view does not associate with the establishment of human resources in order to create a competitive margin. Mohammadi et al. (2014) added that this is more rigid since this is more necessary in changes related to the environment. Furthermore, a resource-based view could not extensively focus on intellectual capital and knowledge, instead, it considers it as a generic type of source (Sharma et al., 2017).

To deal with the shortcomings of the resource-based view, another key concept is developed that is referred to as the knowledge-based view which sees knowledge as a key resource for creating a competitive advantage. Poh et al. (2018) mentioned that the knowledge-based view suggests that the right management of knowledge builds intellectual capital that is significant for the company. In relation to it, this is noted that a company can create a

competitive advantage when its knowledge and intellectual capital are managed effectively. Since every organization competes to maximize its revenues by using its resources in an appropriate manner. The resource-based view suggests that the companies view their resources on the basis of tangible and intangible assets in order to gain a competitive advantage. Provided with the scarcity related to tangible resources, RASHID et al. (2020) stated that achieving competitive advantage among others needs extensive focus on intangible resources. Another theory that supports the importance of intellectual capital is stakeholder theory. This theory suggests that it is not only mandatory for a firm to oblige the immediate shareholders only, rather it is accountable for any group or individual who is affected or can impact the enterprise e-g customers, suppliers, communities or environment as a whole etc. (Kamath, 2014).

Insert Figure 1

3. Literature Review

3.1 Concept of Intellectual capital

A generally approved explanation of intellectual capital is complex to state and it becomes even more challenging to represent a typically implemented typology for intellectual capital due to the fact that this notion is still in the emerging stage of its development (Kwarbai & Akinpelu, 2016). Basically, intellectual consists of the funds or stocks of knowledge, competencies, intangible capabilities, resources, and assets that allow the basic business processes development within the organisation (ul Rehman & Jalil, 2021; Yaseen et al., 2016).

Competitive advantage can be attained in a highly dynamic and competitive business market by incorporating Intellectual capital. Thus, many researchers have conceptualised and suggested that the aim of intellectual capital is to create value for the business (Smriti & Das, 2017). The general components of intellectual capital include structural, relational, and human capitals. Within this model, human capital is related to the individual competencies and knowledge stock in relation to the company delegated by the employees working in it, relational capital notifies the link among external and internal stakeholders (Avci & Nassar, 2017).

S Mohammad (2021) highlighted that structural capital shows the skills underlined in the business operations. Morris (2015) mentioned that a high focus is given on the knowledge and skills of employees instead of the physical or tangible resources of the organization. It is due to the fact that employee skills, competencies, intellect, and individual knowledge would determine the way company's physical resources can be used effectively in order to attain company goals. It is also supported by (Avci & Nassar, 2017) that the employee's own skills and knowledge are the key source to create value. Therefore, it can be evaluated that cost on employees can be considered as investments instead of cost as it increases and sustain business value in the long-run.

3.2 Components of Modified-VAIC^{TM}

Modified intellectual capital is fundamentally based on three key components that are structural capital, relational capital, and human capital (Poh et al., 2018). According to Tarigan et al. (2019), human capital mainly links to experience, knowledge, intellectual agility, qualification, proactivity, intuition, innovative style, skills, and capabilities of the employees. Sharma et al. (2017) reviewed it as a multidimensional process, which might involve constructive habit development, education, health, the advantage of more social interaction, and training.

The sphere of knowledge of a firm might be expanded with fewer efforts through effective social interaction. Preserving human capital is generally a difficult task for an organisation as the workforce's knowledge, skills, and competencies go with them when they leave an organisation (Hifza et al., 2020; Ulum & Syam, 2017).This can be analysed that human capital serves as a substantial component of intellectual capital and supports the

organisation in strategic development and innovation that indicates its significance in business productivity (Xu & Wang, 2018). However, Mohammadi et al. (2014)suggest that companies might attempt to preserve the human capital by providing vocational benefits, bonuses, and lucrative salaries. In the context of Pakistan, the country is positioned at 152 among 189 countries as per the human development index with a 0.56 value that comes at a lower level (UNDP, 2019). This data reflects the low-level investment in the human capital component of Pakistan that is one of the significant components of intellectual capital as discussed above.

According to De Luca et al. (2020) structural capital comprises of innovation capital and process capital. The process comprises of techniques, equipment, and systems of the company (Emadzadeh et al., 2013). Sharma et al. (2017) highlighted that overall structural capital can be secured by different strategies for example trade secrets, patent registrations, brands, trademarks, and copyrights. Besides that, relational capital links to the competencies and knowledge achieved by interconnection not just with customers yet also the other stakeholders such as the government, partners, competitors, and suppliers of the organisation (RASHID et al., 2020). Relational capital comprises external and customer capital (Hifza et al., 2020).Customer capital is dependent on the way organisation deals with relations by satisfying the demands of the customers (Mukherjee & Sen, 2019).

Another necessary element is capital employed that has been researched with respect to the financial capabilities of the companies as the literature shows capital employee, also denoted as CE can be explained as a book value allocated to average company assets (Xu & Wang, 2018). There is another concept of capital employed efficiency that is defined by the value created by the capital employed. All these capitals used by the organisations eventually working towards the overall business performance through their appropriate allocation that enable sustainable business growth (Xu et al., 2021a).

3.3 Corporate sustainable growth

The concept of sustainable organisational growth has a multifaceted meaning and use. Though, from a financial view, sustainable business growth means steady and persistent development, which can be sustained

in terms of profits for future growth and development (Tarigan et al., 2019). Corporate sustainability initially gained importance by the theory proposed by Higgins in which the utilisation of sustainable development rate model was examined in defining practical strength for new businesses (Fonseka et al., 2012). The notion of corporate sustainable development rate expresses which sales growth is persistent with the ground realities of the organisation and about its financial market position (Nguyen, 2016).

In particular, the rate of corporate sustainable aims to define the highest level of yearly growth and development in terms of sales percentage that an organisation can endure without allocating any other equity or reformulating its financial guidelines. Past studies such (Khalique et al., 2019; Ozkan et al., 2017; Poh et al., 2018) indicated that the intellectual capital of a company has a positive impact on its sustainable competitive advantages. The importance of the company's intellectual components has been identified as the key actors in attaining a sustainable competitive margin and serve as major elements for business performance and value creation of an advanced knowledge-based economy. Moreover, this might also validate the reason for market return to be greater than the book value (Tarigan et al., 2019).

Organisations are experiencing challenges to sustain competitiveness, survival, and growth in the market as they are mostly based on their employee skills and competencies for new ideas and innovation to build a competitive advantage for the company (Setyawati et al., 2019). It is possibly dealt with by the concept of intellectual capital that companies achieve sustainable competitive advantage by implementing four key attributes as proposed by Barney in 1991 including value, rarity, imitability, and organisational support particularly in the dynamic knowledge-based economy (Hifza et al., 2020). Hence, this is considered potentially as the knowledge resources, which organisations use as a key component of their competitive factor to add value in the specified market. Competitive advantage, in the long run, exists as the competitors are incapable of adopting or formulating the strategies to create business value on the basis of the four major attributes of this resource-based model. Thus, it can be evaluated that a company can create a resilient and sustainable market position by considering these four attributes and increase its organisational survival through sustainable growth (Pal & Soriya, 2012).

Different researches have been performed to evaluate the relationship of intellectual capital with organizational performance and productivity through the lens of financial aspects using secondary and primary sources. A study conducted by Mohammadi et al. (2014) examined different aspects regarding intellectual capital and their connection to the financial condition of the company. In this research, the authors have taken 14 different latent variables and data was collected by survey questionnaire administered to 79 participants. The findings of the study showed that relational capital has a high impact on the company's financial performance, which is followed by the strong impact of the other two components that are structural and human capital.

Another research conducted by Emadzadeh et al. (2013) applied the balanced scorecard method to measure intellectual capital and its significance in the firm performance. The results of this study gave an idea that intellectual had a significant impact on sustainable corporate performance. Furthermore, intellectual capital was also seen to influence internal growth, learning, customers, and processes. In addition to it, few research scholars have collected secondary data for measuring intellectual capital for example (Fijałkowska, 2014; Pal & Soriya, 2012). These research studies are conducted in both financial and non-financial companies. For instance, Ulum and Syam (2017) determined the relationship between intellectual capital and organizational financial performance of the banking sector in Indonesia. The quantitative analysis of intellectual capital was performed by using the VAIC framework. The results showed a positive and moderate relationship between intellectual capital and banking performance. Moreover, the author has used a survey questionnaire as a research instrument in order to collect primary data from the professionals working in the banking sector, which was then compared and contrasted with the VAIC model. The findings of this research indicated that the application of the VAIC framework provided a much stronger impact of intellectual capital on companies' financial performance as compared to the survey method.

Similarly, another study conducted by Mukherjee and Sen (2019) in India based on analyzing the effect of intellectual capital and the related components on sustainable development of the Indian companies. Moreover, the author also focused on examining the highest influential

intellectual capital component that has a greater impact on sustainable growth as compared to others. The results of this research were also based on measuring intellectual capital by using a modified version of the VAIC model that indicated a positive effect on firms' sustainable growth. Notably, the findings of this research also demonstrate that every explanatory variable including process capital, innovation capital, relational capital, and physical capital give a significant impact in explaining sustainable corporate growth.

Apart from it, some other significant literature studies have shown a notable relationship between the organisational intellectual capital and its performance. For example, Asiaei and Jusoh (2015) aims to view intellectual capital through a multi-dimensional view and its effect on business performance. The authors found that business culture serves a key role in building structural and human capital, however, trust is also a key factor among the different other intellectual capital. Similarly, Sarwar et al. (2016) also examined the role of human capital and practices in the performance of construction firms of Pakistan in which the authors noted that human capital along with human resource practices increase overall company performance. In the similar context, Tran and Vo (2020) explored the links between efficiencies of human capital and organisational performance over different industries in the potential emerging market. The results of this study showed that banking industry does not possess the greater human capital level accumulation as indicated previously.

4. Research Methodology

Annual financial reports of non-financial companies (KSE-100 index) were used to extract secondary data. For this purpose, companies' annual reports were downloaded from their official websites as well as PSX data portal was utilized. Data collected comprised of a six-year period from 2015 to 2020. After excluding financial firms and firms with insufficient data, final sample is based on 72 companies and 432 observations of a balanced panel data was collected. The analysis is performed through Stata14 and SPSS software. Pooled Ordinary Least Square (OLS) regression model is used to depicts the variables used in this study as this methodology is more appropriate to determine the impact of intellectual capital efficiency on corporate sustainability Tran and Vo (2020).

Insert Figure 2

4.2 Hypothesis Formulation

1. Ho_1: M-VAIC has no significant effect on CSG.

   H_1: M-VAIC has a significant effect on CSG.

2. Ho_2: Capital employed efficiency has no significant effect on CSG.

   H_2: Capital employed efficiency has a significant effect on CSG.

3. Ho_3: Human capital has no significant effect on CSG.

   H_3: Human capital has significant effect on CSG.

4. Ho_4: Structural capital has no significant effect on CSG.

   H_4: Structural capital has significant effect on CSG.

5. Ho_5: Relational Capital has no significant effect on CSG.

   H_5: Relational Capital has significant effect on CSG.

6. Ho_6: There is a significant effect of Process Capital on CSG.

   H_6: There is no significant effect of Process Capital on CSG.

4.3 Operationalization

4.3.1 Dependent Variable

Corporate sustainable growth will be our dependent variable in this respective study. Corporate sustainability may be measured in a variety of

ways. Though Van Horne and Higgins' sustainable growth rate model is generally recognized and utilized in the previous researches(Xu & Wang, 2018) . This study will be employing Van Horne and Wachowicsz ‘s steady state model. The equation will be as follows;

$$SGR_{i,t} = \frac{(P \times A \times T \times R)_{i,t}}{(1 - P \times A \times T \times R)_{i,t}} \quad (1)$$

where SGR is corporate sustainable growth, i,t are company and year, P is profit margin, A is equal to asset turnover ratio , T is equity multiplier and R is retention rate (Xu et al., 2021b).

4.3.2 Independent Variables

In this study, Modified-VAIC as a whole (comprising of Capital Employed efficiency plus Intellectual capital efficiency) and Individual components of ICE which are HCE, SCE, RCE, and PCE are the independent variables. VAIC is produced from accounting data relating to financial statements such as the company's balance sheet and the statement of income. VA (Value Added) is the value created by the firm’s resources and can computed as follows (Nimtrakoon, 2015).

$$VA_{i,t} = OUT_{i,t} - IN_{i,t} \quad (2)$$

Here OUT is the total revenue created by a specific firm in year t. IN refers to all the expense cost occurred to create the revenue minus the employee expense.

Moreover, the equation for our model will be;

$$M - VAIC_{i,t} = CEE_{i,t} + ICE_{i,t} \quad (3)$$

$$CEE_{i,t} = \frac{VA_{i,t}}{CE_{i,t}} \quad (4)$$

Equation 4 shows the Capital employed efficiency. $CE_{i,t}$ represents the Capital Employed by a certain business at the conclusion of t periods (i.e., Total Assets less Current Liabilities).

$$ICE_{i,t} = HCE_{i,t} + SCE_{i,t} + RCE_{i,t} + +PCE_{i,t} \quad (5)$$

$$HCE_{i,t} = \frac{VA_{i,t}}{HC_{i,t}} \quad (6)$$

Where $HC_{i,t}$ are employee benefit expenses in year t.

$$SCE_{i,t} = \frac{SC_{i,t}}{VA_{i,t}} \quad (7)$$

Structural capital (SC) is what's left over after subtracting VA and HC in Pulic's model. As HC's creating value increases, so, SC's generation value declines.

$$RCE_{i,t} = \frac{RC_{i,t}}{VA_{i,t}} \quad (8)$$

Sales expenditures serve as a proxy for relational capital, or RC for short.

$$PCE_{i,t} = SCE_{i,t} - RCE_{i,t} \quad (9)$$

SCE is the Structural Capital Efficiency (i.e., SC / VA; where SC = VA-C) and PCE is the Process Capital Efficiency.

4.3.3 Control Variables

This study, following previous researches uses the natural logarithm of total assets as a control variable for enterprise size, using the following calculation:

$$SIZE_{i,t} = ln(Total\ assets) \quad (10)$$

Leverage (LEV) variance will have a significant impact on a company's success. So, leverage will be used as a control variable in this investigation.

4.4 Econometric Equations

$$SGR_{i,t} = \beta_1 + \beta_2 MVAIC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 LEV_{i,t} + \varepsilon_{i,t} \quad \text{(Model 1)}$$

$$SGR_{i,t} = \beta_1 + \beta_2 CEE_{i,t} + \beta_3 HCE_{i,t} + \beta_4 SCE_{i,t} + \beta_5 RCE_{i,t} + \beta_6 PCE_{i,t} + \beta_7 SIZE_{i,t} + \beta_8 LEV_{i,t} + \varepsilon_{i,t} \quad \text{(Model 2)}$$

Model (1) investigates the influence on corporate sustainable growth (SGR) of Modified- VAIC as a whole whereas Model (2) further explores the particular impact on corporate sustainable growth of intellectual capital components.

5. Results

5.1 Descriptive Statistics

Insert Table 1

The table above presents descriptive statistics of selected variables employed in the research. Sustainable Growth rate has a mean value of 24% in non-financial firms of KSE-100 index. M-VAIC has a mean value of 5.452, a maximum of 38.806 and a low of -46.182. The negative M-VAIC score indicates that the investment in processing Intellectual capital is more than its contribution to the firm's value generation process. The mean value of HCE, 4.034, is greater than the other IC components, implying that HCE is the primary driver of creating value among the IC components. It's worth noticing that PCE has the lowest mean value of the IC components, at 0.2, implying that it doesn't contribute to

the firm's value creation process. LEV has a mean score of 0.53, indicating that non-financial enterprises in Pakistan have a low-geared capital structure. Furthermore, the average SIZE value is 17.415, implying that non-financial enterprises in Pakistan are well-established and evolved on average.

The length or lack of symmetry within the distribution pattern is being represented by the skewness value while the distribution curve's peak or height is displayed by the kurtosis value. In the ideal instance, the skewness and kurtosis value shall be zero of a bell-shaped curve. SGR, HCE, RCE, SIZE, and LEV all depict skewness values greater than zero, suggesting positively skewed distributions, but M-VAIC, CEE, SCE, and PCE are showing skewness values < zero, indicating negatively skewed distributions. On the other hand, all of the variables have kurtosis values more than zero, indicating that these are significantly peaked, with more data values concentrated near distribution center.

5.2 Correlation Analysis

Insert Table 2

For the purpose of determining link between two variables, correlation analysis is a statistical method used in research. This analysis aids in comprehending the strength of the linear relationship. Coefficients of Correlation range between -1 and 1. Two variables tend to move in tandem when a positive correlation coefficient exists. A positive correlation coefficient indicates that the two variables tend to move in tandem. The greater the coefficient, the more powerful the relationship, while a negative correlation coefficient suggests that they tend to move in opposite directions: observations with high values for one variable are likely to have low values for the other.

The results show that the explanatory variable M-VAIC is having positive relationship with the dependent variable SGR with a coefficient value of 0.139. the relationship of HCE and PCE with dependent variable is also positive which may imply that by increasing investment in human capital and process capital, a firm's sustainable growth rate may show positive

results. The correlation coefficient of CEE (-0.043) shows that there is negative and weak relationship with the dependent variable. The negative sign may indicate that increase in SGR may not always mean that it is attributable to the physical capital employed in a firm, it can be due to other factors. Finally, we need to keep in mind that correlation does not suggest causality.

Prior to running regression tests or making assumptions, it is expected that the data obtained would follow a normal distribution and as a result, before estimating anything, the data will be normalized so that statistical techniques can be applied to it (Tsagris & Pandis, 2021).

5.3 Normality Assumption:

Normality is a powerful assumption that implies some interesting theoretical properties. In normality assumption it has to be assured that the dependent variable follows a normal distribution or approximately follows. Initially outliers were detected in the data after plotting graph plot of the dependent variable. The graph box showed that dependent variable was not normally distributed which was not a representative of the naturally occurring phenomenon. A simple outlier removal and squared transformation on the dependent variable of SGR had been conducted. After taking the square of SGR, the graph plots were rerun on the newly generated variable, and it was found out that the dependent variable were still non-normal. Therefore, to reach this assumption, rank transforms were applied which are another type of transform. Following this procedure, different normality tests like histograms, Shapiro wilk and Jarque Bera tests were conducted, and it was found that the dependent variable was approximately normally distributed. The variable was then used for further Panel data regression. It is evident from the results given below.

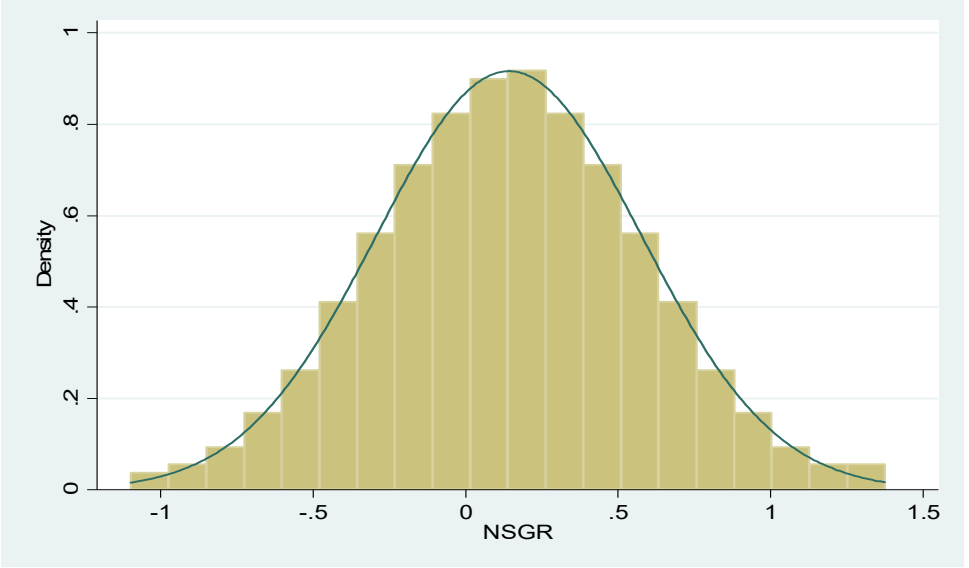


Figure 3, Histogram plot-NSGR

```
. swilk NSGR

                    Shapiro-Wilk W test for normal data

    Variable |   Obs        W          V          z       Prob>z
-------------+--------------------------------------------------
        NSGR |   432    0.99967    0.097     -5.582    1.00000

. histogram NSGR,normal
(bin=20, start=-1.09711, width=.123634)

. sktest NSGR

                    Skewness/Kurtosis tests for Normality
                                                      ------ joint ------
    Variable |   Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------
        NSGR |   432       0.7730        0.7275        0.20          0.9027
```

Figure 4, Shapiro wilk & SK test

5.4 Multicollinearity Assumption:

According to Giacalone, Panarello, and Mattera (2018) Multicollinearity isn't just present or missing; it's also important to assess its severity, which ranges from no collinearity to perfect collinearity. In real data, some level of multicollinearity is almost always present. Moreover, Multicollinearity can cause a variety of problems, including estimation problems, forecasting problems, and interpretation problems.

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
        SIZE |      1.03    0.972099
       MVAIC |      1.03    0.974939
         LEV |      1.00    0.996728
-------------+----------------------
    Mean VIF |      1.02
```

Figure 5, Variance inflation factor, Model 1

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
         SCE |      1.37    0.731920
         RCE |      1.33    0.753784
         PCE |      1.23    0.811960
         HCE |      1.12    0.894667
        SIZE |      1.07    0.934195
         CEE |      1.03    0.969462
         LEV |      1.02    0.979389
-------------+----------------------
    Mean VIF |      1.17
```

Figure 6, Variance Inflation Factor, Model 2

The variance inflation factor is used to determine how much the variance of the predicted regression coefficient is inflated when the independent variables are associated. VIF =1 denotes that the independent variables are

not connected with one another. The presence of a VIF result larger than 1 implies that the variables are moderately related. Because it discovers heavily related variables, VIF has a challenging value of 5 to 10 (Shrestha, 2020). After removing outliers in two of the explanatory variables (SCE, RCE) in model 2, the (VIF) values were < than 5, all these explanatory variables are hence independent linearly, and therefore multicollinearity is not present in my data set.

5.5 Homoscedasticity Assumption

One of the conditions of regression is that the data set be homoscedastic, which indicates that the variances must be constant, rather than heteroskedastic, which means that the variances are not equal(Yang, Tu, & Chen, 2019). In the estimation of your coefficients, heteroscedasticity does not cause a bias. You cannot, however, estimate the variance-covariance matrix adequately due to heteroscedasticity. As a result, the coefficients' standard errors are erroneous. As a result, no t-statistics or p-values can be computed, and hence no hypothesis testing can be done. Overall, OLS loses its efficiency when heteroscedasticity is present, and it is no longer Best Linear Unbiased Estimator.

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of NSGR

         chi2(1)      =     0.92
         Prob > chi2  =   0.3374
```

Figure 7, Heteroskedasticity test

Based on the results we conclude that the data does not follow heteroskedasticity because the significance value of the Breusch Pagan test is 0.3374, which is greater than 0.05.

5.6 Autocorrelation Assumption

The auto correlation of a variable measures the link between its current and previous values. Ideally, there should be no auto correlation in the data set; however, we reject H0 and conclude that auto correlation exists in the data set as the pvalue of DW test is < than 0.05

To escape from the consequences of serial correlation in our data that include untrustworthy hypothesis testing and t-statistics appearing significant on levels on which they are not in actual led us to use the Prais-winston command to solve this issue. After using this command, the Durbin Watson statistic is transformed to 2.010 which means that there no serial correlation present in our data now and this procedure produced estimators that are approximately as efficient as the best linear unbiased estimators. Moreover, there is no omission of observation.

```
.
. estat dwatson

Durbin-Watson d-statistic(  4,   432) =  1.364186

 Durbin-Watson statistic (original)    1.364186
 Durbin-Watson statistic (transformed) 2.010739
```

Figure 8, Serial correlation test

5.7 Regression Analysis

There is no violation of regression assumptions of Normality, Multicollinearity, Heteroscedasticity and Autocorrelation. Before proceeding further, the normality has been achieved because the data was not normal. After achieving the normality, the distribution of data showed homoscedasticity. However, autocorrelation has been removed from the data. Moreover, the results of Hausman specification test aided in the selection of a fixed effects model in a panel data study.

Insert Table 3

When the independent variables are utilized together, the coefficient of determination (R square) denotes the percentage of effect they have on the dependent variable. In this model, R Square=0.405, implying that the link between SGR and M-VAIC accounts for 40.5 percent of the variation in SGR.

As the p-value of explanatory variable M-VAIC is < 0.01, it indicates that it is statistically significant at 1% level of Significance. Further, it can be concluded that Modified Value-added intellectual coefficient has a positive influence on Sustainable Growth Rate (SGR). The control variables SIZE has a positive influence but its relationship is insignificant for this model. Similarly, LEV is insignificant and is negatively influencing SGR.

Insert Table 4

The R- square represents the percentage of effect that the independent variables have on the dependent variable when used together. In this model, R Square= 0.440, implying that the relationship between SGR and Capital Employed Efficiency, Human Capital Efficiency, Structural Capital Efficiency, Relational Capital Efficiency (RCE), and Process Capital Efficiency justifies a 44 percent variation in SGR (PCE).

As p-value of explanatory variables Human Capital (HCE) and Process Capital (PCE) is < than 0.05, it shows that they are significant at 5% level of significance. Moreover, capital employed efficiency (CEE) is significant at 10% level. It can be concluded that HCE and PCE have a positive influence on Sustainable Growth Rate (SGR), while CEE has a negative link with dependent variable SGR. SIZE (Control variable) has a positive influence but its relationship is insignificant for this model. Similarly, LEV is insignificant and is negatively influencing SGR.

6. Discussion

The goal of this research was to explore the link between intellectual capital efficiency and corporate sustainable growth of firms in the presence of control factors. The discussion that follows is based on the results of the Panel regression. It has been widely obtained in our findings that the

combined effect or connection of capital employed and Intellectual capital components (M-VAIC) showed significant effect. Our first Hypothesis was whether M-VAIC has a significant effect on CSG or not. In this study, we tend to accept the alternative hypothesis of H1 where it is stated that there is a significant impact of M-VAIC on corporate sustainable growth. An increase of approximately 2.5% in the sustainable growth rate of firms will be caused by the increase in value added intellectual capital as the findings of table presented shows that the coefficient of M-VAIC is 0.025 As M—VAIC is a combination of CEE and ICE, we can also deduce from these results that physical capital as well intellectual capital proves to be a key driver of sustainable growth of corporations. Thus, this output is accordant with the results found by Xu et al. (2021a) & Tran and Vo (2020).

The second hypothesis stated that capital employed efficiency has a notable effect on CSG. As evident from table the CEE is significant at 10% level. These results support empirical findings of (Mukherjee & Sen, 2019). However, the coefficient value of CEE being negative (-0.03) is not in line with the literature means not enough positive link was found between CEE and its role in CSG of Pakistani companies. The third hypothesis of the study which stated Human capital efficiency (HCE) impacts corporate sustainable growth indeed showed significant results at 1% level of significance. The coefficient of HCE is 0.05 as depicted from the table above, which means that an increase of approximately 5% in the sustainable growth of firms can be observed as the efficiency of Human capital increases. This means that the HCE provides a significant contribution to the long-term growth of Pakistani firms, demonstrating that human resource knowledge, competency, and technical know-how are used effectively and efficiently in Pakistan's top corporations. These findings are greatly supported by many studies like (Saeed et al., 2016; Xu et al., 2021a) etc.

Our fourth and fifth hypothesis was whether SC and RC indicate a significant effect on CSG or not. We tend to accept the null hypothesis of H4 and H5 of this study where it is stated that no significant impact of structural capital and relational capital on corporate sustainable growth exists. In addition to being a labor-intensive economy, as well as lack of investment in R&D due to a lack of finance, a lack of cutting-edge technology and a lack of patent generation are all plausible factors for SCE's

low performance in Pakistani enterprises which is consistent with the results of a neighbouring country. (Fan & Hossain, 2018)

Our last hypothesis of the study stated that process capital's impact on CSG is notable and the results from table are in accordance with it. Therefore, we can reject the null hypothesis and deduce that with a coefficient value of 2%, it positively influences SGR and an increase of approximately 20% in the sustainable growth of firms could be observed as Process capital value increases. It indicates that effective process capital management makes businesses more capable of achieving long-term growth. This result is in line with previous studies like (Kusumawardhani, 2012; Mukherjee & Sen, 2019).

In summation, the data implies that, in addition to physical resources, components of IC– human capital and process capital – play an important role in business long-term success in Pakistan. Furthermore, the R2 value (0.440) in Model 2 is higher than the R2 value (0.405) in Model 1, implying that specific components of IC contribute much more to corporate long-term growth than intellectual capital as a whole. In terms of control variables, no notable relationship among firm size (FS) and Lev was found on corporate sustainable growth in both Model 1 and Model 2. Mukherjee and Sen (2019) also reported similar results for LEV in their study.

7. Conclusion

The results of the research carried out provide evidence that, in context of Pakistan, both Capital employed and IC (as a whole), as well as its components, play a crucial role in the path to CSG. It is important to note, however, that among the components of IC, human capital is the most influential factor in Pakistan's corporate sustainable growth. Taking the findings together, it is possible to conclude that IC and its components do, in fact, help pave the way for corporate sustainable growth in Pakistan.

Hence, this study will assist company owners and directors in thinking about and acting to incorporate IC resources into their businesses and reap the benefits. This research emphasizes the need of policymakers and regulatory agencies developing regulations for measuring and disclosing IC in yearly financial reports as only a handful of top 100 companies disclose

it. In today's active and competitive business environment, corporate growth management is a major challenge for executives, particularly in developing countries like Pakistan. To such an extent, this study presents Pakistani corporate executives with a motto that if IC resources are effectively engaged and taken advantage, the firm's growth and policies can be effectively controlled for future benefits. an ideal level of sustainable growth rate should be the objective as investors are not only interested in the ability to grow of a firm, instead they are more inclined towards whether the growth is sustainable or not.

The limitation of this study includes that another component of intellectual capital known as Innovation Capital was not incorporated in this study as its measurement (I-e R&D cost) was not available for all KSE-100 Index companies. Due to the misinterpretation of numerous meanings of IC and its components, there is still criticism of the Intellectual capital calculation method, as no way of measuring IC has been disclosed by researchers as flawless until now. Future studies should widen the sample base to include all enterprises from all sectors of the KSE because different sector's goal of increasing corporate sustainable growth may comprise of various different methods. E-g tourism companies will be more interested in investing in relational capital while a labor-intensive manufacturing companies would be more interested in employees' benefits (Human capital). This model can be employed cross country with the goal of generalizing the findings of this model. Further research into the relationship between Corporate Sustainable Growth and other dimensions including, Earning Management, Dividend Policy etc. could be conducted. Because the VAIC^{TM} model has been criticized primarily for its measurement of Structural capital efficiency (because to its reliance on HCE), future studies should seek out alternative methods or even design an IC measurement model that can absorb the existing criticism of the VAIC^{TM} model.

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Determinants of Out-of-Pocket Health Expenditure in Pakistan: Empirical Insights from Micro-level Data

*Ayesha Arshad Hammad **Salahuddin Ayyubi & ***Zahid Iqbal

ABSTRACT: Out-Of-Pocket (OOP) health expenditure is an internationally recognized measure of health expenditure at household level, especially in middle income countries. This study explores various socio-economic and demographic determinants of OOP health expenditure in Pakistan. The descriptive analysis and regression type results using Variance-Weighted Least Squares (VWLS) method were generated to find out the nature of impact and the significance of various determinants of health expenditures. As per the findings, the average yearly OOP disbursement on household health was around RS. 13,897 (nearly 3% of household consumption expenditure). The impact of factors like household size, smoke consumption, the number household-dependents, average household education, and consumption expenditure was found statistically significant while having positive effect on OOP health expenditure in the estimated model. Households with the facilities of piped water, proper sanitation and garbage disposal system were having less spending on health. The results have shown that in rural Baluchistan, gas connection was having low impact and number of under-five children had highest impact on OOP health expenditure, while in urban Baluchistan piped water had lowest impact on health spending. The signs of the variables used in this study were in line with the dominant view of the literature.

Keywords: Out-of-Pocket health expenditure, Household, VWLS, Pakistan

1. Introduction

Household spending patterns are being influenced by a host of factors and some categories of such expenses are important for academicians, corporations, politicians and policy makers alike. One of the most important categories of household expenditures, especially in the developing countries, is argued to be the health expenditure, because of its unavoidable and imperative nature as a distinctly different type of expense. The main

* Lecturer, FAST NUCES Lahore, ayesha.arshad@nu.edu.pk
** Assistant Professor, Forman Christian College (A Chartered University), salahuddinayyubi@fccollege.edu.pk
*** Associate Professor, Forman Christian College (A Chartered University), zahidiqbal@fccollege.edu.pk

sources of health expenditures include public and private healthcare expenses. OOP health expenditure is a globally recognized measure of household health expenditure & a dominant source of private health expenditure in many developing countries. According to World Health Organization (2017), payments made at time of receiving any type of treatment, from any type of provider, for any type of disease or health problem are called OOP health expenditures. Such payments exclude any reimbursement by a third party such as the government, a health insurance fund or a private insurance company. According to Pakistan Bureau of Statistics (2018), OOP health expenditure is defined as direct payments for health services from income or saving of households. However, such payment might be compensated later by employers or by health insurance.

According to the report of National Health Accounts (NHA) 2019-20, total health expenditure is comprised of current and capital health expenditure. Capital health expenditure is, sometimes, also known as development expenditure. Only direct health expenditures are incorporated in current health expenditure while indirect expenses like health related expenditures on medical education, training & research are excluded from the total health expenditure.

The report of NHA 2019-20 indicates that out of total health expenditures in Pakistan, 39.8% were made by general government and the rest by private sources. OOP health expenditures constituted 52.8% of total health expenditures in 2019-20. Private expenditures constituted 59.7% of total health expenditures in Pakistan, out of which 88.6% were OOP health expenditures (i.e. 52.8% of total health expenditure) in 2019-20. The breakup of the government health expenditure remained as follows: 26.6 % share of federal and provincial government, 7.2% share of district or Tehsil government, 3.7% of military health expenditure, 0.5% share of development partner or official donor organizations, and 1.2% of social security funds in total health expenditures. The estimates of National Health Accounts 2019-20 also indicate that OOP expenditures on health in Punjab has the highest share (i.e. 53%) while Baluchistan

(63.97%) has the lowest share of OOP health payments (Pakistan Bureau of Statistics, 2022).

Many researchers have studied the factors affecting OOP healthcare expenditures and investigated their catastrophic effects. Bedado et al. (2022) used multiple variable logistic regression model in a cross-sectional study to find out determinants of OOP health expenditures. The results have shown that OOP health expenditures were significantly associated with various factors like family size, income, residence and status of education. Alemayehu et al. (2023) focused on understanding the patterns and the determinants of OOP health expenditures among adult patients with hypertension to analyze economic challenges faced by patients with such health issues. They used multiple linear regression model and identified that factors like wealth index, gender, distance from the hospital, and frequency of visit to hospital resulted in high OOP health expenditures.

1.1 Significance of the Study

World Health Organization (2017) highlights the significance of OOP health payments in Sustainable Development Goals (SDGs) by setting target number 3.8 for the achievement of universal health coverage which is one measure of performance for SDG 3 about good health and well-being. Moreover, SDG indicator 3.8.2 "Proportion of large household health expenditures on health as a share of total household expenditure" focuses on OOP health expenditures. SDG 3 aims to strengthen health systems of all the countries because there are deteriorating conditions of health financing systems in many countries that might lead towards high OOP health expenses, prompting financial hardship.

According to the report of World Health Organization (2019), OOP expenditures are a major source of health financing in middle income countries as compared to low and high income countries. In low income countries, financial barriers could be the reason of low OOP payments whereas high income countries might be facing financial hardship due to OOP expenses on medicines (World Health Organization, 2019). Around 57.6% of total health expenditure have been paid by individual households as OOP payments in 2015-16 where annual per capita health expenditure of Pakistan is 45US$ and the ratio of total health expenditure to GDP is 3.1% (Pakistan Bureau of Statistics, 2018).

1.2 Research Gap

There are many factors that affect the OOP health expenditure in Pakistan. A lot of research has been conducted, around the globe, to evaluate the patterns and determinants of such expenses. However, little attention has been paid towards this issue in Pakistan. One study of Muhammad Malik & Azam Syed (2012) has focused on determinants of OOP payments by extracting data from Household Integrated Economic Survey (HIES) 2004-05 and employing OLS technique. Rehman et al. (2014) have descriptively gathered and analyzed primary data to see the pattern of OOP health expenditure of under-five children in slum areas of Islamabad. Another study by Khalid & Sattar (2016) has done descriptive analysis to examine the pattern of OOP expenditures by pooling six HIES surveys from 1998-2011. Datta et al. (2019) have used logistic regression on data of HIES (2015-16) to check the relationship between medical cost and diseases and to see the critical trends of health expenditure in Pakistan. They have considered only two diseases (blood pressure and diabetes) to understand how these are linked with financial hardship in Pakistan. However, in previous literature of Pakistan, determinants of OOP payments have not been inspected by using the most recent data of HIES in Pakistan. This research was needed to analyze the pattern of OOP health expenses and to find out the important household determinants of such expenditures in Pakistan.

In addition, this study has shown the impact of various factors like smoke consumption and average household education on OOP health expenditure via different econometric models. In the literature, it was either taken as a dummy variable or as the expenditures on smoke. This research, however, modified the 'smoke' variable as the quantity (in units) of smoke consumed by households. Moreover, regarding education, the existing literature focused mainly on household head's education or on spouse education. This study, however, has analyzed the impact of average education of the household instead of just focusing on the education of household head or spouse.

Hence, this study has examined the pattern of OOP expenses on health as well as probed significant causes of OOP health expenditures by

using the most recent data of Pakistan Social and Living Standards Measurements (PSLM)/ Household Integrated Economic Survey (HIES) 2018-19.

1.3 Problem Statement

There is a huge burden of health expenditure at household level where households have different capacity to endure or avoid such expenses. Therefore, it is important to know the circumstances that might affect burden of health expenditure as measured by OOP payments. Keeping this in mind, this study aims at exposing household characteristics for their expected and observed effects on OOP health expenditure in Pakistan.

1.4 Objectives of the Study

This study aimed at exposing household characteristics for their expected and observed effects on OOP health expenditure. Likewise, it explored the nature and significance of numerous factors that might influence OOP expenditures at household level.

The key objectives of this research are:

• To systematically assess nationwide household OOP health disbursements in Pakistan.

• To explore the determinants of OOP health expenditure in Pakistan.

2. Literature Review

Many researchers have elucidated the causes of high OOP health expenditure. Most of the studies have either focused on characteristics of household head like age, gender, marital status, education and employment status; or on characteristics of other household members such as age group, household size, household income and expenditure. Other conditions of household like wealth status, living condition and nature of residence have also been probed for comprehensive exploration of this issue.

Household size has remained an important determinant of OOP health payments that represents total number of members of household. Many studies have found out positive association between OOP health

expenditures and size of household, implying that larger households would be prone to have more spending on health [Mamun et al. 2018; Paul et al. 2018; Sekyi & Domanban, 2012; Pal, 2010; Costa-Font et al. 2007; Rous & Hotchkiss, 2003; Rubin & Koelln, 1993]. The results of Brinda et al. (2014) showed that households having more than five members incur more OOP expenditures. According to Oudmane et al. (2019), more than seven members in a household were positively related to OOP health expenditure. In contrast, Minh et al. (2013), da Silva et al. (2015), and Lee et al. (2019) explained the negative relationship between household size and OOP payments, depicting that larger households would spend less. Yardim et al. (2010) found out in their study that household size had no effect on catastrophic health expenditure and Mugisha et al. (2002) also found it insignificant in their study.

The age group of household members secures a central position in the discussion of moderators of OOP health expenditures. Some studies have also explored the effect of age of household head. More OOP expenditures in household were exposed due to increasing age (Mugisha et al. 2002; and Pannarunothai & Mills, 1997) especially above 65 years (You & Kobayashi, 2011), while household head was negatively related to OOP spending on health (Brinda et al. 2012; Pal, 2010; Rous & Hotchkiss, 2003). The positive effect of age was explained by many researchers. According to Farahat et al. (2018), for women between 18-40 years and men between 40-60 ages had positive relationship with OOP payments. OOP expenditures were higher for age of household members with ages 15 years or above, however, smaller for household members with ages between 10-14 years (Rous & Hotchkiss, 2003).

While analyzing the household characteristics affecting OOP health expenditure, children and elders were mostly considered as vulnerable members of a household and were given more attention. The results of Hailemichael et al. (2019), Paul et al. (2018), Amaya-Lara (2016), Minh et al. (2013), Muhammad Malik & Azam Syed (2012), and Pal (2010) revealed that the households with vulnerable members had positive relationship with OOP health expenditure because they were likely to have more health needs. Households having preschool children were estimated to have high OOP expenditures on health (Kumara & Samaratunge, 2016).

However, there was a negative association between OOP health expenditure and vulnerable age group found by Mamun et al. (2018) and it was also found this of a household that has at least one child and no elderly by Muhammad Malik & Azam Syed (2012). According to Oudmane et al. (2019), Njagi et al. (2018), and Yardim et al. (2010), presence of young children had the negative affect while presence of the elderly people in the household was having a positive effect on OOP health expenditure. The results of Molla et al. (2017) found no significant impact of the presence of under-five children and elderly members on OOP health payments.

Education and employment status are essential in order to analyse the impact of household characteristics on OOP health expenditures. The results of Kumara & Samaratunge (2016), da Silva et al. (2015), Muhammad Malik & Azam Syed (2012), You & Kobayashi (2011), Okunade et al. (2010), and Yardim et al. (2010) demonstrated that education of household head was a positive predictor of OOP health expenditures. In contrast, Oudmane et al. (2019), Njagi et al. (2018), Molla et al. (2017), Brinda et al. (2014), Costa-Font et al. (2007), Rous & Hotchkiss (2003), and Pannarunothai & Mills (1997) explained the negative relationship between household head education and OOP health expenses. The possible reason considered was that more educated people might have better exposure of heath perils. According to Pal (2010), female education, especially in rural areas, reduced OOP health payments. Older and highly educated household heads were also negatively associated with OOP health payments (Rous & Hotchkiss, 2003). According to Sen & Rout (2007), household head's education had insignificant positive relationship with OOP health payments. Moreover, Muhammad Malik & Azam Syed (2012) considered education of household head spouse to be an important factor which had a positive impact of such payments as well.

Profession of head of household was used by some authors. There was a negative relationship of OOP health expenditures with white collar jobs (Muhammad Malik & Azam Syed, 2012) and with households working as manual labor (Brinda et al.2014). According to Sekyi & Domanban (2012), Oudmane et al. (2019), and Yardim et al. (2010) employment status was considered to be the positive predictor of such expenses where they assumed that employed persons had high opportunity

cost of illness as well more capacity to pay for health care resulting in higher OOP health expenditures. However, Njagi et al. (2018), and Amaya-Lara (2016) found negative relationship between OOP health payments and employment showing that there might be more number of working members in household that reduced OOP health payments. Moreover, negative association was considered due to the duration of occupation (Okello & Njeru, 2015) and formal employment (Buigut et al. 2015).

Household income and expenditure play a vital role while studying health spending. Household income is a good indicator of household capacity to spend whereas expenditures show households' tendency to spend. Income is usually measured by expenditure due to lack of income data of households in many developing countries. And it was having negative relationship with OOP health payments [Sekyi & Domanban (2012), Oudmane et al. (2019), Pannarunothai & Mills (1997)]. In contrast, Mamun et al. (2018), Molla et al. (2017), Amaya-Lara (2016), Okello & Njeru (2015), da Silva et al. (2015), You & Kobayashi (2011), Okunade et al. (2010), Sen & Rout (2007), Rous & Hotchkiss (2003), Rubin & Koelln (1993) have explicated positive relationship between household income and OOP health expenditure.

Among other household head characteristics gender also gets attention. According to Oudmane et al. (2019), Molla et al. (2017), Sekyi & Domanban (2012), You & Kobayashi (2011), Okunade et al. (2010), Pannarunothai & Mills (1997), gender of household head had a negative impact on OOP health expenditures. Male household head experienced less OOP health expenses (Muhammad Malik & Azam Syed, 2012) whereas households with male head incurred more OOP health expenses found by Mamun et al. (2018), Rous & Hotchkiss (2003), and Brinda et al. (2012). Furthermore, many studies had considered a positive relationship between household head's gender and such payments [Pal (2010), Mugisha et al. (2002), Costa-Font et al. (2007), Brinda et al. (2014)]. Njagi et al. (2018) extensively reviewed previous literature and concluded that different studies displayed diverse effects of gender but, on the whole, women were exposed to incur more health spending.

According to Pal (2010), method of cooking, household asset index and the access to electricity negatively predicted OOP expenditures on

health. Method of cooking and household's access to electricity indicate household's capacity to make expenses. Safe cooking methods have two dimensional relations as it showed more wealth as well as better health. In addition, household asset index also depicted the well-being of households. According to the study of Pal (2010), Household asset index consisted of various indicators i.e., radio, television, air conditioner, air cooler, sewing machine, refrigerator, bicycle, motorcycle, car. Rubin & Koelln (1993) reported a positive association between asset index and such expenses for non-elderly members. According to Okunade et al. (2010), wealth index was positively associated with OOP expenditures on health.

The study of You & Kobayashi (2011) considered good toilet facility and good sanitation as negative predictors while good water as positive predictor of OOP health payments. According to Muhammad Malik & Azam Syed (2012), OOP health expenditures had a positive relationship with unhygienic toilet and unsafe water. There was negative relationship between OOP health expenditure and water [Mamun et al. (2018)] and with lack of plumbed toilet [Brinda et al (2012), Brinda et al. (2014)]. Additionally, OOP health expenditures were negatively associated with piped water, good sanitation and good garbage disposal system (Rous & Hotchkiss, 2003). According to Mamun et al. (2018), access to sanitation was positively associated with OOP health expenses. Moreover, a positive relationship between travelling cost to health facility and OOP health payments, depicting that households far from health facility were likely to incur more OOP health expenses, was found by Muhammad Malik & Azam Syed (2012), and Njagi et al. (2018). In contrast, Kumara & Samaratunge (2016) explained that less distance to government was linked with more OOP health payments.

Consumption of smoke has also serious effects on health. In the literature, it was either taken as a dummy variable or as the expenditures on smoke. This research, however, modified the variable as the quantity of smoke consumed by households. Costa-Font et al. (2007) Rous & Hotchkiss (2003) found out positive impact of smoke on OOP health expenditures, stating that households with consumption of smoke were making more spending on health. Some studies reported that households living in rural areas have high OOP spending [Njagi et al. (2018), Amaya-

Lara (2016), Minh et al. (2013), You & Kobayashi, (2011), Yardim et al. (2010)]. According to Rous & Hotchkiss (2003), OOP health expenditure was negatively associated with households residing in urban areas.

Besides the determinants of OOP health expenditures, there were some studies measuring the catastrophic effects of OOP expenditures as well. According to Dorjdagva et al. (2016), catastrophic health expenditures were higher in richer households who had more capacity to pay. Xu et al. (2011), and Xu et al. (2003) analyzed health expenditures of multiple countries with results of cross country analysis showing that there were disparities in catastrophic health expenditures of different countries. The catastrophic OOP health expenses fall the poor segment of society into poverty trap. To curb the catastrophe arising as a result of high OOP health expenditures, policy implications are needed by the researchers.

From this literature review, it was found that household level socio-economic variables were worth exploring determinants of OOP health expenditure in various countries around the globe. Mainly, micro level studies, employing cross-sectional survey data, were conducted to study household OOP health expenditures. In addition, various econometric methods (mostly Simple Least Squares) were employed by researchers. It is learnt from an erudite discussion that almost all studies, while exploring determinants, have performed regression analyses by using different econometric techniques.

3. Methodology

The model of demand for health, constructed by Grossman (1972), was used for the theoretical understanding of this study. Grossman's model of health demand brought a great development in the field of health economics. The data for this study was extracted from PSLM/HIES 2018-19. This survey was conducted by Pakistan Bureau of Statistics (PBS).

Since the data used in this research was cross-sectional in nature, the Variance-Weighted Least Squares (VWLS) regression model was employed which resolves the problem of heteroscedasticity. The problem of heteroscedasticity is common in cross-sectional data. In the presence of heteroscedasticity, OLS estimators become inefficient. In order to get

homoscedastic variance (i.e. efficient results) it is favorable to use VWLS regression. Mostly, VWLS is helpful in case of data related to scientific measurements, having errors of measurement with known sizes. Further, it can also be used in case of categorical analysis of data (data with categorical independent variables and continuous/discrete dependent variable).

VWLS regression can be fitted in the following type of econometric model:

$$y_i = X_i b + \varepsilon_i$$

Where

y_i denotes dependent variable

X_i denotes a list of independent variables

ε_i denotes error term with normal distribution as mentioned below:

$$\varepsilon_i \sim N\ (0, v_i)$$

VWLS regression follows the assumption (mentioned in equation 2) that the estimates s_i^2 for the variance v_i are already in the regression model: the error variance is not needed to be estimated). VWLS regression estimates large standard error errors for the coefficients in the regression analysis. However, it should be noted that VWLS cannot be appropriately used if only the relative proportion of the error variance of y_i is estimated.

3.1 Model Specification

The general model employed to see the impact of different variables on OOP health expenditure is as follows:

$$OOP = \beta_0 + \beta_1 HHSIZ + \beta_2 HHEXP + \beta_3 SMOKE + \beta_4 EDU + \beta_5 CHILD + \beta_6 ELDER + \beta_7 WATER + \beta_8 SANI + \beta_9 GARB + \beta_{10} ELEC + \beta_{11} GAS + \varepsilon$$

Where

OOP:	Out-Of-Pocket Health Expenditure
HHSIZ:	Household Size
HHEXP:	Household Consumption Expenditure
SMOKE:	Smoke Quantity
EDU:	Average Household Schooling

CHILD: Number of Under-5 Children

ELDER: Number of Elders (65y or Above)

WATER: Piped Water

SANI: Proper Sanitation

GARB: Proper Garbage Disposal

ELEC: Electricity in Household

GAS: Gas in Household

ε: Error Term

The impact of these variables on OOP health payments was seen in all the estimated models. The details about coefficients, their signs and significance, has been presented in section 4 (Results and Discussion).

In 2018-19, average education of household decreased to 2.8 years ranged from 0 to 21 years. Looking at the variable of smoke quantity, on average 323 units of smoke were consumed per household ranged from 0 to 18300 units. These statistics can be seen in table 1 and table 2.

Table 1

Summary Statistics of Variables

Variables	Mean	SD	CV
OOP	13897	30061	216.3
HH Expenditure	411815	375099	91.1
Under-5 Children	0.85	1.1	126.4
65y or Above Elders	0.25	0.53	209
HH Size	6.5	3.23	50
Average HH Schooling	2.8	2.9	105.9
Smoke Quantity	323	611	188.9

Table 2

Summary Statistics of Dummy Variables

Variables	Mode	Skewness	Kurtosis
Electricity (lighting fuel)	0	0.54	1.3
Gas (cooking fuel)	1	-2.49	7.2
Piped Water	0	1.63	3.7
Sanitation	0	1.28	2.6
Garbage	0	1.1	2.1

4. Results and Discussion

The results of estimated model have shown the impact of various factors on the household OOP health expenditure in Pakistan. Moreover, ten sub-samples of the model were estimated to explain the impact of these factors in urban and rural settings separately. As the anthropological, economic, social and climatic distribution vary distinctly across provinces in Pakistan, therefore, besides aggregate sub-samples of OOP health expenditure for data were estimated for rural and urban settings, disaggregated sub-samples were also estimated for each of the four provinces.

Each sub-sample shows the impact of eleven different variables on OOP health expenditure of Pakistani households. All the estimated coefficients of all the selected variables in the model and the sub-samples were statistically significant at 99% confidence. The variance inflation factor (VIF) was estimated to detect the problem of multi-collinearity in the estimated model and its sub-samples. VIF value was less than 1.5 in the estimated model and all of its sub-samples, predicting no issue of multi-collinearity. Moreover, the problem of heteroscedasticity was resolved after using VWLS method. Since this study used cross sectional data, other data issues like autocorrelation or stationarity were not relevant. The strategy adopted to explain the model and its sub-samples was to discuss the impact of each of the eleven variables at aggregate as well disaggregate levels to compare the influence of each of the eleven variables on OOP health expenditure in Pakistan at household level for all the selected categories of analysis. The complete model and sub-sample summaries are shared in the Appendix.

4.1 Findings of the Study

The impact of **household size** was found positive of household OOP health expenditure in the estimated model, resulting into an increase in household OOP health expenditure due to increase in household size. The highest impact was in rural KP while the lowest was in urban Sindh. On average, for an increase of one household member there was an increase in household OOP health expenditure of RS. 60.9 in the rural households

while that of RS. 63 in the urban areas. There was an increase in OOP health expenditures of RS. 68 in rural KP and RS. 50 in urban Sindh.

There were two other variables that had a positive impact on household OOP health expenditure, namely, **the number of under-five children** and **elderly** in household. Both these variables were constructed to see the impact of number of dependents in the household on its OOP health expenditure, assuming the household members in each of these two groups to be the dependents. The number of under-five children in household had positive impact on OOP health expenditure, explaining the increase in OOP health payments for an increase of one under-five child in household.

Just like the number of under-five children, the number of elderly members in household also had a positive impact on OOP health expenditure. Among provinces, the impact was highest in urban Punjab and smallest in rural KP. On average, for an increase of one elderly member in the household there was an increase in household OOP health expenditures of RS. 2642 in urban Pakistan and RS. 2654 in rural Pakistan. In addition, the impact was estimated to be RS. 2647 in rural KP and RS. 6822 in urban Punjab.

Average **education** of household had positive impact on household OOP health expenditure whereby an increase in one year of education of household caused increased OOP health expenditure. The rationale for such an impact could be better realization of health-related expenditure to be carried out for improved human capital formation, as a consequence more education. The impact was highest in rural KP and smallest in urban Baluchistan. In the estimated model, the impact on average was more in the rural households than in the urban households (perhaps the difference between more and less educated person, in terms of realization of health expenditures' importance, is more in rural areas than in the urban areas). On average, for an increase of one year of education of household there was an increase in household OOP health expenditures of RS. 167 in in urban Baluchistan and nearly RS. 298 in rural KP.

There was a positive impact of **household expenditures** on household OOP health expenditures in Pakistan whereby an increase in

overall household expenditures caused increased household OOP health expenditures in the estimated model. The impact was highest in rural Punjab and smallest in urban Baluchistan. In the estimated model, the impact was greater in rural settings than in the urban settings. On average, for an increase of RS.10000 in household consumption expenditure, there was an increase in OOP health expenditures of RS. 233 in urban Baluchistan and nearly RS. 305 in rural Punjab while all the other settings were within this range of rural and urban Punjab.

The quantity of **smoke consumption** had also positive impact on household OOP health expenditures in Pakistan where an increase in smoke consumption resulted in an increase in household OOP health expenditures in the estimated model. The impact was highest in urban Sindh and smallest in rural Punjab. On average, for an increase of RS.1000 units of smoke consumption there was an increase in household OOP health expenditures of RS. 1394 in Pakistan, RS. 1448 in urban Sindh, and RS. 1350 in rural Punjab.

The impact of all the other variables, including piped water, sanitation, garbage disposal, and gas, was negative on household OOP health expenditure in Pakistan in the estimated model. The negative impact of **piped water** on household OOP health expenditure depicted that households with piped water facility enjoyed better health conditions and therefore required less health expenditure. The urban households of Baluchistan with piped water facility spent around RS. 805 less than other households who were not having that facility, while the rural households of KP incurred nearly RS. 960 less than the other households.

There was a negative impact of proper **sanitation** in household on OOP health expenditures in Pakistan. The negative impact showed that households who had the facility of proper sanitation system spent less household OOP health expenditures in the estimated model than those households that did not have that facility. Households of urban Baluchistan with proper sanitation system spent around RS. 3461 less than the other households.

There was negative impact of proper **garbage disposal** system on OOP health expenditure in the estimated model. The impact explained that households with proper garbage disposal system had spent on average less on OOP health expenditures than those households who did not have proper garbage disposal system in the estimated model, the scale of this impact varied widely across the categories, however. In the urban areas of KP, the households having proper garbage disposal system spent around RS. 2858 less than the other households.

The impact of household **gas connection** was found negative of household OOP health expenditure. The negative sign indicated that households with gas connection had spent on average less on OOP health expenditure than those households that did not have gas connection whereas positive sign depicted that households that use gas as cooking fuel had spent on average more than the other households. The rural households that used gas as cooking fuel disbursed less OOP health expenditures than the other households. Among rural areas, the impact was highest in Baluchistan while smallest in Punjab. In rural Baluchistan, the households with gas paid nearly RS. 1980 less than the other households, while in rural Punjab the impact was RS. 2073 less than the other households. In urban areas, the impact of gas on OOP health payments for the whole country was found negative than its estimated impact on urban households of all the four provinces. On average, households using gas as cooking fuel spent RS. 2042 less than those households that did not use gas for cooking purposes. When the impact was seen specifically for urban households of provinces, contrarily, households using gas as cooking fuel had spent on average more than the other households. The households who used gas for cooking purposes on average spent RS. 494 more in urban Punjab and RS. 707 more in urban Baluchistan.

Electricity had a positive impact on household OOP health expenditures, explaining that households with electricity connection spent more on OOP health expenditures those households who did not have electricity connection. The results showed positive sign with the exception of rural Baluchistan. The results showed an increase in the health expenditure for the households with electricity connections. The impact was more in urban settings than in the rural settings. The rural-urban gap

was widest in the case of KP where the impact was almost twice as much as was in the case of rural KP.

4.2 Discussion

In this study, the sampling unit of analysis of this research was household with the recall period of one year. The OOP health expenditure of households with one-year recall period usually revealed fewer zero values (Muhammad Malik & Azam Syed, 2012). The findings of different variables used in this this study confirmed the results of previous research.

The variable '**household size**' was expected to have a positive impact on household OOP health expenditure as presented by the existing literature, specifying that larger households would incur more OOP health expenditure [Mamun et al. 2018; Paul et al. 2018; Sekyi & Domanban, 2012; Pal, 2010; Costa-Font et al. 2007; Rous & Hotchkiss, 2003; Rubin & Koelln, 1993]. In contrast, Minh et al. (2013), Silva et al. (2015), and Lee et al. (2019) explained the negative relationship between household size and OOP payments. Contrary to the studies showing negative impact, the results of this research were aligned with the positive impact of household size on OOP health payments. In addition, the positive effect of **smoke consumption** by households was also studied in the literature. The findings of this research were supported by Costa-Font et al. (2007) Rous & Hotchkiss (2003) who found out increased OOP health expenditures as a result of smoke.

While analyzing the household characteristics affecting OOP health expenditure, **children** and **elders** were mostly considered as vulnerable members of a household. The results of these two variables carried the positive sign, consistent with the literature, and were statistically significant also. These findings were in line with the results of Hailemichael et al. (2019), Paul et al. (2018), Amaya-Lara (2016), Minh et al. (2013), Muhammad Malik & Azam Syed (2012), and Pal (2010) revealing that the households with vulnerable members had positive relationship with OOP health expenditure because they were likely to have more health needs.

Education was also essential to analyze the impact of household characteristics on OOP health expenditures. The findings of this study were

based on the fact that more educated people take greater care of their health. This study analyzed the impact of average education of the household instead of just focusing on the education of household head or spouse. The existing literature focused mainly on household head's education. The positive and significant relationship between education and OOP health expenditures was corroborated by the findings of Kumara & Samaratunge (2016), Silva et al. (2015), Muhammad Malik & Azam Syed (2012), You & Kobayashi (2011), Okunade et al. (2010), and Yardim et al. (2010), demonstrating that education of household head was a positive predictor of OOP health expenditures. The findings of Muhammad Malik & Azam Syed (2012), however, showed education of household head's spouse to have a positive impact on OOP health expenditures. In contrast, Oudmane et al. (2019), Njagi et al. (2018), Molla et al. (2017), Brinda et al. (2014), Costa-Font et al. (2007), Rous & Hotchkiss (2003), and Pannarunothai & Mills (1997) held a different view, explaining the negative relationship between household head education and OOP health expenses.

Household income and **consumption expenditures** have been interchangeably used in the existing literature of health spending. Household income is a good indicator of the capacity of household to spend whereas expenditures show households' tendency to spend. To discuss the variable of interest, namely, household consumption expenditures, it could be seen that its impact on OOP health expenditure was positive and statistically significant in this research. These results were consistent with the study of Yardim et al. (2010) which concluded the positive relationship between per capita household expenditure and OOP health payments.

The negative sign of the coefficient for dummy variables like **piped water**, **sanitation** and **garbage disposal** indicated a negative impact of these variables on household OOP health expenditure whereby households with facilities of piped water, proper sanitation and garbage disposal system had spent less on health than those households that did not own such facilities. The results for each of these variables carried the expected signs (negative sign) and were also statistically significant. The findings of You & Kobayashi (2011) have corroborated the negative impact of proper sanitation but opposed the finding of piped water as a negative predictor of OOP health payments. The negative impact of piped water was in line with

the findings of Mamun et al. (2018), Muhammad Malik & Azam Syed (2012), and Rous & Hotchkiss (2003). Additionally, the negative sign of proper sanitation and garbage disposal system was consistent with the findings of Rous & Hotchkiss (2003). However, the findings of Mamun et al. (2018) provided a different view regarding sanitation stating that households having access to sanitation had spent more OOP health expenses.

Household's access to **gas** and **electricity** indicates household's capacity to make expenses. However, methods of cooking have two dimensional relations as it indicates more wealth as well as better health. The findings of this research observed the positive impact of electricity in Pakistan. There was a negative sign of gas for all the estimated model and all the sub-samples with the exception of urban dwellings of four provinces, which observed positive impact of gas on OOP health expenditures. The study of Pal (2010) has corroborated the negative impact of gas on OOP health expenditures. On the contrary, the positive sign of electricity was not matched with the study of Pal (2010) that concluded electricity to be negatively affecting OOP health expenditures.

Unlike Rahman et al. (2020) Datta et al. (2019) Lee et al. (2019) Brinda et al. (2018) Farahat et al. (2018) Njagi et al. (2018) Paul et al. (2018) Kumara & Samaratunge (2016) Brinda et al (2012) You & Kobayashi (2011) Pannarunothai & Mills (1997) this study could not analyze the impact of diseases on OOP health expenditures due to some limitations of data.

From this detailed discussion of the estimated results, it was concluded that the research hypothesis could not be rejected. The coefficients of different socio-economic and other variables have indicated the significant impact on household OOP health expenditure in Pakistan. The comparison of these results with the earlier research would not be conclusive in itself as these comparisons find constraints in terms of differences in nature of data, econometric models, and estimation techniques. Some significant differences in the time period of data and unit of analysis were also revealed while reviewing the previous studies.

5. Policy Implications

Healthcare system directly affects the economy of a country. Pakistan is a struggling economy with poor health indicators in the region. By investing in health through a health sensitive budget, Pakistan could not only be saving lives and promoting human rights, it can also further its economic interests strategically for a safer, healthier and wealthier Pakistan.

Understanding the determinants of OOP health expenditures can help policymakers develop possible strategies to reform the overall healthcare system. Regarding the policy implications, targeted financial support could be provided to vulnerable groups to alleviate the financial burden of healthcare expenditures. Further, regulating healthcare cost including consultation fee, diagnostic tests and other healthcare expenditures can prevent healthcare providers from overcharging pateints. There is a dire need for investment in health education and preventive programs to promote a healthier lifestyle. Moreover, continuous monitoring and evaluation of policies could also play a vital role in improving the overall performance of healthcare system.

6. Conclusions

From this study, the research hypothesis, providing the basis of the argument that various factors influence spending on health, was proved. The coefficients of different socio-economic and other demographic variables have indicated the significant impact on household OOP health expenditure in Pakistan. Surprisingly, the signs of many variables used in this study were in line with the dominant view of the literature. The impact of factors like household size, smoke consumption, the number of under-five children and elderly in household, average household education, and consumption expenditure was found positive and statistically significant of OOP health expenditure in all the estimated models. Households with the facilities of piped water, proper sanitation and garbage disposal system were having less spending on health.

As per findings of **Sindh** data, household size had relatively ***low*** impact while smoke consumption was having ***highest*** impact on OOP health expenditure in *urban* Sindh.

The results of **Punjab** showed that there was ***highest*** influence of consumption expenditure and gas on OOP health payments, and ***lowest*** impact of smoke consumption and garbage disposal in *rural* Punjab. In *urban* Punjab, the number of elderly members in household had ***highest*** impact on OOP heath spending.

In *rural* **Baluchistan**, gas connection was having ***low*** impact and number of under-five children had ***highest*** impact on OOP health expenditure. In *urban* Baluchistan piped water had ***lowest*** impact in both times. The province-wise results showed that there was ***less*** influence of number of under-five children, consumption expenditure, average household education, piped water, and proper sanitation in *urban* Baluchistan.

The results of **KP** described that the households with electricity and elderly members had ***lowest*** effect on OOP health expenses and households with piped water, proper sanitation were having ***highest*** influence in *rural* KP. In *urban* KP, households with the facility of electricity and garbage disposal had ***highest*** impact on OOP health spending.

The comparison of these results with the earlier research might not be conclusive in itself due to many constraints (like differences in data, estimation techniques). However, the results of this study are hoped to be useful in policy analysis for household support in dealing with health expenses.

7. Limitations and Scope for Future Research

There is two-dimensional effect of health-related expenditures. On one hand, health expenditures affect health status, while, on the other hand, health status influences health expenses. This causal relationship between OOP expenditure on health and status of health was not analyzed in this study. Further, as the data used for this research was survey-based, it could have some implications of recall bias (some respondents might not easily recall expenses). In addition, supply side factors of health care (such as healthcare providers) were not considered due to the unavailability of such information in data used in this research. Hence, there can be further improvements in this study if household surveys add some other health related aspects in data. For future research in this area of study, researchers can explore OOP health expenditure by using different nature of data, unit of analysis, econometric models, or estimation techniques.

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APPENDIX

Table A1:

Results of Pakistan- Overall and Urban-Rural Settings

APPENDIX

Table A1:

Results of Pakistan- Overall and Urban-Rural Settings

Dependent: OOP	**Overall**		**Rural**		**Urban**	
	Model		***Sub-Sample 1***		***Sub-Sample 2***	
Independent Variables	**Beta**	**Sig**	**Beta**	**Sig**	**Beta**	**Sig**
HH Expenditure	.030427	0	.0304319	0	.0303772	0
Under-5 Children	877.5881	0	878.4679	0	867.3958	0
65y or Above Elders	2653.805	0	2654.234	0	2642.038	0
HH Size	61.01735	0	60.91316	0	63.22367	0
Average HH Schooling	288.9416	0	288.7465	0	288.6243	0

Lighting Fuel	691.697	0	692.0428	0	728.7589	0
Cooking Fuel	-2058.57	0	-2059.691	0	-2041.909	0
Piped Water	-942.6708	0	-942.0367	0	-936.7148	0
Sanitation	-4906.587	0	-4907.477	0	-4898.246	0
Garbage	-414.6661	0	-452.828	0	-409.8563	0
Smoke Quantity	1.393464	0	1.39163	0	1.401101	0
_constant	-137.6436	0	-137.609	0	-188.5489	0
Observations	24748		15891		8857	
Model chi2	35700000	0	27500000	0	7895932.7	0
Goodness of fit (chi2)	24732.97	0.5042	15875.61	0.5061	8831.97	0.5370

Table A2:

Results of Rural Setting of Provinces

Dependent : OOP	**KP**		**Punjab**		**Sindh**		
	Sub-Sample 3		***Sub-Sample 4***		***Sub-Sample 5***		
Independent Variables	**Beta**	**Sig**	**Beta**	**Sig**	**Beta**	**Sig**	**Beta**
HH Expenditure	.0303674	0	.0304976	0	.0303663	0	.029849
Under-5 Children	860.9394	0	875.7332	0	876.9628	0	881.0382

65y or Above Elders	2646.926	0	2648.409	0	2654.395	0	2668.829
HH Size	68.41486	0	58.05587	0	61.81554	0	62.37787
Average HH Schooling	297.6826	0	288.2137	0	289.6099	0	245.3905
Lighting Fuel	676.4292	0	706.0808	0	694.5681	0	772.2756
Cooking Fuel	-2037.987	0	-2073.153	0	-2059.873	0	-1979.44
Piped Water	-959.4863	0	-943.9692	0	-958.4311	0	-778.889
Sanitation	-4912.355	0	-4902.494	0	-4880.947	0	-4738.79
Garbage	-584.6178	0	-448.0648	0	-555.1222	0	-1819.85
Smoke Quantity	1.396904	0	1.349599	0	1.393604	0	1.439121
_constant	-150.6519	0	-136.456	0	-132.4718	0	-130.666
Observations	3018		7809		3497		1567
Model chi2	1189052.9	0	14700000	0	7313406.48	0	176440.2
Goodness of fit (chi2)	3002.51	0.515	7791.03	0.5169	3483.99	0.502	1497.19

Dependent: OOP	KP		Punjab		Sindh		Baluchistan	
	Sub-Sample 7		*Sub-Sample 8*		*Sub-Sample 9*		*Sub-Sample 10*	
Independent Variables	**Beta**	**Sig**	**Beta**	**Sig**	**Beta**	**Sig**	**Beta**	**Sig**
HH Expenditure	0.0237708	0	0.0237	0	0.0238503	0	0.0232827	0
Under-5 Children	268.4715	0	240.5963	0	246.5654	0	231.7789	0
65y or Above Elders	6744.372	0	6822.006	0	6756.597	0	6535.386	0
HH Size	67.23922	0	50.47659	0	50.07166	0	65.45829	0.003
Average HH Schooling	209.5333	0	202.0646	0	199.9442	0	166.6908	0
Lighting Fuel	1346.229	0	1117.973	0	1153.853	0	1219.405	0
Cooking Fuel	507.3909	0	493.9815	0	499.6378	0	707.1999	0
Piped Water	-890.4142	0	-883.0648	0	-870.9697	0	-805.0481	0
Sanitation	-3492.222	0	-3640.591	0	-3661.616	0	-3460.66	0
Garbage	-2858.289	0	-2849.108	0	-2844.468	0	-2798.247	0
Smoke Quantity	1.385684	0	1.437752	0	1.447566	0	1.370195	0
_constant	-1020.156	0	-695.2751	0	-742.3578	0	-908.9857	0.009
Observations	1446		3938		2715		758	

Model chi2	1857719.3	0	3176338.36	0	2385499.05	0	25929.24	0
Goodness of fit (chi2)	1429.84	0.526	3921.82	0.5158	2697.95	0.524	737.17	0.584

Table A3:

Results of Urban Setting of Provinces

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Behaviour Towards Climate Change – Intentions of The People of Karachi

* Shagufta Shabbar ** Siddiqua Alibhai

Abstract: In Pakistan, climate change is affecting agricultural output, increasing healthcare burden, causing havoc with lives, and damaging properties. Urban flooding has become a continuous issue. But are the people able to make a link between their actions and the impact it may have on causing climate change? Although some climate change mitigation strategies are being implemented by the government and various non-governmental organizations, they are far from being successful. Besides blaming the authorities little is being done by the people towards conservation, a major factor being the lack of interest in climate change. It is important to understand whether the general public recognizes the significance of mitigation strategies, and if so what actions, if any, are they taking. The current research uses primary cross-sectional data of 398 respondents collected using social media platforms in 2022, in order to find the intention of the public behind actions such as energy and water conservation and usage of cloth bags in place of plastic ones. Using logistic regression and qualitative analysis this paper investigates the level of awareness of the residents of Karachi in the context of climate change and their responsiveness regarding the need to take steps to reduce the adverse effects of climate change. The results show that the general behaviour of the people stems from their own preferences instead of concern for climate change, indicating the need for a deeper understanding of behavioural response towards climate change. This study calls for policy actions inducing behavioural change in the citizens, through green nudges.

Key words Climate change, energy conservation, intent-oriented, mitigation, recycling
JEL Classification Q53, Q54, Q38, Q25

1 Introduction

Studies on climate change in South East Asian region, reveal that local people do have an understanding that human activities, like cutting hills,

*PhD Scholar at IBA Karachi, sshabbar@iba.edu.pk

** Freelance Researcher siddiquaalibhai@gmail.com

deforestation and building infrastructures cause landslides (Ahmed, et al., 2022). However, opinions about the causes vary among the natives. Many believe human actions cause climate change, others recognize mitigation as a joint responsibility of the government to raise public awareness and citizens to show restraint by conserving resources like water and energy (Ahmed, & Atiqul Haq, 2019). The residents of Pakistan, are lacking insight on benefits and self-efficacy; there is a careless attitude towards gasoline use, energy and water consumption at household level, and recycling waste. The higher income and more educated strata are aware of the threats of climate change and are more likely to alter their behaviour and mitigate (Alvi, et al., 2020). Our objective to conduct research on the people of Karachi, their behaviour and intentions towards climate change, came from the gap existing in literature, as specifically the residents of Karachi were not found to be the subject of any study in the context of climate change. Awareness exists in varying degrees in Pakistan, we found literature on urban and rural women of Sindh[1], who are aware of climate change, however their awareness comes from secondary sources and their knowledge about hazards of climate change come from personal experience (Memon, et al., 2022). A study on urban, peri-urban and rural areas of Pakistan shows that the people are not equipped with the awareness of climate crisis nor do they possess knowledge of mitigation and adaptation strategies (Hussain, et al., 2018; and Hussain, et al., 2020). And even if they do have knowledge and may demonstrate the intention, they do not translate it into actual behaviour (Nguyen, Nguyen, & Hoang, 2019; Ceglia, de Oliveira Lima, & Leocádio, 2015; and Hanss, Böhm, Doran, & Homburg, 2016).

More and more governments are making their citizens responsible for climate change at the household level. As lifestyle choice and choosing environment friendly conduct by individuals will bring forth benefits collectively (Kent, 2012). People with more concern for the environment

[1] Sindh is a province in Pakistan, Karachi is a megalopolis of Sindh

are more likely to practice energy conservation, for instance by consuming energy-efficient light bulbs and other appliances. However, the study of 9 OECD countries shows that motivation to adapt is low when energy-saving investments are of higher costs, and more time consuming in acquiring and implementing (Urban and Scasny, 2012; and Elahi, Khalid, & Zhang, 2022). The higher cost of the product deters people unless they are fully aware of the benefits of the product (Trivedi, Patel, & Acharya, 2018; and Taghikhah, Voinov, & Shukla, 2019). The intention to purchase environment friendly products also depends on demographic variables such as age, gender, income and education (Shuai, Ding, Zhang, Guo, & Shuai, 2014; and Wang, Shen, Springer, & Hou, 2021). It additionally depends on easy and sufficient availability of environmental friendly products (Bonini, & Oppenheim, 2008; and Peattie, 2010).

Individuals do not like to consider their own lifestyles as the cause of climate change; it is much easier for them to blame other industrialised economies for contaminating the earth. Recent research reveals that developed countries too are struggling to make their citizens conscious of the threat climate change poses globally. In order to promote sustainable living, individuals, households, neighbourhoods and community level engagement is needed. It is imperative that all stakeholders opt for both mitigation (reduction of emissions from energy use) and adaptation to environment-friendly lifestyles to avoid the threats climate change poses (IPCC, 2007). Factual information on climate change must be communicated in a manner where the message hits home (Jang, 2013). Simultaneously more and complete information should be provided to the consumers regarding the environmental impact of their actions (Li, Long, & Chen, 2017). Likewise, green product awareness should be increased through concentrated efforts (Sreen, Purbey, & Sadarangani, 2018).

In a society like Pakistan, the role of women and children and that of the marginalized groups must be recognized as they are the potential agents of

change. Making them knowledgeable about the threats of climate change will create a society that will consciously adapt its lifestyle to mitigate GHG emission. Adaptation comes from learning-by-doing (Salman, et al., 2018). Therefore, an all-inclusive view and approach is required to understand Pro-Environmental Behaviours (PEBs) in order to change to a low-carbon society. At a national level, industrial and commercial sectors must have the pro-environmental attitude and at the individual level, people must make a pro-environmental choice. The main reason to adopt or not to adopt PEBs is the cost. Saving, followed by habit and convenience motivate people to switch to PEB. In some economies, rules and regulations are in place thus it is incumbent to follow PEBs, yet in other societies moral values (no wastage of resources) enforce PEBs (Lee, et al., 2013). People in general display more pro-social behaviour when in public. The reason is that being visible to others makes one conscious about being judged; it is the reverse of the Bystander Effect. [2]Actions like displaying a reusable grocery bag motivate the pro-environment actors as it is sending a positive signal to the valued environment friendly group, thus reinforcing responsible behaviour "green to be seen". Thus the social influence shapes green intentions of the people (Wu, & Chen, 2014; and Choi, & Johnson, 2019).

Low carbon lifestyles encompass reduce, reuse and recycle. It includes avoiding or reducing driving and flying, red meat and dairy consumption, material and energy consumption. Low carbon lifestyle means adopting low-carbon and climate-resilient technologies e.g. installing insulation; support for large-scale low-carbon infrastructures e.g., wind farms etc., (Whitmarsh, et al., 2021). Low-carbon lifestyle change will impact tourism as well. Holiday destinations, the transportation system at these tourist locations will cause geographic and seasonal shifts in tourism demand, whereby demand may increase or decrease of specific tourism markets

[2] Bystanders will come forward to help if they know they are being watched or there is a CCTV camera around.

(Gössling, et al., 2012). Society and science have to work together to ensure the dangers of climate change are understood by all citizens. The two cardinal rules to be followed are, first the rights of the entire global community must be of concern, which is inclusive of developing nations and especially poor nations and second is to ensure sustainable development for future generations (Change, et al., 2006).

Denial of climate change or ignoring the magnitude of grave environmental problems occurring due to climate change, will lead to the breakdown of ecosystems that the earth relies on. Global warming is already creating havoc to the environment, the need of the hour is to acknowledge the situation and work towards securing our future. Ian Lowe, (in his review of Haydn Washington's book, *Climate change denial: Heads in the sand*) says, "*Climate change denial is the biggest single obstacle to achieving a sustainable futu*re". Policy makers, scientists and citizens must be on board to reduce the damage caused by climate change. The proverbial head in the sand where climate change is concerned, does not make our habitat any less vulnerable from the effects of the crisis we are facing. Behaviour change, individual as well as societal, is central to reducing emissions. Collectively, lifestyles will have to change if mitigation is to be achieved. Reducing the effects of climate change not only requires changes in consumer behaviour but communities and organisations have to come forward and play their part. Especially those in positions of political power can impact policies.

Environmentally concerned citizens are divided on how to tackle climate change, some are advocates of individual behaviour change while others advocate collective social action as they blame social structures for causing climate change (Kenis, & Mathijs, 2012). Policy makers are relying on behaviour change regardless of huge investments in clean/renewable energy to reduce carbon emissions. As behaviour change will translate into mitigation. Social media plays a great role in influencing responsible behaviour by promoting low carbon lifestyles (Piccolo, & Alani, 2015).

Creating awareness about the adverse effects of climate change can improve attitudes and behaviour towards mitigation and adaptation. According to IPCC, developing and poor countries are more vulnerable to climate change, and have lower levels of understanding environmental issues as per PEW Global's 2006 research (Masud Al-Amin et al., 2016).

Pakistan's National Climate Change Policy of 2012 and its subsequent updated versions clearly states its intention to conserve energy. In Karachi, K-Electric (electricity distributor) in an attempt to tackle the problem of short supply of electricity started a media campaign of making citizens responsible for energy conservation. But did it have the desired impact? Similarly, the government in an attempt to reduce the consumption of plastic, started a drive in 2021 to decrease usage of plastic. Cloth bags were encouraged but did that change the habits of the citizens? Karachi lacks fresh water supply in most of the areas. Fresh water supply uses energy for processing. There are many times when there is no supply and households resort to buying water from 'Tanker Mafia'[3]. But what are the households doing to conserve water consumption. Are there any specific steps being taken to conserve resources or does the government need to create a more impactful awareness campaign to make the citizens more responsible? These are important questions that this study aims to answer.

This paper seeks to understand the actual meaning behind the actions taken by the people which may result in having an impact on the climate. Intent oriented behaviour is taken here as being the cause behind the action taken which can in turn impact the climate (Stern, 2000; Whitmarsh, 2009). Altruistic people are motivated to demonstrate actions that are environmentally intent oriented (Stern, 2000). Stern describes attitudes and values as important factors influencing environmentally-significant behaviour. The older age group are more likely to adopt environment

[3] Tanker mafia is a term used to illegal selling of fresh water to households that lack a consistent water supply

friendly actions (Cheng, et al., 2017). Further, the fear of health hazards makes people implement protective measures. Knowledge about climate change and global warming increases the risk perception and people act in self-interest to protect themselves. Since the threat of climate change is portrayed as a global issue, implying that it is more of an external shock, therefore it becomes convenient to blame other countries around the world and their GHG emissions as factors contributing to climate change. Thus the local people absolves themselves to a certain extent and considers their small steps taken towards mitigation as insignificant and as the best they can do (Sharples, 2010).

The contribution to literature in this study is two folds. First, the research in this paper investigates the actions taken by the residents of the city of Karachi and tries to discern if they are taken 'out of concern for climate change' or are 'energy conservation practices'. Thus the aim of this research is to firstly gauge the level of awareness about climate change amongst the population of Karachi, how conscious are households of their own carbon footprint, and what measures are being taken at individual level to become more environment friendly. Hence measuring their values and moral obligation and assessing their association with behaviour that has a significant impact on the environment. To understand this the variables used are described in detail in the data section. Secondly, our study intends to learn whether the citizens connect mitigating the negative effects of climate change at individual level with better quality of air to breathe, better health and general wellbeing. To the best of our knowledge there is no study in the context of Pakistan that has made an attempt to understand these dimensions and thus our study aims to fill this gap in literature. For this purpose, primary data was collected via online survey, the link was shared to school, college and university students, homemakers, and people in the workforce on various social media platforms, who in turn were requested to share the link to the survey with their contacts. The aim was to collect data by snowballing technique. More on this in the data section. With

pervasive digital connectivity and with the Theory of Six degrees of Separation in place, we collected data from as many respondents as consented and were willing. The current study draws from the detailed theoretical foundations provided in Wang, Shen, Springer, & Hou, (2021). The comparison provided of the most popular theories is provided in figure A1 given in the appendix.

2 Contextual Background

Climate change is threatening our ecosystem on earth. Sustainable development goals (SDGs) are designed to encourage stakeholders to take appropriate actions to conserve the planet. Human activities such as manufacturing, energy producing coal-powered plants, fossil fuels etc., are causing a rise in the earth's temperature annually, adversely impacting agriculture, water resources, forests, biodiversity, health, coastal management and causing extreme temperatures leading to melting of glaciers. WWF (New Zealand) states that the main cause of climate change is due to "increased use of fossil fuels". The Intergovernmental Panel on Climate Change (IPCC, the UN Environment Program's climate body) states that there are various evidences to confirm that the planet is slowly warming. This change in the climate has caused not only increased sea levels and melted glaciers but also caused drastic changes in the Earth's climate patterns. At international level IPCC aims to motivate people to help decrease carbon pollution by 2050 to zero.

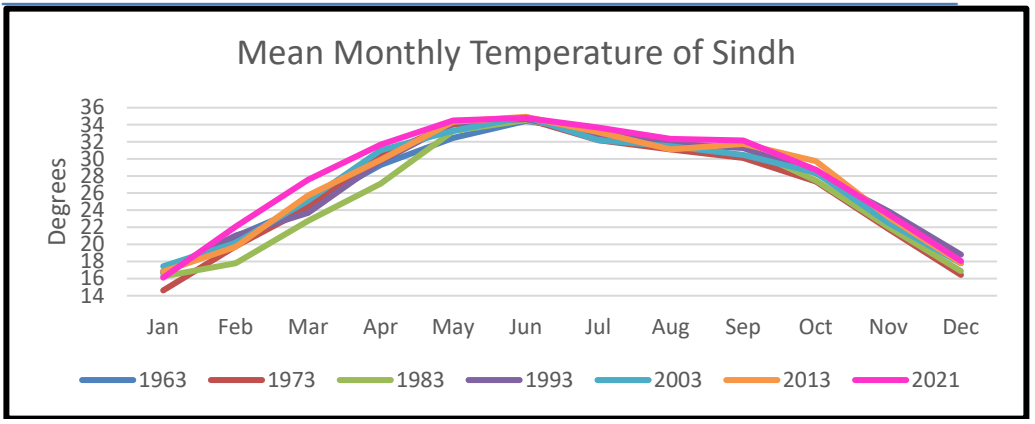
Pakistan has been having its own share of constantly increasing environmental challenges (Pakistan Economic Survey, 2021-2022). Study by Mani et al. (2018) reveals that the Pakistan's average temperature is already higher than the optimal level required for maximum consumption; further increase in temperatures will negatively impact labour productivity thereby decreasing standard of living. Climate change affects living standards as there is a negative correlation between consumption and rising temperatures. CO2 emissions from fuel combustion are the largest

contributors of Greenhouse gas (GHG) emissions. GHG emissions in Pakistan have been on the rise since 2015. Sector-wise breakdown of total GHG emissions in 2019 is, Industrial sector 32%, Transport 28%, Electricity 27%, Building sector 11% and Other Energy-related sectors 2% (Climate Transparency Report, 2020).[4] Breakdown of electricity production from various sources in 2015, is given as, oil 37.2%, gas and coal 25.9%, hydroelectric sources 30.7 %, renewable sources 0.8% (excluding hydroelectric), Nuclear sources 4.8% (World Bank Data).

In a span of around four decades, Pakistan has seen an increase in annual mean temperature of 0.9 degrees (World Bank, 2021).[5] Figures for mean monthly temperatures and average monthly rainfall for Pakistan are presented in figures A3 and A4 in the appendix. The data of the last three decades show that there has been increase in temperature and rainfall no longer follows a seasonal pattern. There has also been a significant surge in the number and intensity of heat waves in the province (sub-national) of Sindh where Karachi is located. Figure 1 shows the data of six decades and indicates that the mean temperature has increased over the years in the Sindh province. Climate Risk Country Profile: Pakistan (2021), notes that the rise in daily maximum temperature is more pronounced than the mean temperature increase. It is seen that at high temperatures consumption, as indicator of living standards, decreases. Due to this challenges like health issues, undernourishment and poverty will continue to rise, affecting all provinces with Sindh being most vulnerable (Mani, et al., 2018). The sixty years' data in figure 2 also shows erratic behaviour and a notable increase in the level of precipitation. Thus further indicating that Pakistan and specifically Sindh are being significantly affected by climate change.

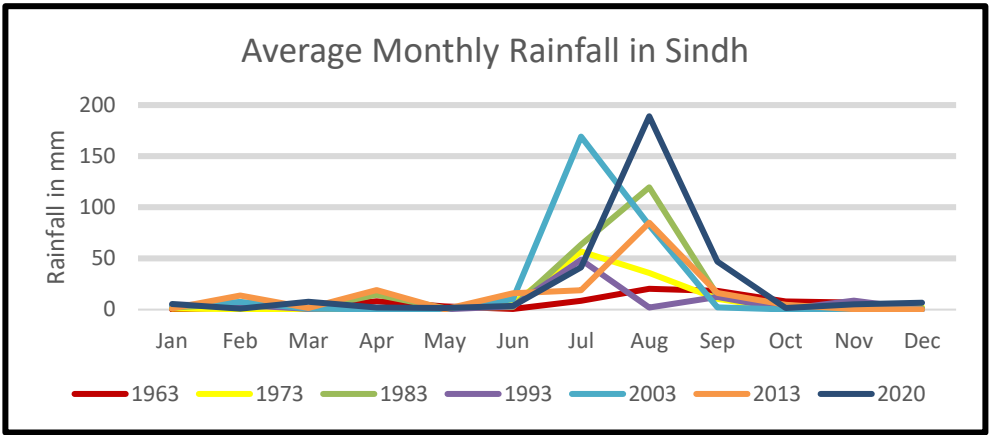
Figure 1

[4] For GHG emissions in Pakistan compared to SAARC countries please see appendix figure A2
[5] Climate Change Knowledge Portal for Development Practitioners and Policy Makers



Source: World Bank Climate Change Knowledge Portal
Note: This is only for selected years.

Figure 2



Source: World Bank Climate Change Knowledge Portal
Note: This is only for selected years.

Energy consumption is used as an indicator by policy makers and research scientists to see if the general public is pursuing the climate change mitigation strategies (Whitmarsh, 2009). It has been observed that energy consumption has increased globally. In terms of Pakistan there is a noticeable steep rise in this consumption. In 2021, Pakistan's Electricity

Consumption rose to a total of 116,816.0 GWh as compared to 108,371.0 GWh in 2020, as reported by the Ministry of Finance of Pakistan. Fossil fuel consumption through coal, rose to 4,875,302.0 Ton of Oil Equivalent (TOE) in 2020 from 2,640,347.0 TOE in 2019. Electricity Consumption in Sindh in 2020 was 20,876.0 GWh. In Karachi, the huge surge in energy demand has mostly been catered by non-renewable energy sources (Civil Society Coalition for Climate Change (CSCCC)).[6] Around 70% of the demand is met by use of natural gas and 28% from oil. Only 8% of the Sindh area has some form of forest resources. Climate change has increased natural disasters including floods (flash floods due to intense monsoon rainfall and melting glaciers); and heat waves. Additionally, there is lack of fresh water supply due to poor water infrastructure in the quickly expanding city of Karachi. Therefore, fresh water scarcity and insufficient supply of energy are the two most serious issues being faced by the citizens. Karachi, as a metropolis of Pakistan, bears burden of being overpopulated and thus is not only susceptible to climate change but also lacks resources to meet the basic needs of half its population! The heat waves and floods that Karachi has endured in the recent few years are evidence of environmental breakdown of the city. Therefore, it is important to understand whether the behaviour of the people is such that it has a significant impact on the environment (Stern, 2000).

3 Data and methodology

The focus of the study is Karachi which is the largest city of Pakistan both in terms of area and population. With a population at 14,916,456 (2017 census), it is estimated to have increased to 16.8 million in 2022. This megacity is also the provincial capital and is an economic magnet. According to estimates of United Nations-World Population Prospects, it continues to grow at around 2.5% annually. The increased pressure on the

[6] Pakistan Climate Change portal (CSCCC)

city's limited resources and infrastructure has made it a centre of heated discussion as it increasingly faces the brunt of climate change in terms of urban flooding and heat waves. Karachi serves to be an ideal setup for understanding the attitudes of its diverse demographics.

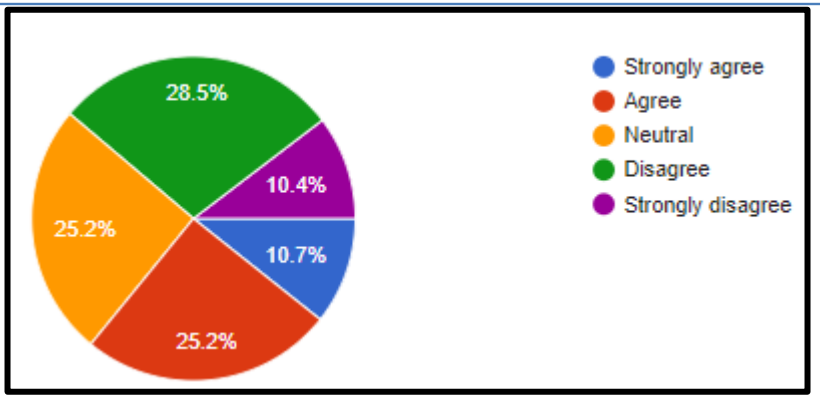
This survey uses primary level cross-sectional data which is both quantitative and qualitative in order to better understand the behavioural responses towards climate change and the intentions behind the actions taken by the people such as energy and water conservation and usage of cloth bags in place of plastic ones. Before the start of the survey, a pilot was conducted on 25 people. In total data was collected from 450 respondents but due to some responses not meeting the set criteria, they were rejected. The current research uses data of 398 respondents. The data collection period was from March to May 2022. An exponential non-discriminative snowball sampling method is used to fill questionnaires in an internet-based survey. Although it has the disadvantage that it 'increases the likelihood that the sample is not representative of the population' (Fricker, 2008); it is cost effective and respondents can answer questions at their convenience. The respondents are able to give better thought out answers and since the sharing of identity is not mandatory, they are more willing to share correct information. At the start of the survey their consent was taken to use their response for the purpose of our study. It was assured that their identities will not be made public.

There were 37 questions in total. Except two, all questions were closed-ended. These open-ended questions are "List two actions you usually take to conserve energy at home" and "In your opinion, whose responsibility is it to control climate change?" In order to analyse these qualitative questions, we used the qualitative software NVivo. This software did a thematic coding of the responses, which were then merged with the other quantitative data for analysis. The closed-ended questions were fixed-response ones. For example, "Do you turn off lights that you are not using?" If the response was yes, then the next question asked the respondent to

choose from the options given. These options were: convenience, to save money, habit, moral obligation, to reduce the heat in the atmosphere, or to save energy. The survey included specific questions to understand the intent behind the actions undertaken. For example, “Have you taken any specific action to mitigate the impact of climate change e.g. energy conservation?” If the response was yes, then the respondent was asked the open-ended question mentioned earlier which required listing of actions taken.

Further the surveyed were asked about their habits regarding usage of appliances and their reasons for switching off the air conditioner (AC) or heater; and do they feel that their measures taken at the individual level for example, of choosing to walk short distance instead of taking the car or keeping the AC thermostat at 22°C or above are helping the environment. As many as 95.2% of the respondents believed that climate change is real. But surprisingly only 35.9% of the respondents showed that they were satisfied with their own efforts to reduce climate change by engaging in any one of the mentioned activities. The results are shown in figure 3 below.

Figure 3: Satisfied as a citizen with habits to reduce carbon footprint, pollution, conserving water and energy



Source: Authors' own estimation (2022)

The data collected reflected the response from people belonging to various socio-economic groups; however, due to the design of the survey it was not possible to collect responses from the people who belong to the very lower spectrum of income group. Also a large number of respondents were university students. Since university students may be considered more aware of climate change it is expected that this may have given a biased result. Thus the results of this study must be taken with some reservations. 22.4% of the respondents were above 45 years old. Demographic details are given in table 1.

Table 1: Demographic profile of respondents

		Percentage of total
Gender	Male	42.7
	Female	55.8
	Prefer not to say	1.5
Age	18-24	48
	25-34	13.6
	35-44	11.8
	45-54	16.3
	55-64	6.3
	Above 64	3.8
Household Income	Up to Rs. 50,000	8.8
	Rs.51,000 - Rs100,000	18.4

	Rs. 101,000 - Rs. 150,00	17.6
	Rs.151,000 - Rs.200,000	19.9
	Above 200,000	35.3
Household size	1-2	3
	2-3	0.3
	3-4	29.4
	4-5	0.5
	5-6	45.5
	6-7	0
	7-8	12.6
	More than 8	8.8

Source: Authors' own estimation (2022)

Response to question regarding causes of climate change was used as a covariate. The survey also asked questions to determine the demographic profile of the respondent. These included questions related to gender, age, total household income, education of respondent, area of residence in the city and household size. We classify the variable 'area of residence' as part of any of the seven districts of Karachi. The respondents were also required to share if they believed climate change was a real threat or not and this was used as a control variable. The other relevant independent variables are opinions asked regarding 1) whose responsibility it is to mitigate climate change, 2) being affected by torrential rains of 2020 and heat wave of 2015, and 3) having suffered due to lack of fresh water supply and air pollution. The last two variables are binary in nature. Two regressions are run, one for each of the two dependent variables. The dependent variables include a) buying energy savers; and b) using cloth bag for shopping.

The third variable of interest for this study is conserving water. The reason for having conserving water as a variable is because the provision of fresh water requires energy. Water treatment, filter and pumping increases the carbon footprint and wastage leaves less for the ecosystem. Understanding the context and dynamics of the city where the survey was conducted is important to link it with the behaviour of the people. The city has been suffering with lack of fresh water supply in all its districts. Therefore, when

the survey asked if they conserve water each respondent stated in affirmation that they do so. Consequently, the analysis in the current study made an attempt to understand how the respondents conserve water and what they do when they face water shortages.

Due to the nominal nature of the first two dependent variables, logistic regression is used. For the second regression multinomial logistic regression is used since it has more than two categories whereas in the first one binomial logistic is used.[7] This is done following the methods adopted by Saguye, (2016); and Marie, Yirga, Haile, & Tquabo, (2020). For dichotomous outcome linear probability model and probit model can also be used. However, the disturbance term in the linear probability model does not have a normal distribution. This makes statistical inferences questionable. Additionally, the estimators are inefficient due to the heteroscedasticity issue in the error term. Another reason why linear probability model is not suitable is because in the absence of restrictions on the beta coefficients, the probabilities do not fall in the distribution. Probit model can also be used and the cumulative distribution function gives a sigmoid distribution. Probit model uses Maximum Likelihood Estimation instead of OLS, like the Logit model. But the logit model ensures that the probability stays in the limit of 0 and 1. Due to the weakness in the linear probability model and probit model, the logit model is used here. The functional form of logit model is selected using the specifications given in Gujrati and Porter (2003) in the context of climate change.

Logistic regression allows independent variables to be nominal and/or continuous. One of the assumptions of this regression is that dependent variable should have exhaustive categories. The logit model is specified as:

[7] Other studies that have used this estimation strategy in climate change context are Ahmed, Ahmed, Chowdhury, & Atiqul Haq, (2022); Ahmed, Alam, Ahmed, Ambinakudige, Almazroui, Islam, ... & Mahmud, (2022); and Ahmed, & Atiqul Haq, (2019).

$$Logit\ (P) = \log(\frac{P}{1-P})$$

$$P_i = \Pr(\frac{Y=1}{X=x_i})$$

$$\Pr\left(y=\frac{1}{x}\right) = \frac{exp^x}{1+e^x}$$

$$= \log\left(\frac{P_i}{1-P_i}\right) = Logit\ (P_i) = \beta_0 + \beta_1 X_1 + \cdots + \beta_n X_n + e$$

$$\frac{P_i}{1-P_i} = \exp(\beta_0 + \beta_i X_i)$$

Where the ratio of $(\frac{P_i}{1-P_i})$ is the probability of using anyone of the strategies. The βs are the parameters to be estimated, the Xs are the independent variables and the e is the error term. Details of all the dependent and independent variables are given in the next section. The independent variables are analysed to check for statistical issues. Absence of multicollinearity between the independent variables is checked which is also an assumption required for logistic regression. If the explanatory variables are highly correlated with each other than they do not provide any unique information in the regression model and can cause problems while fitting the model. It is done by the variance inflation factor (VIF). The correlation matrix checks the degree of collinearity between the variables and the variables are considered collinear if the coefficient correlation matrix is greater than 0.5. A value lower than this indicates absence of multicollinearity. A value of 1 indicates perfect collinearity. The correlation matrices for the variables used in the two logit estimations are given in appendix table A1 and A2.

4 Results

The regression results for energy conservation at home gauged through the usage of energy efficient bulbs is shown in table 2. The reference category is not buying energy efficient bulbs. The McFadden pseudo R-square shows that the full model represents a 9.4% improvement in fit in contrast to the null model. Since it is a logistic regression, the coefficients cannot be interpreted. Most of the control variables were found to be insignificant. That was quite a surprising result. It indicated that people's behaviour to use energy savers is not dependent on their gender, income, age, area of residence in Karachi and household size. The two variables that were found to be significant are the level of education and experience of heat wave. To further understand the reasons behind buying the energy efficient bulbs the respondents were asked to choose from given options. The findings are shown in table 6 and discussed that the main reason for buying energy efficient bulbs is to save money.

Table 2: Regression results related to energy conservation

Dependent variable: Do you buy energy efficient light bulbs?	**Prob>chi-square = 0.02** **Pseudo R2 = 0.17**
Independent Variables	**Coefficient**
Gender	0.33 (0.61)
District	0.20 (1.05)
Age	0.18 (0.61)
Education	1.1** (2.21)
Household size	0.03 (0.17)
Household income	0.07 (0.34)
Think climate change is real	0.04 (0.07)
Taken any specific action to mitigate the impact of climate change	0.45 (1.29)

Satisfied as a citizen with your habits to reduce carbon footprint, and energy use	0.17 (0.66)
Reasons to turn off extra lights	0.07 (0.29)
Participation in campaigns about climate change	0.25 (0.66)
Suffered from heat waves	1.30** (2.19)

Note: Figures in parenthesis indicates the value of z-statistics.
Significance levels: * p < .01, ** p < .05, *** p < .1.
Source: Authors' own estimation

Although 94.2% of the people stated that they believed that climate change is real and 4.8% showed uncertainty; 29.1% of the people believed that it is solely the government's responsibility to carry out climate change mitigation strategies. 56.3% of the respondents stated that it is both the government's and the individual's responsibility to adopt specific mitigation strategies. When asked if *they have taken any specific action to mitigate the impact of climate change,* only 43.7 % respondent said yes. Others either said no or showed uncertainty regarding their action. This indicates that most of the people believe that they are indeed being responsible citizens. However, when asked if they were satisfied as a citizen with their habits to reduce carbon footprint; pollution; and conserving water and energy, 34.8% agreed. This shows that people understand and realize that they are not taking sufficient actions towards mitigating climate change.

There was another question to better understand the behaviour of the people and this question asked *do you feel you are doing your level best to protect the environment and lessen the effects of climate change?* The response for this question showed that only 38.8% said that they were indeed putting in an effort.

Pakistan being a developing country does not have a proper recycling mechanism in place. There is no concept of sorting trash by the households

before discarding in the garbage. This sorting of garbage and then selling the garbage for recycling is done by untrained individuals who do this on their own accord with the sole purpose of earning cash. Thus there is no organized sector for recycling. And in connection to this there is no formal market for selling recycled products, like in the developed countries. Thus there is no concept by households to buy recycled products. However due to lack of resources people have the habit of reusing disposable items such as one-time use plastic bottles, which may in fact be detrimental to their health. In connection to this the respondents were asked if *they intentionally use/ purchase recycled items (such as recycled paper bags/cards/envelopes).* Only 34.6% said that they do so. This indicates that even if they are using the recycled products, it is not due to concern for climate change. Out of the people that said that they recycle/upcycle products, 41.2% said that they do so in order to be environmentally friendly. A smaller number mentioned the reason behind this action so as to save money. Details are shown in table 4.

Further the question regarding plastic bag usage also shows little concern for the environment. Only 22.1% of the people make the additional effort of carrying cloth bag for shopping. While 27.1% said that they do not carry cloth bag for shopping, an additional 14.5% reported that they do not stop the shop keeper when the shop keeper hands their grocery in plastic bags. This shows that people are generally more inclined towards their own convenience. Multinomial logistic regression results for using cloth bags out of concern for climate change are shown in table 3. The reference category is not using cloth bag. The chi-square test shows that it is significant. The McFadden pseudo R-square shows that the full model represents a 9.4% improvement in fit in contrast to the null model.

Table 3: Regression results related to using cloth bags out of concern for climate change

Dependent variable: Using cloth bag for shopping Base outcome = 0	Prob>chi-square = 0.00

		Pseudo R2 = 0.09
Independent Variables	**Coefficient Comparison group 1**	**Coefficient Comparison group 2**
Gender	0.92* (3.27)	0.83* (3.10)
District	0.17** (2.24)	0.10 (1.27)
Age	0.12 (1.11)	0.11 (1.02)
Education	0.05 (0.27)	0.12 (0.70)
Household size	0.08 (1.04)	0.05 (0.64)
Household income	0.02 (0.23)	0.16 (1.50)
Think climate change is real	0.12 (0.36)	0.21 (0.69)
Taken any specific action to mitigate the impact of climate change	0.03 (0.18)	0.04 (0.25)
Satisfied as a citizen with your habits to reduce carbon footprint, and energy use	0.19 (1.52)	0.14 (1.12)
Participation in campaigns about climate change	0.35** (1.77)	0.20 (1.13)
Intentionally use/ purchase recycled items	0.05 (0.32)	0.27** (1.68)
Recycle/ upcycle (creative reuse of) items	0.67** (2.05)	0.68** (2.18)
Taken part in planting of trees around neighbourhood	0.55** (1.96)	0.61* (2.29)
Pollution has affected health	0.09 (0.50)	0.02 (0.18)
Feel irritated due to pollution	0.10 (0.56)	0.25 (1.28)
Constant	3.49 (2.92)	1.49 (1.28)

Note: Figures in parenthesis indicates the value of z-statistics.
Significance levels: * p < .01, ** p < .05, *** p < .1.
Source: Authors' own estimation

There is a significant association between usage of cloth bags and those who have been involved in campaigning for climate change and planting of

trees. The association is not significant for those who have been effected by pollution, who believe that climate change is real, household size, household income and education. The results indicate that those people who recycle or upcycle items are inclined to use cloth bags. This shows that the demographic variables do not significantly impact the behaviour towards taking actions to counter climate change. Rather the behaviour stems from other factors such as previous exposure to climate change issues and having an understanding of the importance of conserving resources and reducing wastage.

In the survey 40% responded that *they have at least once taken part in a campaign about an environmental issue.* Additionally, 40% of the respondents were directly affected by the heavy rains in August, 2020; and 42% have experienced the heat waves in Karachi. Heat waves have become specially frequent and intense after 2015. One of the questions encouraged them to think back to the year of 2015 when the city had the worst form of heat wave during the summers. The respondents recalled and 21.78% mentioned that they suffered immensely during that heatwave. There were three responses that even revealed having lost a close friend / family member due to the heat wave in 2015. Even though the respondents were impacted by these two major calamities due to climate change, the data shows that many did not make efforts to tackle the issue. For example, only half of the respondents stated that they have ever planted a tree. This is surprising when 95% respondent that their health has been impacted adversely due to air pollution in Karachi. 95.1% feel irritated by it. It is also more surprising when only 17.1% said that they prefer walking short distance instead of using a vehicle due to it being more environmentally friendly. More details on the reason for them walking over short distances is shown in table 4 below. This leads to some very important insights. Even though people feel the impacts of climate change, their behaviour is not motivated by a concern out of climate change.

The air conditioner consumes around 3000 to 5000 watts of electricity per hour. The lower the temperature setting, the more power is used. This increases GHG emissions in the form of hydrofluorocarbons (HFCs). Although newer versions of air conditioners now use HFCs (which is considered better than halons and chlorofluorocarbons which were used in older versions, contributing to the depletion of Earth's ozone layer). Keeping this information in mind, people were asked their preferred temperature setting of the air-conditioner, as lower settings demand more energy. The electricity distribution company of Karachi is K-Electric and it regularly advertises and encourages people to keep the setting of air-conditioners above 24 degrees. Yet 81.45% of the respondents stated that they keep the setting below 25 degrees. Further even if they are choosing a higher setting their main reason for choosing so is to save money and not out of concern for climate change. This is shown in table 4.

Table 4: Intentions behind actions

Actions taken by HH	**Reasons for action (% of total respondents)**							
	To be environment-friendly	Convenience	Save money	Health related	Habit	Moral obligation	Other reason	N.A./ I do not
A.C. temperature preference	17.7	19.3	38.9*	7.7	12.5	1.9	--	1.9
Turning off extra lightings	3.5	1.3	51.3*	0	20.9	22.9	0.3	--
Buy energy saver bulbs	0	2.9	81.3*	--	0.7	2.2	8.6	4.2
Recycling/ upcycling	41.2*	7.9	12.9	0	8.2	3.4	0.8	25.6
Prefer walking over short distances	17.1	28.4*	5.7	17.1	17.3	1.3	1.8	11.4

Source: Authors' own estimation
*Note: * Most popular opinion*

Respondents were also inquired about their usage of heaters. But since Karachi is not a city with extreme winters, more than 70% said that they do not even own a heater. Out of those that do own the heater, only 1.7% said that they leave the heater running when they leave the room for a short while. Another interesting insight that we got from the survey was this that although only 1.3% mentioned that they do not turn off the lights that are not being currently used, 51.3% of the people mentioned their intention of switching off the lights is to save money. Only 3.5% said that they turn the lights off because they want to be environmentally friendly. It could be a possibility that the frequent encouragement by the K-electric had some impact on the people and therefore 22.9% of the people said that it is their moral obligation to save electricity and that is the reason that they turn off extra lights. Similarly, when inquired about their main reason to purchasing energy savers, they mentioned that it is in order to save money. Thus saving money seems to be the main reason for the actions taken by the people and these actions do not stem from out of concern for climate change.

Fresh water supply uses up energy and thus causing an increase in the carbon footprint. Conserving water can reduce this footprint. The city of Karachi is often faced with shortages of fresh water supply for the households. When inquired about lack of fresh water supply in the households, 97% showed that they feel extremely frustrated with this recurring issue; 71.2% resort to using tankers while 22.5% use the untreated well water. Further they were inquired about the specific actions they take to conserve water usage even when there is no water shortage. The most popular action is to turn the tap off while brushing teeth. However, other practices that can conserve water such as using a bucket for shower or using washing machines for full loads are not followed by the majority of the people. The responses related to washing machine and shower are concerning as both activities waste a lot of fresh water. Actions such as checking for water leakage requires additional effort is also done less frequently. Table 5 shows that only 3.3% of the respondents make an effort

to reuse the water for example the water left after washing vegetables. This indicates that they do not want to make an extra effort or go out of their way to conserve water. Only in dire circumstances when there is no water coming from the pipeline and water needs to be purchased from other sources, then the people conserve water properly.

Table 5: Water conservation

Actions taken to conserve water at home	Yes
Check toilet for leaks	66.89%
Turn off the water while brushing teeth	90.03%
Use bucket for shower	37.75%
Use automatic washing machine only for full loads	35.76%
When washing dishes, don't leave the water running for rinsing	73.84%
other(reuse water/ use aerorated shower)	3.31%

Source: Authors' own estimation

5 Discussion

The current study shows that 29.1% of the people believe that it is solely the government's responsibility to carry out climate change mitigation strategies while 56.3% of the respondents stated that it is both the government's and the individual's responsibility to adopt specific mitigation strategies. These findings support findings of previous studies such as Ahmed, & Atiqul Haq, (2019) which show that people expect the government to shoulder more responsibility towards climate change mitigation strategies. The current study shows that even though the respondents were impacted by two major climate change related calamities in the past decade, many did not make significant efforts. A probable reason being that they consider their actions small and believe that they cannot make a difference. Our study also indicates that most of the people have the perception that they are being responsible citizens and that they realize that their actions are not sufficient to mitigate climate change. They

believe that they need to change their behaviour and play a more active role. This is important to consider as people who believe in the urgency of responding to climate change are the ones who would undertake specific actions to mitigate the impacts (Bateman, & O'Connor, 2016; Mildenberger, et al., 2019).

Our findings show a significant association between usage of cloth bags and those who have been involved in campaigning for climate change and planting of trees. This shows that it is important to raise awareness and give green nudges on an ongoing basis. The role of teachers in this regard is especially important as discussed in Ahmed, et al., (2022) and also usage of social media. In a study in Bangladesh the results showed that 61% of the respondents agreed that there has been some change in the climate (Huda, 2013). And this awareness is dependent on other socio demographic characteristics (Hasan, & Akhter, 2011; Bayard, et al., 2007). In our study we found a strong relationship between awareness and the covariate for education; however, there was no association with other control variables such as the household size and household income.

Almost all the respondents in our study agreed that their health has been impacted adversely due to air pollution in Karachi and 95.1% feel extremely irritated by it. This is in line with another study in Bangladesh which shows that climate change has had adverse impact on health (Ahmed, & Atiqul Haq, 2019). But even though the people feel an adverse impact on their health, their behaviour is not motivated by a concern out of climate change. The findings of this study show that saving money seems to be the main reason for the actions taken by the people and these actions do not stem from out of concern for climate change. The results are in line with Whitmarsh, (2009) that people in Karachi are not taking actions such as energy conservation, recycling, decreasing plastic usage and water conservation due to a concern for climate change but mainly due to monetary concerns.

6 Concluding Remarks and Policy Implications

Pakistan is one of the ten most vulnerable nations suffering climate crisis. Frequency and intensity of rainfall have increased. Karachi's unplanned and unsystematic expansion has made it to the ten worst cities to live in, as per the Economist. The continuous increase in energy consumption along with invisible public mitigation efforts to control climate change, is a cause of serious concern. This study made an attempt to understand the intention behind the actions that people take. Although it seems that these actions are mitigation strategies, for example turning off extra lights, the survey results revealed that the true intention behind these actions is not what it seems. The results show that people are not willing to make personal sacrifices for the issue at hand. Although many claim that it is everyone's/ own responsibility; there are not many actions that they are willing to take out of their comfort zone. The people seem to underestimate the impact they are having. The results support the findings of Whitmarsh, (2009) that people in Karachi are not taking actions such as energy conservation, recycling, decreasing plastic usage and water conservation due to a concern for climate change. Rather the actions taken by the households reflect a concern for their own gain which mainly includes monetary concerns. This is in negation to literature that assumes that people resort to climate change mitigation strategies by decreasing their consumption of energy. This is an important dimension to consider for policy decisions. The government should adopt strategies for green nudges. These include revamping the energy sector, manufacturing industries, transportation and construction.

Radical actions must be taken, like introducing carbon pricing, that is impose carbon taxes or emissions trading, also known as 'cap and trade'. This can work as an incentive to various sectors of the economy (UN EMISSIONS GAP REPORT 2022). Another significant step in the right direction to lower emissions, will be to encourage usage of public transport, cycling, walking and discouraging usage of private vehicles (Climate

Change 2022: Mitigation of Climate Change (AR6 WGIII)). Pakistan government has taken some measures to provide electric public transport but there needs to be an aggressive policy action to increase the number and improve the quality of service of public transports. Correspondingly it is also important to ensure easy access and sufficient availability of other environmental friendly consumer products (Bonini, & Oppenheim, 2008; and Ottman, Stafford, & Hartman, 2006). It is important to change the behaviour of the people to transition them into adapting PEB (Taghikhah, Voinov, & Shukla, 2019). Thus a holistic approach is required to understand PEBs in order to change to a low-carbon society.

Year 2020 began with the Covid-19 pandemic which forced countries around the world to go into lockdown. Lockdown meant economic activity came to almost a standstill, and the welfare of people and the economy have suffered adversely. However, a massive reduction in economic activities led to cleaner air, much reduced global emissions and less air, water and noise pollution. Lessons can be learnt from the Covid-19 lockdown that in order to save the planet from environment degradation, less disruptive and more planned ways should be incorporated. The state and citizens can work together for a carbon resilient future. Post-Covid-19 world should engage citizens in their capacity to bring forth accepted, embedded and bearable behaviour changes in the context of climate change (Howarth, et al., 2020). For a significant reduction in our carbon footprint, it is imperative that we all work together. Each action matters and there is an urgent need to mobilize the people to take responsibility for their actions. Community level initiatives to change behaviours towards preservation of energy, water and reduction in the use of plastic is the need of the hour. It should be a mandatory part of school curriculum to instil environmentally responsible behaviour from the very beginning. Countries can benefit by incorporating climate change education in the curriculum and by promoting awareness about its adverse effects, and educating learners about mitigation and adaptation strategies (Ahmed, et al., 2022). School and college teachers have an idea what climate change is, and arming teachers with the

knowledge of climate change, its threats and how to mitigate and adapt will help students at an early age to understand the dangers, this in turn will encourage pro-environment behaviour (Chowdhury, et al, 2021). Also not just celebrating Earth day and Water Day for a week, but practicing environment friendly actions daily. Government and NGOs should campaign in a way that gives the message of "Are you doing your bit?" Increased public involvement by holding dialogue, and having community groups and consultation will create the right awareness and bring about long term behavioural change. Impactful media campaign is also needed to ensure people join hands to take the desired actions. Policy makers should design effective communication strategies and pair them with appropriate economic measures to have a significant behavioural change in the people. To bring about behavioural change people will require more and complete information regarding the environmental impact of their actions as suggested in a study by Li, Long, & Chen, (2017). Print, electronic and social media are powerful in creating awareness, starting trends and can be instrumental for environmental campaigning. Today's world follows what the media broadcasts and streams. Therefore, opinions are formed and shaped by the all-powerful social, electronic and print media. Thanks to the reach of media environmental issues have been highlighted. But the media has failed so far to bring forth actual changes in behaviour of the population. As a CSR, media can play its role in propagating environmental activism (Jiménez-Castillo, & Ortega-Egea, 2015).

This study is limited as the internet survey did not reach the length and breadth of Karachi. Therefore, considering the diverse population of this metropolis, the findings of this study should be taken with some reservations. Further, our findings reveal that a certain gender and age bias is there as more females and a younger population have filled the questionnaire. As a future work, data can be gathered which is more representative and surveyors may actually interview the respondents to explain the climate change related nomenclature like climate crisis,

mitigation, carbon footprint, GHG emissions, energy and water conservation, renewable energy etc.

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Conflicts of Interest
None declared.

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Appendices

Table A1: Correlation Matrix for independent variables in the first Logit regression for energy conservation

	Gender	District	Age	Edu.	HH size	HH income	Think CC real	Action to mitigate CC impact	Satisfied with habits	Turn off extra lights	Participation in campaigns	Suffered from heat waves
Gender	1.00											
District	0.04	1.00										
Age	-0.12	0.09	1.00									
Education	-0.06	0.01	0.46	1.00								
HH size	-0.01	0.07	-0.09	-0.02	1.00							
HH income	-0.01	0.09	-0.02	0.07	0.02	1.00						
Think CC real	-0.02	-0.05	0.03	0.01	0.03	-0.13	1.00					
Taken action to mitigate CC impact	0.11	-0.07	-0.09	-0.16	-0.08	-0.08	0.13	1.00				
Satisfied with habits to reduce carbon footprint, and energy use	-0.01	-0.13	-0.25	-0.13	-0.09	0.23	-0.07	0.08	1.00			
Reasons to turn off extra lights	0.04	0.04	0.03	-0.03	-0.07	0.09	0.01	-0.03	0.01	1.00		

Participation in campaigns about CC	0.03	0.04	0.16	0.05	-0.08	-0.00	-0.03	0.09	-0.01	0.01	1.00	
Suffered from heat waves	0.06	0.10	0.05	-0.01	-0.04	0.11	0.00	0.12	0.01	0.09	0.04	1.00

Note: HH means household, and CC means climate change

Table A2: Correlation Matrix for independent variables in multinomial logistic regression related to using cloth bags out of concern for climate change

	use/ purchase recycled items	Recycle	campaigns about CC	Trees	Pollution affected health	Irritated by pollution	Gender	District	Age	Edu.	HH size	HH inc.	Think CC real	Mitigate CC	Habit
use/ purchase recycled items	1.00														
Recycle	0.03	1.00													

campaigns about CC	0.15	0.08	1.00												
Trees	0.07	0.13	0.12	1.00											
Pollution affected health	0.07	0.02	0.08	0.08	1.00										
Irritated by pollution	0.11	0.06	0.08	0.01	0.32	1.00									
Gender	-0.01	0.24	-0.03	-0.03	-0.12	0.01	1.00								
District	0.01	-0.00	0.03	-0.06	0.03	0.06	0.04	1.00							
Age	-0.03	-0.08	0.15	-0.04	0.00	0.06	-0.12	0.09	1.00						
Education	0.02	-0.05	0.05	-0.06	-0.02	-0.02	-0.07	0.02	0.46	1.00					
HH size	-0.04	-0.04	-0.09	-0.03	0.00	-0.02	-0.01	0.07	-0.07	-0.02	1.00				
HH income	0.07	-0.09	-0.00	-0.01	0.16	0.11	-0.01	0.08	-0.02	0.07	0.02	1.0			
Think CC real	0.04	0.10	-0.03	-0.03	0,07	-0,01	-0.02	-0.06	0.04	0.01	0.03	-0.1	1.00		
Action to mitigate CC	0.10	0.15	0.09	0.14	0.05	0.08	0.12	-0.08	-0.09	-0.16	-0.09	-0.1	0.13	1.00	
Satisfied with habits to reduce carbon footprint, and	0.07	0.04	-0.01	0.05	0.09	0.03	-0.01	-0.14	-0.25	-0.13	-0.09	0.22	-0.07	0.09	1.00

energy use															

Note: HH means household, and CC means climate change

Figure A1: Comparison of theories

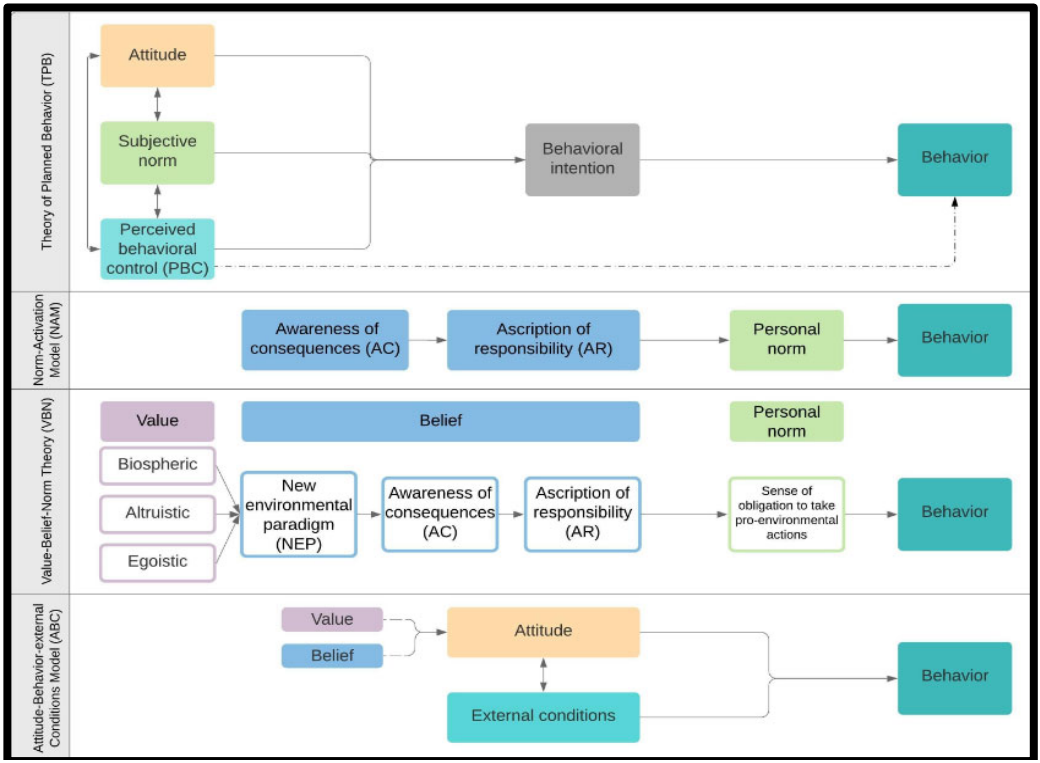


Image Source: Wang, Shen, Springer, & Hou, (2021).

Figure A2

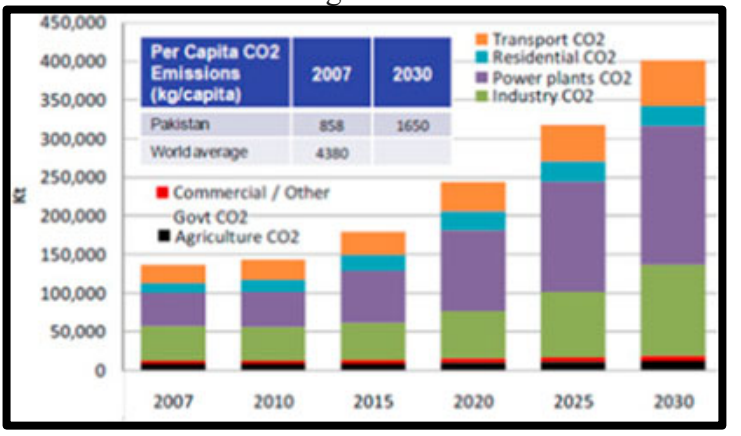
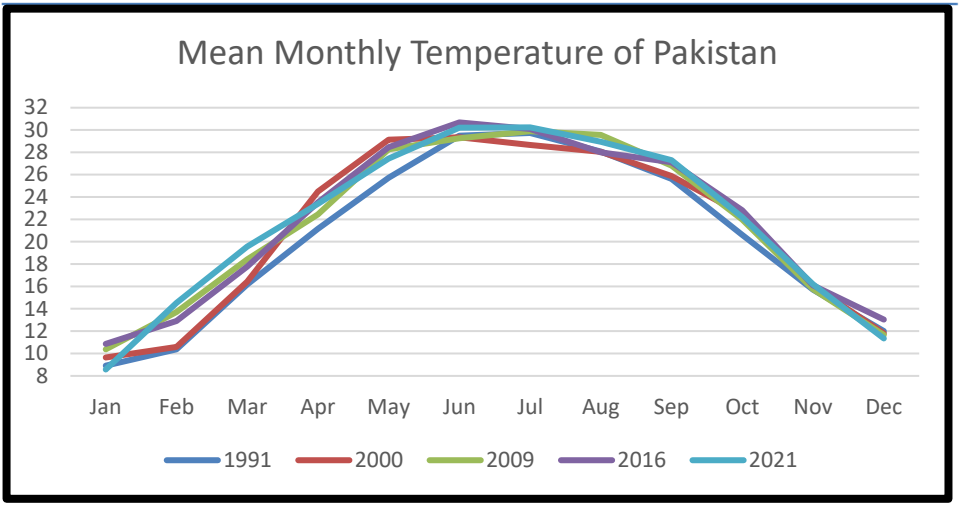


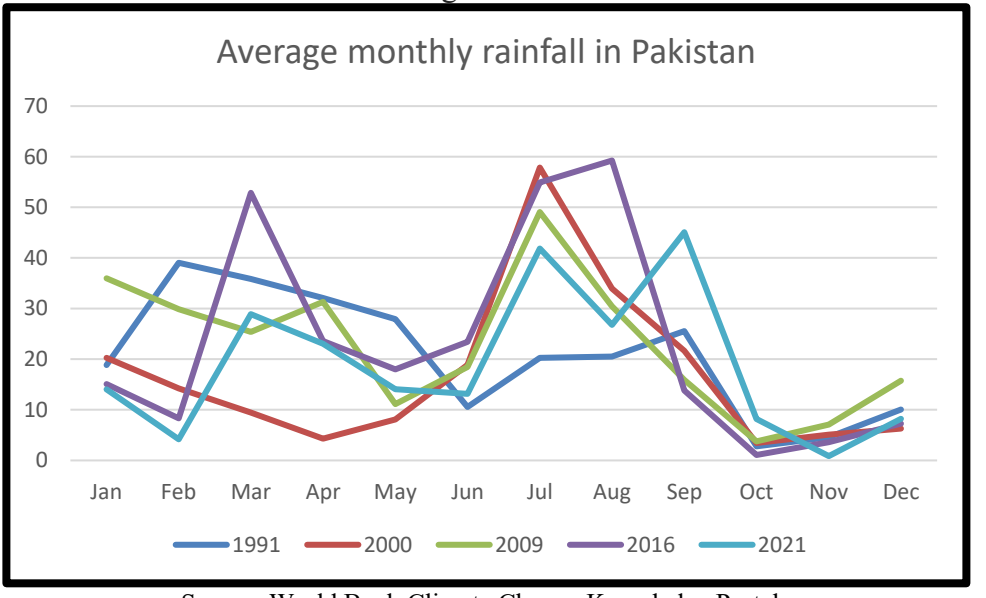
Image Source: Abas, Kalair, Khan, & Kalair, (2017).

Figure A3



Source: World Bank Climate Change Knowledge Portal
Note: This is only for selected years.

Figure A4



Source: World Bank Climate Change Knowledge Portal

Note: This is only for selected years.

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Determinants of Ecological Footprint: Empirical Evidence from Selected South Asian Economies

* Faizan Noor

Abstract: This study investigated the impact of globalization, tourism travel expenditures, technological innovations and population density on the ecological footprint of India, Pakistan and Bangladesh during the period of 1995 to 2020. To measure the short and long run association, Panel Auto Regressive Distributive Lag (ARDL) method is utilized. The results indicate that there is significant positive long run relationship between globalization & technological innovation with the ecological footprint of India, Pakistan and Bangladesh. While, contrarily, expenditures on tourism travel and population density has significant negative impact on the ecological footprint. The study suggests limiting the level of globalization at optimum level and favors innovations of green technology.

Key Words: Tourism, Globalization, Technological innovations, Population density, Ecological footprint

1. Introduction

It is an observed fact that climate change due to environmental degradation has adversely affected the economic and social sectors of subcontinent region during last few years. In order to fulfill the ambition of economic development, the economies of Sub Continent started adopting policies of globalization, technological innovations, promotion of tourism and management of population burden to maintain the population density less dense.in their geographical and historical places. But the consequences of this growth had to be borne in the form of environmental degradation and climate change due to high emission of greenhouse gases and CO2. During past few years environmentally sustainable development has become an important solicitousness for all economies of the world, with the goal of carbon neutrality in consideration (Tao et al., 2021). The multifarious nature of economic, social and environmental human pursuits has incited a negotiation between economic growth and ecological perseverance (Nathaniel et al., 2021b).

India, Pakistan and Bangladesh are such countries in South Asia that have 14 out of the world's 15 cities that are hazardous contaminated by the noxious particles marked (P.M 2.5). The latest global alliance on health and pollution report on health data synthesis 2019 reveals that India stands second, while, Pakistan third following China, in the figures where people kick the bucket prematurely each year due to pollution. Whereas, during winter season in this region bloomy mist, substantial with Sulphur and lead condenses as winds and rains abate. Moreover, throughout November Delhi witnessed atrocious five-day span of smog since 2016. On the other hand, World Health Organization and epidemiologists expressed concerns that deadly air pollution in Pakistan and India may increase the ratio of Covid-19 death.

In no other region of the world has pollution become more intense in the past few years than in Pakistan, India and Bangladesh, which are home to one third of the global population. An if this situation continues for the next few years, the environmental degradation will have more devastated effects on these economies. Projections of the World Health Organization' recent report reveals that the life expectancy has decreased by 6.7 years in Bangladesh. The estimates of global climate risk index 2020 reveals that among the countries that are most effected by climate change during the period of 1999-2018, Pakistan ranks 5th and Bangladesh 7th with CRI score of 28.83 and 30.00 respectively. During this period Pakistan faces the loss of 3792.52$ million and Bangladesh 1686.31$ million. India, on the other hand, ranked 5th in this ranking in 2018 in terms of climate risk and bore the loss of 37807.82 $ million.

Different scholars have utilized different variables to measure the environmental quality. Among these most of the researchers employed ecological footprint as a reliable quantitative scale to determine the environment finest. Ecological footprint is suitable indicator of environment quality in comparison with CO2 emission (Anser et al., 2021; Shokoohi et. al 2022). The fundamental advantage of ecological footprint is that it quantifies the demand and supply side of the nature. To measure the demand aspect, it sums up all the productive fields for which an individual or merchandise compete. The ecological footprint calculates the

ecological capital that a specific group of individuals or goods demand to produce the natural resource it uses (comprising food items and fiber goods, livestock and fish items, places for urban framework) and to take up its byproduct, particularly the discharge of CO2. The ecological footprint is a broad gauging metric used to compares the emission of greenhouse gases by resource utilization of human beings with natural means restoration and devastation assimilation ability (Nathaniel et al., 2021a;). Enhancement of industrial sector, tourism and globalization have substantially abated the environmental resources and accelerated the ecological footprint matric (Sarkodie, 2021).

Carbon footprint is assumed as one of the significant and swiftly increasing element of environmental footprint. It is utilized to quantify the fossil fuel oriented outflow of greenhouse gases. This continuous concentration of carbon dioxide in air is termed as ecological debt. Presently, the share of CO2 in overall global ecological footprint stands 60% (Global Footprint Network, 2020). Now a day, rapid roaring ecological footprint is assumed a foremost interest of researchers, who associate distinct economic and ecological footprint to find suitable answers. Hence the foremost objective of research is to empirically analyze the influence ofglobalization, tourism expenditures, technological innovations and population density on ecological footprint of Pakistan, India& Bangladesh by using the data from 1990 -2018.

Growing tourism is playing its significant role in global economic development. Development of tourism sector not only contributes in the growth of national income of the country but also considered essential for creating employment opportunities. Development of tourism proliferate the income of transporters, ameliorates the provision of infrastructure to elevate trade. Despite the key role of this sector in economic development, tourism sector is alsoa major contributor of climate deterioration caused by excessive emission of CO2 and greenhouse gases (GHG) as a result of fuel consumption by transportation sector. The tourism sector's share in CO2 emission is about 75% (Zhang & Liu, 2019). Besides, the development of tourism sector paves the way for developing the infrastructure on modern lines to provide adequate facilities to the tourists, which leads to environmental pollution by depleting natural resources (Razzaq et al., 2021a; Nathaniel et al., 2021b).

Another factor which may have eloquent effect on ecological footprint is globalization. Globalization refers to the multidimensional social, cultural, economic and political association among the nations of the world. Globalization has promoted trade activities, technological innovations, skills of the workers, social norms and tourism among the world community (Godil et al., 2021). Globalization lure nations to use modern technology and utilization of nonrenewable energy resources to meet the needs of energy requirements for different sectors of the economy that leads it towards the more emission of CO2 and GHG that contaminate the environment. Only strong political will and determination can limit the impact of globalization on the environment by adopting environment friendly green technology (Pata, 2021; Saud et al., 2020). It is an observed fact that globalization promotes research and development and that leads to the invention of modern production tools and methods that are effective in controlling environmental degradation.

Technological innovations have reshaped the production sectors of the economies. Today, almost every economy of the world tries to invent such production equipment's and methods that may not only produce large amount of goods but also pose little effect on the ecological foot print. Most of the developed countries of the world have shifted their production units on modern technologies while, developing countries are also making steps to use those production techniques that are less harmful for environment. Therefore, it is essentil to measure the impact of technological innovations on the ecological foot print.

Population is another key factor which contributes in increasing the level of ecological footprint. Population expansion escalatesthe need of fossil fuels and energy, this increase in demand brings increase in ecological footprint in return by releasing more greenhouse gases and CO2 into the atmosphere. Population density is decisive element in deciding the level of ecological foot print (Gupta, Saini and Sahoo, 2022). Population density is inversely related with the ecological footprint (Kongbuamai, Zafar, Zaidi and Liu. 2022)

Pakistan, India and Bangladesh are emerging economies of Subcontinent with similar social, political and economic systems. For the sake of economic prosperity these economies are following multi-faceted strategies including tourism, technological innovations and globalization that have adversely affected the environment of these economies. Therefore, there is a dire need to examine the influence of these factors on the ecological foot print of Pakistan, India and Bangladesh. This study will measure the influence of globalization, technological innovations, tourism development and population density on the ecological foot print of Pakistan and India and Bangladesh by employing the data from 1990 to 2020.

Despite the rising fear about environmental sustainability and the growing significance of measuring ecological footprints, there is a prominent hole in the prevailing literature concerning the exact determinants of ecological footprints in South Asian economies. While several analyses have investigated this theme on a universal scale or in the setting of developed countries, there is an inadequate body of research that probes into the exclusive aspects and dynamics inducing ecological footprints in South Asian nations. This research gap is predominantly critical given the region's diverse socio-economic and environmental characteristics, along with its noteworthy population size and fast economic growth, all of which contribute to typical ecological footprint patterns. Hence, there is a need for empirical study and in-depth analysis to recognize and comprehend the vital determinants shaping ecological footprints in South Asian countries, which can enlighten policy-making and sustainable development policies tailored to the region's specific opportunities and challenges.

2. Review of the Literature

2.1 Globalization and Ecological Footprint Nexus

Sabir and Gorus (2019) empirically analyzed the impact of globalization measures FDI, trade openness KOF and technological innovations on the ecological footprint of South Asian economies during the period of 1975 to 2017. The study utilized ARDL method to examine the long-run associatio among the regress and regressors. The findings of the study suggest that globalization measures have significant impact on the

ecological footprint . While, technological changes have insignificant influence on the ecological footprint.

Rehman et al. (2021) analyzed the effect of globalization, energy use and trade on the environmental footprint of Pakistan by utilizing data from 1974 to 2017. The study used ARDL method to measure the long run relationship among the dependent variable and regressors. Results of the study indicate that globalization, energy use and trade have significant positive impact on the ecological footprint of Pakistan. Likewise, Yang et al. (2021) have empirically examined the impact of globalization and population aging on the ecological footprint of OECD countries by using panel data during 10970 to 2017. The study used pooled mean group method to calculate the association between the variables. The findings of the study reveals that globalization and population aging have significant negative impact on the ecological footprint of OECD countries.

Awosusi et al. (2022) studied the effect of globalization, political risk and technological innovations on the ecological footprint of BRICS countries. The study utilized panel quantile regression to investigate the relationship between variables. The results of the study reveal that political risk, economic growth and technological innovations have positive significant impact on the ecological footprint in BRICS countries. On the other hand, globalization has significant positive association with the ecological footprint. Moreover, Amegavi, Ahenkan and Buebeng (2022) empirically analyzed the impact of economic globalization and bureaucratic quality on the ecological footprint of Ghana during the time period of 1990 to 2016. To measure the short run and long run association among variables the study has used autoregressive distributive lag method. The results of the study show that economic globalization has negative impact on the ecological footprint of Ghana. Inversely, institutional quality has shown meaningful positive impact on the environentl footprint.

2.2 Tourism and Ecological Footprint Nexus

Salih, Gokmenoglu and Even (2018) evaluated the effect of tourism advancement on the environmental quality of op 10 tourists visiting countries of the world. The study utilized ecological footprint as proxy for

environmental quality. The findings of the study reveal that there is evidence of inverted U shaped Kuznets curve existence. Moreover, tourism development has shown significant negative effect on the ecological footprint of Turkey.

Godi, Sharif, Rafique and Jermsittiparsert (2020) measured the implication of tourism, financial improvement and globalization on the ecological footprint of Turkey during the period of 1988 to 2018. The ARDL model is utilized to estimate the short and long run relation between ecological footprint and regressors. The results of the ARDL show that tourism, financial growth and globalization have positive meaningful effect on the ecological footprint of Turkey. Similarly, Xiaojuan et al. (2022) measured the outcome of inbound tourism on the ecological footprint in top 10 densely populated countries of the world during the period of 1995 to 2021 by using dynamic panel threshold model. The estimates of the study indicate that tourism improves the environment at some extent and after reaching at optimal level enhancement in inbound tourism adversely affect the environment.

Liu, Farah, Wajahat and Tafazal (2022) empirically analyzed the presence of environmental Kuznets curve travel & tourism and ecological footprint of Pakistan during the period of 1980 to 2017. In order to measure the influence of tourism expansion, economic growth, energy consumption, trade openness and foreign direct investment on the ecological footprint, the study used ARDL method. The results of the study confirm that the regressors have significant contribution in environmental degradation of Pakistan.Guven and Bolu (2022) analyzed the effect of tourism, energy consumption and economic growth on the environmental quality of Turkey during the period of 1963 to 2016. The results of the Vector Error Correction model show that tourism development has no effect on the environment of Turkey. Whereas, on the other hand, energy consumption and economic growth have adversely affected the environmental quality of Turkey .

2.3 Population Density and Ecological Footprint Nexus

Audi et al.;(2016) discovered the essence of significant positive correlation among energy use, financial advancement and population density in Lebanon during the time period of 1974 to 2014. Also, Sasleem

at al.; (2018) in their empirical study found the presence of meaningful positive relationship between the population density and carbon dioxide (CO2) emmission for selected panel of economies during the time span of 1975 to 2015.Sciubba and Weber (2019) evaluated the implication of population growth on the CO2 emmission by using panel data of 1062 regions of 22 European nations during the time spane of 1990 to 2006. The estimates of the study indicate that regions with high population growth witnessed higher level of carbon emmissoin as compared to lower population growth regions of Europe.

Edwards (2020) examined the significance of total population, immigration and alternative energy usage on the CO2 emission in United States of America. The findings of the estimation show that there exists positive significant relation between population, immigration and CO2 emission in USA. While Chaurasia (2020) empirically investigated the influence of population on the CO2 emission via global energy demand. The study used the panel of 44 most CO2 emmitted countries of the world during the period of 1990 to 2019.. The estimates of the study reveal that increase in global energy use due to increase in population has positively contributed in the CO2 emission of selectedcountrires.

2.4 Technological Innovations and Ecological Foorprint Nexus

Manga and Destek (2021) empirically analyzed the significance of technological innovations and financializaion preocess with renewable and non renewable energy sources as control varibles on the carbon emmission and ecological footprint of big emerging economies during the period of 1995 to 2016. The study has utilized second generation panel methods to calculate the interdependance among variables. The evidence of the study show that technological innovations and financialization have signficant role in co2 emission, While, they have insignificant effect on the ecological footprint.

LiXu, Wang, Wang and Zhang (2022) measured the role of technological advancement, natural resources prices, foreign direct investment and renewable energy prices on the ecological footprint of

China by using time series data from 1990 to 2017. The study used FMOLS, DOLS and CCR methodologies to investigate the effect. The results of the study indicate that technological advancement natural resources prices and renewable energy sources reduced the ecological footprint in China. Whereas, on the other hand, foreign direct investment has contributed in the enhancement of ecological footprint. Moreover, Gao et al., (2022) analyzed the role of green technology innovations on the CO2 emmision in 30 chinese provinces over the period of 2008 to 2020. The study has used fixed and mediating effecct methodologies to estimate the parameters. The results indicate that green technology innovations has limit the CO2 emmissions in the selected panels of China.

Mohini , Saini and Sahoo (2022) the empirically assessed the potantial of ecological footprint of Bangladesh during the period of 1990 to 2016. The study utilized technological innovations, urbanization and natureal resources as key determinants of ecological footprint of Bangladesh. In order to measure the long run effect, the study used ARDL bound method. The findings sugdest that technological innovations and natural resources have reduced the ecological footprint. While, urbanization has adverese effect on the ecological footprin of India.

3. Research Design and Methodology

During last two decades a serious attention has been given to the issue of environmental degradation in developing and developed countries and various factors are held responsible for this degradation. Among these, globalization, tourism and population growth are important contributors in carbon emission in developing countries. Countries of south Asian Regions Pakistan, India and Bangladesh are top in the list among those countries where the issue of environmental degradation is becoming more serious with the passage of time.

The study is designed to investigate the impact of globalization, tourism development, Technological innovations and population density on the ecological foot print of Pakistan, India and Bangladesh during the period of 1995 to 2020. The functional form of the model will be as follows

$$EFPit = f(GLOBit, TEit, PRNit, POPDit)$$

In order to measure the association among the parameters of dependent and explanatory variable, the econometric form of the model is as follows

$$lnEFP_{it} = \beta_0 + \beta_1 lnGLOB_{it} + \beta_2 lnTE_{it} + \beta_3 lnPRN_{it} + \beta_4 POPD_{it} + \mu_{it}$$

Where

$EFPit = Ecological\ footprint$

$GLOBit = Globalization$

$TEit = Expenditures\ on\ Tourism\ travel$

PRN_{it}= Number of Patent Rights Registered

$POPDit = Populatioin\ Density$

$\mu it = Residual$

$ln = Natural\ Log$

Demonstration and Sources of Data

Variable	Demonstration	Unit	Sources of Data
$\boldsymbol{EFP_{it}}$	Ecological footprint	% Per Capita	Global Footprint Network (GFN)
$\boldsymbol{GLOB_{it}}$	Globalization	% KOF Globalization Index	WDI
$\boldsymbol{TE_{it}}$	Expenditures on Tourism travel	Percentage	WDI
$\boldsymbol{PRN_{it}}$	Number of Patent Rights (Proxy of Technological Innovations)	In numbers	WDI
$\boldsymbol{POPD_{it}}$	Populatioin Density		WDI

		Total Numbers	
Ln	Natural Log		

As mentioned in the above table, we used globalization, expenditures on tourism travel, technological innovation and population density as independent variables. Globalization often leads to increased international trade, which can boost consumption and production. As countries engage in global supply chains, they may produce and consume goods and services that have higher ecological footprints. This can result in increased resource extraction, energy use, and emissions. Likewise, tourism generates a significant amount of waste, including plastic bottles, packaging, and disposable items. The disposal of waste in environmentally responsible ways can mitigate the ecological impact of tourism travel. Further, innovations in energy-efficient appliances, building design, and transportation can lead to lower energy consumption and, consequently, a reduced ecological footprint in terms of energy-related emissions. Moreover, as a population grows, there is typically an increase in the demand for essential resources such as food, water, energy, and raw materials. This heightened demand can lead to over-exploitation of natural resources, resulting in a larger ecological footprint.

3.1 Econometric Specification

3.1.1 Panel Auto Regressive Distributive Lag (ARDL)

Economic literature provides various methods to estimate the panel data models. On one side from the perspective of Loyza and Racieenodel (2006) there are traditional panel models like pooled OLS, fixed and random effects. But the drawback of these usual techniques is that these are unable to distinguish between short run and long run results. Moreover, according to Campos and Kinoshitev (2008) the estimates of traditional methods give biased results in the presence of endogenous regressors. While, on the contrary, the methods of dynamic panel models GMM-difference and GMM-system estimates are fruitful when the panel contains

large number of countries (N) as compare to the time span (T) i.e. N>T (Arellano and Bond; Arellano and Bover).

Considering the drawbacks of different panel methods, the study focused on panel auto regressive distributive lag model (Panel ARDL). The advantage of this technique is that on one side it provides short run and long run estimates separately and on the other side, it is applicable in the case when variables are stationary at different level of order. This technique is also suitable when we have large number of time and smaller group of countries, as in the case of this study. When variables are of $I(1)$ and co-integrated the residual will follow $I(0)$ process. One of the fundamental property of co-integrated variable is its return to any divergence from long run equilibrium. This property predicts the dynamics of error correction which arises due to the divergence of the variables in the model from equilibrium. Therefore, it is rational to re-characterize the above model into the error correction form

$$\Delta Y_{it} = \emptyset_i Y_{t-j} + \theta_i X_{i,t-j} \sum_{j=1}^{p-1} \gamma_{ij} \Delta Y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij} \Delta X_{i,t-j} + \mu_t + \varepsilon_{it}$$

Here $\emptyset$, which is error correction parameter reveal the rapidity of correction. In case, when $\emptyset = 0$ long run relationship does not exist. Therefore, for a long run relationship among dependent variable and repressors it is essential for $\emptyset i$ to be significant with the negative sign and its value must lie between 0 and 1. Because only in that case, it will reveal the convergence tendency.

4. Results of The Estimation

4.1 Panel Unit Root Test

Before applying an appropriate technique to estimate the model, it is proposed to check the stationarity of the variables. In the literature there are various methods available to predict the unit root. Among these the study has used Lin Li Chu (2002) test. The null hypothesis of this test shows the

presence of unit root. The findings of this test indicate that ecological footprint is stationary at level, while, globalization and tourism travel expenditures and number of patent rights are stationary at first difference. Hence the given model also supports the application of panel ARDL methodology for estimation.

4.2 Results of the Estimation

The study used panel ARDL method to estimate the association among ecological footprint and regressors. The results of the estimation are given in the following table.

Table 1. Short Run Results

	Coefficient	St. Erroe	t-Statistic	Prob.*
COINTEQ01	-0.670065	0.292076	-2.294143	0.0327
D(LNGLOB)	-1.617241	0.840462	-1.924229	0.0687
D(LNTTE(-2))	0.087477	0.009272	9.434869	0.0000
D(LNPRN)	-0.343420	0.133774	-2.567160	0.0184
D(POP_DENSITY)	-0.219889	0.766864	-0.286738	0.7773
D(POP_DENSITY(-3))	-0.542320	0.538386	-1.007308	0.3258
C	2.648288	1.306294	2.027329	0.0562

Table 2. Long Results of Panel ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGLOB	1.728667	0.125010	13.82821	0.0000
LNTTE	-0.440725	0.053333	-8.263727	0.0000

LNPRN	0.618447	0.022509	27.47580	0.0000
POP_DENSITY	-0.008767	0.000718	-12.21341	0.0000
Author's own calculations (EViews 10)				

The results of the estimation indicate that there exist long run relationship between the dependent variable and regressors as the value of error correction is negative significant and lies between zero and one i.e. -0.670065. Globalization has shown positive significant impact on the ecological footprint of Pakistan, India and Bangladesh. A 1 percent increase in the globalization bring 1.013599 increase in the ecological footprint of these nations. The same significant positive long run relation has also been endorsed by the studies of Sabir & Gorus (2019) Rehman et al. (2021), Guan et al., (2022) and Awasusi et al. (2022). This positive impact may infer that the globalization has assisted the spread of innovation and technology across the globe that led to the expansion of more helpful and environmental technologies that help to reduce the ecological footprint. Also, globalization has promoted greater intercontinentalcooperation and intelligence sharing on environmental issues. Nations and governments are now able to switch information, research conclusions, and appropriatemethods on sustainability and environmental conservation. This collective knowledge assists in discoveringhelpfulanswers to moderate the ecological footprint internationally.In other words, from the perspective of knowledge sharing and partnerships, globalization has encouraged greater global collaboration and knowledge sharing on environmental issues which helps in finding effective solutions to reduce the ecological footprint globally.

Whereas, on the other hand tourism travel expenditures has significant negative effect on the ecological footprint. Increase in tourism travel expenditures make tourism costly and as a result only a few tourists visit the tourist's spots. It limits the demand and consumption of fossil fuels

at lower level which is beneficial for ecological footprint. These findings are consistence with the findings of Khan and Hou (2021) and Balli et al. (2019) but contrary with the results of Guan et al. (2022). A 1 % increase in the tourism travel expenditures brings 0.440725 % fall in the ecological footprint. Moreover, technological innovations have shown the positive and significant impact on the ecological footprint. Chunling et al. (2021) also found the same positive association of technological innovation in the case of Pakistan but inconsistent with the results of Adebayo &Odugbesan (2021) for Brazil, Khan et al. (2020), and Ahmad et al. (2020) for China. A 1 % increase in the number of patent rights brings 0.618447% increase in the ecological footprint. While population density has shown the negative impact on the ecological footprint. A 1% increase in the population density of India, Pakistan and Bangladesh brings 0.008767 fall in the ecological footprint. At present, population density of Pakistan, India and Bangladesh is 288.55, 464.15 and 1265.18 respectively (World Bank 2020). Whereas, only few big cities of these countries are densely populated. Moreover, this negative association is due to the fact that consumption mainly depends on availability of natural resource. While, abundant resources are presently available in these countries to explore which are adequate to maintain balance within the ecosystem. This negative association of population density with the ecological footprint endorsed the findings of Kongbuamai, Zafar, Zaidi and Liu (2022), Aşıcı and Acar (2016), Aşıcı and Acar (2018) for 87 economies and Dogan et al. (2020) for BRICST.

5. Conclusion and Policy Recommendation

5.1 Conclusion

Environmental degradation is the ultimate result of various human activities. Almost all the developing and developed countries of the world are facing the severe issue of environmental degradation and climate change. Among these, India, Pakistan and Bangladesh are the main countries in South Asia who are facing the consequences of this environmental degradation in the form of economic damages. It is therefore needed to determine those factors who are responsible for this issue. For

this purpose, the study has used globalization, tourism development, technological innovations and population density as the key determinants of ecological footprint during the period of 1995 to 2020. The study utilized panel ARDL method to measure the association among the variables. The results of the study indicate that there exist significant long run relationship among ecological footprint and regressors. Globalization and technological innovations have shown positive effect on the ecological footprint. Whereas, tourism development and population density have negative impact on the ecological footprint of India, Pakistan and Bangladesh.

5.2 Policy Recommendations

Considering the results of estimated the study proposed following policy measures to policy makers

- As globalization and innovations have positive significant impact on ecological footprint therefore, policy makers should focus on the promotion of globalization and innovations at sustainable level to save the environment. Moreover, policy makers should devise such policies that may help to create environment friendly green technological innovations.
- While, on the other hand, tourism and population density has shown negative effect. Hence, policy makers should make sustainable level of tourism and population density.
- To harness the positive impact of globalization on ecological footprints and promote sustainable development, policymakers can implement a range of policies and strategies: 1) Encourage international trade agreements that prioritize environmental sustainability. This can include provisions for the promotion of sustainable practices, reduced trade barriers for green technologies, and the incorporation of environmental standards in trade negotiations. 2) Implement carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, to internalize the environmental costs of greenhouse gas emissions associated with global trade. Revenue generated from these mechanisms can be reinvested in clean energy and sustainable infrastructure projects.

- Governments of South Asian economies need to prioritize investments in renewable energy sources, such as solar, wind, and hydropower. Provide financial incentives, subsidies, and tax breaks to promote the adoption of clean energy technologies.
- As our study reported that technological innovation has positive impact on ecological footprints in long run so governments need to allocate additional funding for research and development (R&D) initiatives focused on environmentally friendly technologies and practices. Also, need to provide tax incentives for businesses and organizations that invest in R&D aimed at reducing their Ecological Footprint.

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