

Assessing Levels of Environmental Consciousness among Informal Sector Workers: A Case Study of Pune City (India)

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Abstract

The informal sector makes up a large share of urban labour. However, workers often lack awareness of the environmental impact of their activities. The study aims to determine informal sector workers' environmental consciousness and sensitivity level. A survey was conducted involving 208 respondents employed in diverse occupations. The questionnaire comprises 42 questions exploring participants' awareness and behaviour concerning the use of environmentally harmful things, waste management, recycling, and other related aspects. According to the descriptive analysis, 58% of employees prioritise utilising eco-friendly products or techniques in their day-to-day work. Sixty-two per cent of employees reported health problems related to workplace environmental variables. Financial limitations are preventing 43% of respondents from implementing eco-friendly practices. A sizable percentage of people occasionally work to conserve the environment. The regression analysis shows that employees in the informal

sector who have positive attitudes, are in good health, and earn more money are more likely to be environmentally concerned. Based on the results, promoting positive attitudes towards environmental issues among informal workers is crucial. Therefore, programs and policies that increase awareness, educate the workers, and cultivate a feeling of environmental responsibility are essential. Access to better health and income opportunities also supports long-term environment-friendly livelihoods.

Keywords: Environmental Consciousness, Environmental Awareness, Principal Component Analysis, informal sector, Pune city, India

JEL: Q50, Q56, R11

1. Introduction

The informal sector operates outside formal labour contracts, legal frameworks, and established regulatory mechanisms and is vital to the economy in nations like India. It significantly boosts employment and income, especially for those with limited skills or resources to access formal employment. Eighty-three per cent of the workforce is employed in the unorganized

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sector (Periodic Labour Force Survey, 2017-18) in India.

This sector is very much concerned about environmental degradation. Chaudhuri and Mukhopadhyay (2006) used a three-sector general equilibrium model that includes an informal sector that generates an intermediate input for the formal sector. The informal manufacturing sector generates pollution, so when the formal sector uses more output from the informal sector, the pollution level rises, and the gap between the actual and allowable pollution levels widens. The theoretical study found that the amount of pollution has an inverse relationship with the productivity of a representative worker. The growth of the polluting informal sector may impair environmental standards even if the allowable pollution level is decreased.

The informal sector is prominent for its lack of regulation and minimal adherence to environmental and occupational safety standards. Workers in the informal sector often need more awareness about environmental issues and sustainable practices. This lack of consciousness leads to environmentally harmful activities, such as improper waste disposal, pollution, resource depletion, and non-adherence to safety measures. Thus, understanding their perspectives, knowledge, and behaviours toward environmental conservation is important in forming inclusive and effective strategies to promote sustainable practices within these communities.

However, empirical studies on environmental consciousness in the informal sector are minimal. According to Bali & Kambhampati (2022), the informal sector contributes significantly to environmental pollution and deterioration accompanying economic activity growth in emerging nations. Sultana et al. (2022) argued that informality

significantly hinders sustainable development, while economic growth and economic freedom promote sustainability. However, in the context of Indian cities, Tripathi & Chandiramani (2024) examined how ownership of informal businesses is affected by environmental pollution in Indian metropolises with a population of one million or more.

In this context, Pune, a city in India, is a suitable case study for this research due to its growing informal sector and rapid urbanization. The city's informal sector encompasses diverse occupations, including street vending, waste picking, small-scale manufacturing, construction, and more. Therefore, knowing the level of environmental consciousness within this sector is important, considering the environmental challenges the city already faces due to urbanization, population growth, and industrialization. Pollution, water contamination, air quality degradation, and improper waste management are just a few of the challenges faced by this sector.

Against this backdrop, the present study assesses the drivers of environmental consciousness among the informal workers by focusing on the attitude, health, and income of the workers. We consider 208 persons working in the informal sector based on a prepared questionnaire for a primary survey. The findings of this study contribute academically by filling a critical literature gap and hold practical implications for policymakers, urban planners, and environmental advocates seeking to foster environmentally conscious practices within informal urban settings, ultimately navigating Pune toward a more resilient and sustainable future.

The paper has been structured as follows. The literature is thoroughly reviewed in section 2. Section 3 presents a conceptual framework.

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Section 4 provides data and methodology. Section 5 presents the empirical findings. Section 6 concludes by summarizing the key findings and policy implications.

2. Literature Review

2.1. Definition of Environmental Consciousness

Environmental consciousness refers to an individual's propensity to engage in eco-friendly behaviour, encompassing awareness, interest, attitudes, and actions aimed at addressing environmental problems. (Kim & Lee, 2023). It is multidimensional, encompassing cognitive, attitudinal, and behavioural factors, including environmental knowledge (facts about ecosystems and human-environment relationships), values (importance of nature conservation), attitudes, and motivations (D'Attoma & Ieva, 2024).

The concepts of environmental consciousness, covered in previous studies, are primarily concerned with preventing and improving environmental pollution and damage caused by human activity. They encompass knowledge of environmental issues and interest in, sentiments for, and viewpoints regarding environmental issues. Consequently, numerous definitions of environmental consciousness are frequently discussed in research as an inherent element affecting a person's eco-friendly consumption habits. The importance of the natural world and its preservation is known as environmental value, and the comprehension of ecological concerns is referred to as environmental knowledge. According to Kim and Lee (2023), the degree of awareness of environmental issues and willingness to support activities that deal with problems or directly contribute to solutions. Environmental concerns can be categorized based on underlying motivations,

primarily into altruistic and egoistic values. Altruistic motivations reflect concern for the well-being of others and the environment, driving individuals to adopt eco-friendly behaviours for the collective good, even without personal benefit. In contrast, egoistic motivations are centered on self-interest, where environmentally friendly actions are taken if they align with personal gain, such as cost savings or social recognition. (Kumar & Pandey, 2023).

Environmental knowledge refers to an awareness of environmental issues, their impacts, and the collective responsibility to address them. It shapes attitudes, influencing consumer behavior and decision-making. Informed individuals are more engaged in sustainable actions, with studies showing a strong link between environmental knowledge, attitudes, and green purchasing intentions (Shah et al., 2021). Environmental knowledge lacks a uniform definition but is increasingly categorized into system knowledge (understanding ecosystems and environmental issues), action-related knowledge (knowing how to take environmental action), and effectiveness knowledge (evaluating the best strategies for maximum impact). These dimensions shape individual responses to sustainability challenges (Härtel et al., 2023). Laheri et al. (2024) apply the Theory of Planned Behavior to conceptualize environmental consciousness as a multidimensional construct encompassing environmental concern, knowledge, and values. Their findings suggest that environmental values most strongly influence attitudes toward purchasing green products, followed by knowledge and concern.

Perceived environmental efficacy refers to the beliefs of individuals and groups in their ability to take meaningful action toward

environmental solutions, self-efficacy shaping personal behaviour, and collective efficacy shaping the effort of a group as a whole (Miller et al., 2022).

Perceived Consumer Effectiveness (PCE) refers to how much a person believes their individual actions can make a difference. It is a subjective assessment of one's ability to help solve a problem. In the environmental context, PCE reflects the extent to which someone thinks their personal consumption choices contribute to solving environmental issues (Arias & Trujillio, 2020). In the study by Asadi et al. (2020), PCE refers to consumers' belief that adopting electric vehicles can help reduce the negative environmental impact of using cars. Hans & Doran (2020) defined PCE as the ability of the consumer to contribute to specific sustainable development-related outcomes through particular behaviours. Still, it is distinct from environmental concerns or viewpoints and adds something special to forecasting eco-friendly purchases and other environmentally conscious behaviours. Furthermore, a person's inclination to engage in a certain activity is greatly influenced by their conviction that it may effectively address environmental concerns.

In this paper, environmental consciousness is defined as a complex concept that includes an individual's understanding of ecological concerns as well as their attitudes and actions in relation to them. It comprises, among other things, environmental consciousness, the desire to adopt eco-friendly behaviours, and the belief that one's own actions may effectively reduce environmental harm. We highlight the interaction of behavioural elements (such as recycling practices and involvement in environmental initiatives) with cognitive elements (such as environmental knowledge) and attitudinal factors (such

as environmental values and concerns). Our definition covers the comprehensive aspect of environmental consciousness and its influence on encouraging sustainable consumption practices by incorporating these components.

2.2. Relationship between environmental consciousness and informal sector

Environmental risks and insufficient safety and health regulations are especially noticeable in the informal economy. Employees in the informal sector lack the knowledge, resources, and technical know-how needed to put health and safety procedures into place. An integrated strategy for health promotion, social protection, and employment creation should be used to address the challenge of protecting the health and well-being of workers in the informal sector. One essential requirement for sustainable growth is the need for a healthy environment. The close connection between development and health is addressed explicitly in Chapter 6, which is on safeguarding and human health and is part of Agenda 21 of the UN Conference on Environment and Development (UNCED). Therefore, addressing basic needs and protecting vulnerable populations, such as the impoverished, are essential for sustainable development.

In the case of the informal sector, inadequate safety and health regulations, as well as a need for environmental awareness, are especially pronounced. Large-scale human and material losses are caused by unfavourable working conditions, including poor buildings and frequently extremely inadequate welfare facilities. Additionally, there are nearly no occupational health services, which negatively impacts the general well-being of informal workers and

their families and their quality of life. These factors burden national economies.

Most urban informal sector workers reside in impoverished neighbourhoods and lack access to social safety, welfare services, essential awareness, and labour in hazardous and unhygienic conditions. Many people who operate in the informal sector combine their home and employment location. Unwanted living and working situations can lead to poor health and disease vulnerability. The majority of informal workers work in hazardous conditions. Within this industry, it is frequently difficult to distinguish between living and working conditions, as both are linked to more general issues of poverty and underdevelopment. Dangerous working conditions impair the health of workers in the informal sector and also lower productivity and income because of ill health and incapacity to work efficiently. Table 1 presents the detailed review of literature. Based on this backdrop, we formulate the following hypothesis:

- H1:** The attitude of informal sector workers and environmental consciousness are positively correlated.
- H2:** The health of workers in the informal sector is positively correlated with environmental consciousness.
- H3:** Environmental awareness and workers' income in the unorganized sector are positively correlated.

3. Conceptual framework

Based on the literature review, we assess the level of consciousness among informal sector

workers by considering attitude, health, and income. Consciousness, in this study, refers to individuals' awareness and concern regarding environmental issues such as pollution, waste management, and conservation of natural resources. It is essential to understand the levels of environmental consciousness among informal sector workers to devise effective strategies for promoting sustainable practices. Theoretically, people who have more favourable views on the environment, better physical and mental health, and higher income levels are likely to exhibit higher levels of environmental consciousness. This positive relationship suggests that as attitudes, health, and income improve, individuals become more conscious and concerned about environmental issues. Figure 1 presents the main conceptual framework used in the study.

Attitude refers to individuals' beliefs, feelings, and evaluations towards environmental conservation and sustainability efforts. Positive attitudes towards the environment are expected to correlate with higher levels of environmental consciousness. People with a favourable attitude toward the environment are more likely to support eco-friendly regulations, recycle, and conserve energy, among other pro-environmental behaviours. As their attitudes towards environmental issues become more favourable, their level of environmental consciousness is expected to increase. Overall, a positive attitude reduces the exploitation of resources like land, water, or raw materials, which improves environmental consciousness.

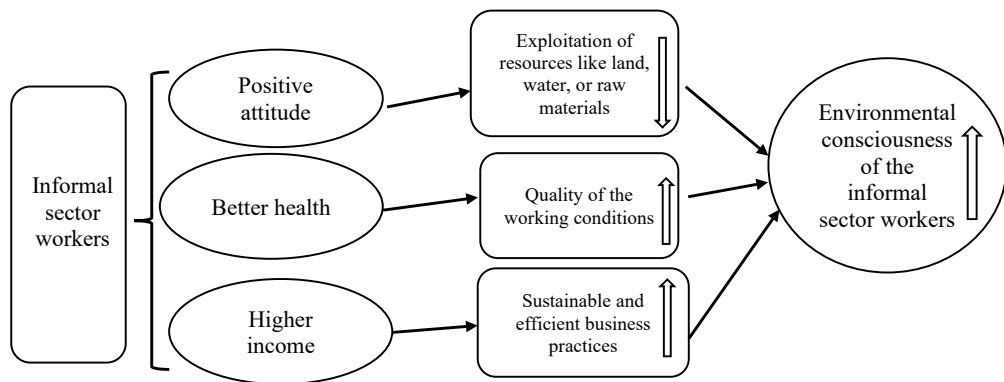


Figure 1. Conceptual framework

Source: Authors' compilation based on review of literature

Table 1. Detailed review of literature

Author	Objective	Variables	Methodology	Source of data	Conclusion
International studies					
Sultana et al. (2022)	To investigate how the unorganised sector affects development's sustainability in 50 developing countries	GDP per capita, trade to GDP ratio, Life expectancy at birth, Maternal Mortality rate, Under 5 Mortality rate, death due to Air pollution, CO ₂ /Nitrous oxide/Methane emissions per capita	Pre- estimation testing, Estimation method (FE and RE)	WDI (2020), ILOSTAT (2021), WHO (2020), State of Global Air (2020)	Sustainable development cannot be achieved through informal economic activity. Businesses and organisations in this area also frequently overlook sustainability policies.
Tong et al. (2021)	The objective of this study is to understand the importance of the informal recycling sector in respect of Vietnam's solid waste management system.	36 scrap dealers, 127 scrap buyers, 760 households	Field survey, key informant interview	Vietnam Ministry of Natural Resources and Environment (2011)	According to the study, from the standpoint of a circular economy, informal recycling activities are crucial to the SWM system. The accumulation of waste from the unorganised sector pollutes the surrounding environment.
Soharwardi et al. (2021)	To determine the simultaneous relationship between environment, informal sector, and poverty in Pakistan, Bangladesh, and India.	Total taxes, inflation rate, CO ₂ emissions, GDP, Informal sector employment, poverty, tertiary enrollments (proxy of higher education)	Generalized Momentum Method (GMM), Heterogeneous Panel unit root test	WDI, Labor Force Survey (2017-18)	Environmental deterioration, the informal sector, and poverty were found to be correlated in both directions by this study. In a similar vein, the informal sector and CO ₂ emissions also have diverse causes.

Author	Objective	Variables	Methodology	Source of data	Conclusion
Abid (2024).	To examine the impact of informal economy and ecological footprint on environmental regulation in 25 Sub-Saharan Africa economies.	Ecological footprint, GDP per capita (sample of 25 SSA countries from 1991-2017).	Static and dynamic panel data model	Labor Force Survey, ILO	The study comes to the conclusion that environmental contamination and the informal economy are strengthened by the region's lax environmental regulations.
Cvetković et al. (2019)	To understand the causes of fear of disasters among young adults in Turkey, Serbia, and Macedonia	Earthquakes, Droughts, Epidemics, Extreme temperatures	One-way ANOVA statistics	Primary survey based on 537 respondents	It concludes that fear was increased by exposure to adverse weather, images of the effects of disasters, and prior disaster experience.
Cvetković et al. (2019)	This study set out to investigate local self-governments' capacity building in the area of disaster risk management (DRM).	Type of local self-government, allocates budget funds for DRM, disaster risk assessment, disaster headquarters	Multivariate regression analysis	Primary survey	The DRM system has not been fully established at the local level either, largely due to its normative and functional incompleteness and partial non-establishment at the central level.
Cvetković et al. (2024)	The study aims to investigate environmental awareness, knowledge, and safety among students in Montenegro and North Macedonia	Environmental awareness attitudes, Knowledge of environmental protection attitudes, Contribute to environmental safety	Multivariate regression analysis	400 face-to-face interviews	Policymakers and educators can develop focused interventions to improve environmental education and promote a sustainable culture in both Montenegro and North Macedonia by identifying areas of strength and areas that require improvement.
Adei et al. (2021)	To identify the working environment of informal sector workers and highlight the role of planning as a first step in formalizing the sector to improve their working environment.		Review of relevant literature on the working environment of informal sector workers in Ghana with a focus on occupational health and safety issues.	Peer-reviewed articles, reports, and studies stored in electronic databases such as Google Scholar, PubMed, MEDLINE, Web of Science, JSTOR, and SCOPUS.	Despite its important role in employment and income generation, the informal sector faces unsafe working conditions that harm workers' health and safety.
Chaudhuri and Mukhopadhyay (2006)	To evaluate how various policies affect the economy's environmental standards.	Competitive wage rate, capital/labor output ratio, world price, return to capital, output level, domestic/aggregate capital stock	Small open economy with 3 sectors operating (agriculture, 2 manufacturing)	ILO	Reducing the allowable pollution level through regulatory bodies is a successful strategy to stop environmental deterioration in developed nations.

Author	Objective	Variables	Methodology	Source of data	Conclusion
Indian perspective					
Balasubramanian and Sarkar (2020)	To explain the organizing experiences of informal Sector workers engaged in large numbers in the Western Indian town of Alans.	Interviewed 18 persons	Single case study approach, purposive sampling	NSSO (2014), Economics Survey (2018)	The study was able to monitor the challenges that scholars often mentioned through internal democracy, grassroots unionism, establishing solidarity with other social movements, and worldwide labour solidarity.
Mukhtar & Gotmare (2021)	To study the health burden on informal workers and the existence and extent of utilization of health schemes for the unorganised sector in India.	Health hazards, healthcare expenditure, health insurance awareness, and access to government schemes	Literature review and analysis of secondary data	NSSO survey (2011-12). Ministry of Labour & Employment reports, ILO conventions, and other published studies.	Unorganized sector workers face significant health hazards and financial burdens due to limited access to health insurance and poor working conditions, necessitating enhanced awareness and comprehensive health security schemes.
Chowdhury et al. (2023).	To investigate the differences in health outcomes among older workers by formal and informal sector of employment in India.	Poor cognitive functioning (PCF), functional limits (FL), and chronic health problems (CHC).	Binary logistic regression models	Large-scale agricultural investment (2017- 2018)	In order to promote active and healthy ageing, policymakers should place a high premium on enhancing the health of this susceptible group.

Source: Authors' compilation based on review of literature

Health encompasses both physical and mental well-being. It is an independent **variable** because individuals' health status can influence their ability to engage in environmentally conscious behaviours. Poor health conditions may hinder individuals' ability to participate in activities promoting environmental sustainability. Research suggests a positive correlation between good

health and pro-environmental behaviours. Individuals who are physically and mentally healthy are more likely to have the energy, motivation, and cognitive capacity to prioritize environmental concerns and engage in sustainable practices. Therefore, as health improves, individuals may demonstrate higher levels of environmental consciousness by enhancing the quality of working conditions.

Table 2. Variables used to measure environmental consciousness and information sector in India

Main Theoretical and Empirical Studies	Variables of the Conceptual Framework	Variables used in the Empirical Study
Tong et al. (2021)	36 scrap dealers, 127 scrap buyers, 760 households	Scrap shops
Soharwardi et al. (2021)	Total taxes, inflation rate, CO ₂ emissions, GDP, Informal sector employment, poverty, tertiary enrolments (proxy of higher education)	Employment
Mukhtar & Gotmare (2021)	Health security, occupational safety, social protection, health insurance awareness, and workforce participation in the unorganized sector.	Health care expenditure, enrolment in health insurance schemes, occupational health hazards, and workforce participation rate.
Chowdhury et al., (2023)	The following are outcome variables: poor cognitive functioning (PCF), functioning limits (FL) and chronic health (CHC). Additional independent factors include demographics and socio-economic and demographic, work characteristics, life-style behaviour, and childhood and health.	Health issues, demographic characteristics, behaviour
Netto (2024)	225 postgraduate and higher-degree students from the University of Kerala (cross-sectional descriptive research design using purposive sampling to select a sample).	Measuring variables using validated categorical and Likert scale instruments on environmental consciousness, concern, and pro-environmental behaviour.
Sultana et al. (2022)	CO ₂ emissions, Ecological footprint, Nitrous Oxide Emissions, Economic growth and Informal economy(%GDP), Renewable/Non- renewable energy consumption, control of corruption, socio- economic condition	Ecological footprint

Source: Authors' compilation based on review of literature

Income level is an independent variable because it can affect individuals' access to resources, opportunities, and education, which may influence their environmental awareness and behaviours. Higher income levels provide individuals with more options to adopt environmentally friendly practices. Studies have shown that higher income levels are associated with greater environmental awareness and adopting sustainable behaviours. Individuals with higher incomes may have the financial means to invest in

eco-friendly products, technologies, and lifestyle choices. Additionally, education and awareness campaigns on environmental issues are more accessible to those with higher incomes. Therefore, individuals will likely demonstrate increased environmental consciousness as income levels rise. Overall, the higher income of a worker improves sustainable and efficient business practices. Table 2 presents the detailed explanation of variables used for the analysis.

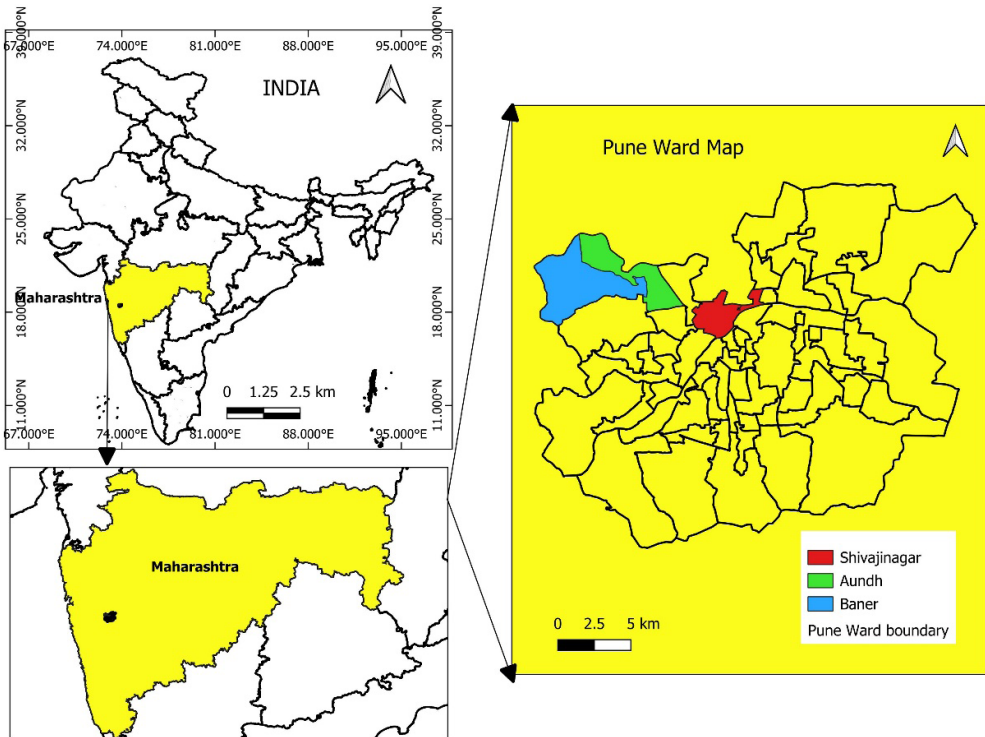


Figure 2. The location of the study area in Pune City

Source: Authors'

4. Data and methods

4.1. Data

The research employs the Survey Research Method (SRM) and targets 208 workers in diverse occupations such as street vending, waste picking, small-scale manufacturing, and construction. The questionnaire comprises 42 questions designed to align with the study's purpose of observing worker's attitudes and behaviour. Given the dispersed and unorganized nature of the informal sector, a systematic sampling approach was utilized, involving a structured process to select participants. Firstly, a list of various occupational domains within the informal sector in Pune was compiled. The list

included occupations such as street vending, waste picking and construction site workers.

The sample size comprised 208 individuals segmented into various categories:

- 103 Municipal Solid Waste Management workers (split between 50 government-affiliated workers and 50 randomly selected roadside workers).
- 55 street vendors
- 50 workers from construction sites

The survey was conducted in the Shivajinagar and Aundh-Baner areas of Pune, specifically in Ward Nos—92, 12, and 13, respectively. Of 208 workers, 95 were male, and 113 were female. Figure 2 presents the locations of the study area of Pune City.

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To select the appropriate sample size, we use the following formula proposed by Yamane (1967):

$$n = N/(1+N(e)^2) \quad (1)$$

where n is the sample size, N is the population size, and e is the level of precision. The total number of informal workers in Pune City was about 25 lakhs in 2020.¹ However, ward-wise data on the number of informal workers is not available. It is important to indicate that our sample represents households as we consider only one informal worker from each household. As per the latest census data 2011, Pune had about 742,602 households. However, the Shivajinagar ward had households of about 60387 and Aundh-Baner 39419, so the total number of households in these wards was 99,806. Considering a 95% confidence level and $P = 0.7$, the total sample households will be about 203. Therefore, we consider 208 workers as the sample size.

4.2. Regression models

We consider the following regression equation for the analysis.

$$\text{Consciousness} = \beta_0 + \beta_1 \text{attitude} + \beta_2 \text{health} + \beta_3 \text{income} + \varepsilon \quad (1)$$

where β_0 is the intercept, β_1 , β_2 , and β_3 are the coefficients for Attitude/behaviour, health, and income respectively. ε is the well-behaved error term. The dependent variable- consciousness is measured

reflecting individual's levels of awareness and concern regarding environmental issues. The independent variables include attitude, health, and income, each categorized differently. Based on review of literature, we expect that attitude, health, and income have a positive effect on the environmental consciousness.

Attitude and health are categorical variables taken as binary (Yes/No), where 'Yes' = 1 and 'No' = 0, indicating the presence or absence of positive attitudes or good health, respectively. Income is categorized into four ranges, i.e. Rs.1000 - Rs.5000; Rs. 5000 - Rs.10000; Rs. 10000 - Rs.15000; Rs. 15000 and above; with the highest average category of income = 1 and otherwise 0. According to the survey, the highest average income among the workers falls between Rs. 5000 - Rs. 10,000. Table 3 presents the description of the variables used for the analysis. We have quantified 22 questions for the regression analysis, although we asked 40.

The sample size comprises 208 respondents, with a total of 22 variables utilized in the study. The variables' descriptive statistics are shown in Tables 4. The correlation coefficients indicate that, more or less, there is a moderate correlation between the variables. For instance, variables X19 and X20 have r^2 value 0.42; variables X21 and X19 have r^2 value 0.38; variables X9 and X3 have r^2 value 0.34. To make the final estimation more appropriate, we use PCA to reduce the number of independent variables.

¹ https://www.iimb.ac.in/turn_turn/pune-industrial-workforce.php (Accessed on 4 April, 2025)

Table 3. Variables measure consciousness, attitude, health, and income

Abbreviation	Variables
Consciousness	
X1	Do you segregate recyclable materials from general waste during your work activities? (Yes=1, No=0)
X2	Do you prioritize using environmentally friendly materials in your daily work operations? (Yes=1, No=0)
X3	Do you participate in initiatives aimed at reducing environmental pollution in your working area? (Yes=1, No=0)
X4	Do you conserve water while performing your work tasks? (Yes=1, No=0)
X5	Do you properly dispose of hazardous waste materials? (Yes=1, No=0)
X6	Do you adhere to guidelines aimed to reduce air/water pollution during your work activities? (Yes=1, No=0)
X7	Do you engage in practices such as carpooling or using public transport? (Yes=1, No=0)
X8	Are you aware of the environmental impact of your daily work activities? (Yes=1, No=0)
X9	Have you received any training or information regarding eco-friendly practices within your occupation? (Yes=1, No=0)
X10	Do you believe incorporating environmentally sustainable practices into your work routine can positively contribute to your community? (Yes=1, No=0)
Attitude	
X11	Do you want to incorporate waste reduction practices in your work tasks? (Yes=1, No=0)
X12	Do you incorporate waste reduction methods into your work routines? (Yes=1, No=0)
X13	Do you actively participate in or support community initiatives focused on environmental conservation? (Yes=1, No=0)
Health	
X14	Do you think that by practising waste reduction, your health is deteriorating? (Yes=1, No=0)
X15	Do you think an unclean environment affects your health? (Yes=1, No=0)
X16	Do you believe improving environmental conditions could positively impact your health and well-being? (Yes=1, No=0)
X17	Are you aware that having an unclean environment around you can lead to many diseases, such as cholera, dengue, malaria, respiratory problems, typhoid and many more? (Yes=1, No=0)
Income	
X18	Do you receive incentives or monetary benefits to follow waste reduction practices? (Yes=1, No=0)
X19	Do you think that low income affects your ability to adopt environmentally friendly practices? (Yes=1, No=0)
X20	Do you believe that those with greater incomes are more accountable for practicing waste reduction and management? (Yes=1, No=0)
X21	Do you think that individuals with a higher income have more ability or ease to practice waste management/reduction? (Yes=1, No=0)
X22	Income (highest category average income = 1 and otherwise 0)

Source: Authors' compilation based on primary data

Table 4. Descriptive statistics of the variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
X1	208	0.12	0.32	0	1
X2	208	0.29	0.45	0	1
X3	208	0.35	0.48	0	1
X4	208	0.71	0.45	0	1
X5	208	0.08	0.27	0	1
X6	208	0.10	0.30	0	1
X7	208	0.63	0.48	0	1
X8	208	0.31	0.46	0	1
X9	208	0.06	0.23	0	1
X10	208	0.40	0.49	0	1
X11	208	0.69	0.46	0	1
X12	208	0.48	0.50	0	1
X13	208	0.12	0.32	0	1
X14	208	0.48	0.50	0	1
X15	208	0.79	0.41	0	1
X16	208	0.71	0.45	0	1
X17	208	0.88	0.32	0	1
X18	208	0.04	0.19	0	1
X19	208	0.40	0.49	0	1
X20	208	0.56	0.50	0	1
X21	208	0.69	0.46	0	1
X22	208	0.56	0.50	0	1

Source: Authors' estimation based on primary data⁵. Empirical results

5. Empirical results

5.1. Descriptive analysis

Several Likert scale questions were asked to workers to understand better their level of consciousness. These questions aimed to understand various aspects of their background, experiences, and perceptions. The answer is divided into seven days of a week (every time), three to four days of a week (rarely), and zero days of a week (never).

The informal sector workers were asked about their prioritization of using environmentally friendly materials or methods in their daily work activities. The responses revealed that 57.7% of them sometimes prioritize such practices, indicating moderate consideration for environmental factors. 34.6% admitted to never prioritizing using environmentally friendly materials or methods, suggesting that a significant portion of workers may need to engage in eco-friendly practices

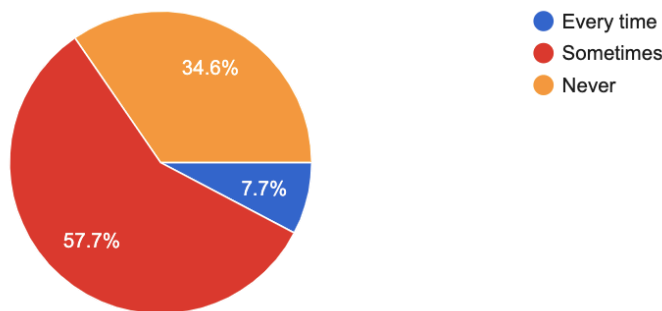


Figure 3. In your daily activities at work, how frequently do you prioritize using environmentally friendly materials or methods?

Source: Authors' estimation based on primary data

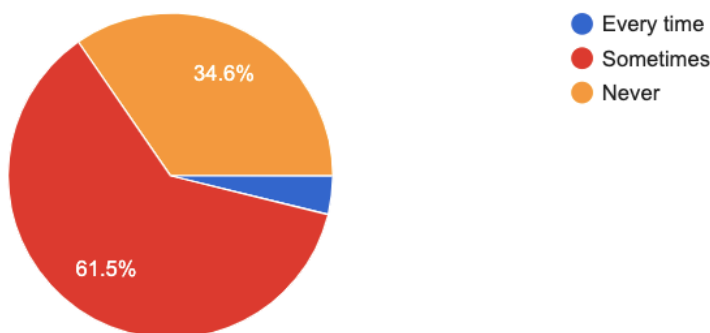


Figure 4. How often do you experience health issues such as headaches, nausea or respiratory problems that you suspect are linked to environmental factors in your workplace?

Source: Authors' estimation based on primary data

actively. 7.7% of respondents claimed to prioritize environmental considerations every time they engage in their work activities, indicating a small yet notable proportion of workers who consistently prioritize sustainability (Figure 3).

Workers were asked about the frequency of health issues they experience, such as headaches, nausea, or respiratory problems, which they suspect are linked to environmental factors in their workplace. The results show that a majority, 61.5%, reported experiencing these health issues sometimes, indicating a substantial portion of workers face occasional

challenges potentially attributable to their work environment. 34.6% stated they had never encountered such health issues, suggesting a significant proportion of workers may not perceive any direct link between their health problems and workplace conditions. However, a smaller percentage, 3.8%, reported experiencing these health issues every time they work, indicating a minority who consistently face health challenges they attribute to environmental factors in their workplace (Figure 4).

Also, 42.3% of respondents reported facing challenges in adopting environmentally

friendly practices due to financial constraints. This indicates that many workers' ability to engage in sustainable practices is hindered by financial limitations. 40.4% stated they never face such challenges, suggesting that a considerable number of workers need to perceive financial constraints as a barrier to adopting environmentally friendly practices in their work. However, 17.3% of respondents reported facing financial constraints every time they adopt eco-friendly practices, indicating a notable minority consistently grappling with financial barriers in their sustainability efforts (Figure 5).

Next, we ask about their consistency in engaging in behaviours to reduce their environmental footprint, such as recycling or conserving water. The results indicated that a majority, 59.6%, reported engaging in these behaviours sometimes, suggesting a significant portion of individuals make occasional efforts towards environmental conservation. However, 40.4% stated they never engage in such behaviours, indicating that a considerable proportion of respondents do not actively participate in actions to reduce their environmental impact.

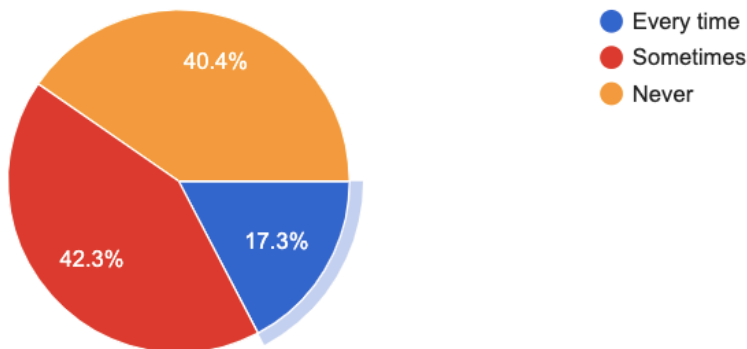


Figure 5. How frequently do you face challenges in adopting environmentally friendly practices due to financial constraints?

Source: Authors' estimation based on primary data

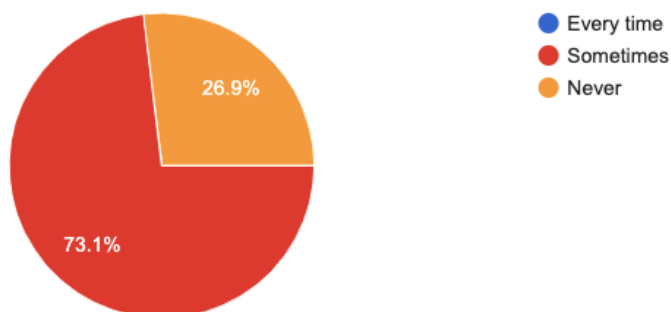


Figure 6. How often do you actively seek out information on environmental issues affecting your workplace and community?

Source: Authors' estimation based on primary data

The workers were asked how actively they seek information on environmental issues affecting their workplace and community. Results showed that a majority, 73.1%, reported doing so sometimes, indicating a significant portion of individuals periodically seek information on environmental matters relevant to their surroundings. 26.9% stated they never actively seek such information, suggesting that a notable proportion of respondents may need more consistent engagement with environmental concerns in their workplace and community (Figure 6).

These findings highlight the varying levels of awareness and interest in environmental issues among individuals. Therefore, it underscores the importance of education and outreach initiatives to promote environmental consciousness and foster informed decision-making for sustainable practices.

5.2. Principal Component Analysis (PCA)

A principal component analysis (PCA) statistical method breaks down high-dimensional data into a smaller group of uncorrelated variables called principal components. In a dataset, PCA minimises the number of variables (dimensions) while preserving the largest amount of information (variance). It is a pattern recognition technique that helps us identify and determine which parameter among variables is more crucial than others. Instead of being subjective in our weight selection, PCA enables us to weigh the variables based on their variability justifiably.

Prior to conducting PCA, we must assess and confirm the accuracy of the data. The

proximity of the measured values is referred to as validity. Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) index are used to assess validity. The validity of data must be assessed before the Principal Component Analysis (PCA) is carried out. Validity is the degree to which the measured values are similar. The Kaiser-Meyer-Olkin (KMO) index and Bartlett's test of sphericity are used to assess the validity. The KMO index compares correlation between variables. A higher KMO value indicates a strong correlation between variables, suggesting that a smaller number of components can explain the variance of the data. With a significance probability of $0.000 < 0.01$ for Bartlett's test of spherical, the original hypothesis is rejected, suggested that the parameters are connected and so appropriate for PCA analysis.

Table 5 presents the initial Eigenvalues. We consider eigenvalues larger than 1 for the analysis of the main components, following Kaiser's (1960) rule of thumb. The main rationale is that a principal component (PC) can explain more variance in a dataset than a single original variable if its eigenvalue is larger than 1. In other words, that component collects more information than a single original feature. We retain four components for the consciousness index as Eigenvalues associated with components 1, 2, 3, and 4 are greater than 1. Similarly, one component is retained for the attitude index. However, we kept two components for each health and income index. The first five components of the consciousness index account for about 70% of the variance. However, it is about 40% to 60% for all other indices.

Table 5: Explanation of Total Variance

Consciousness				
Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.13	0.74	0.21	0.21
Comp2	1.39	0.12	0.14	0.35
Comp3	1.27	0.11	0.13	0.48
Comp4	1.15	0.11	0.12	0.59
Comp5	1.04	0.09	0.10	0.70
Comp6	0.95	0.24	0.10	0.79
Comp7	0.71	0.16	0.07	0.86
Comp8	0.55	0.07	0.05	0.92
Comp9	0.48	0.15	0.05	0.97
Comp10	0.33	.	0.03	1.00
<i>Attitude</i>				
Comp1	1.26	0.27	0.42	0.42
Comp2	0.99	0.23	0.33	0.75
Comp3	0.76	.	0.25	1.00
<i>Health</i>				
Comp1	1.63	0.60	0.41	0.41
Comp2	1.03	0.13	0.26	0.67
Comp3	0.90	0.47	0.23	0.89
Comp4	0.43	.	0.11	1.00
<i>Income</i>				
Comp1	1.90	0.76	0.38	0.38
Comp2	1.13	0.16	0.23	0.61
Comp3	0.97	0.36	0.19	0.80
Comp4	0.61	0.22	0.12	0.92
Comp5	0.39	.	0.08	1.00

Source: Authors' estimation based on primary data

Figure 7 presents the heatmap of scoring coefficients after orthogonal varimax rotation. Factor loading is the relationship between the principal components and the original variables, often known as covariances. A variable that contributes substantially to that primary component is said to have a high factor loading. The factor loading's magnitude

indicates each variable's degree of association with the component. A loading near 1 suggests that the variable significantly contributes to the component, whereas a loading near 0 indicates that the variable makes a minimal contribution. In other words, we can better comprehend what each component reflects and which variables contribute most to

each component by interpreting component loadings.

Heatmaps are practical tools for visualising data's density, intensity, or frequency over a given region or dataset. The heatmap presents how strongly variables load on different components in our case. Blue shades denote a strong negative influence on the coolwarm colour scheme used in the heat maps. In contrast, red shades imply higher positive values, indicating a significant positive influence of a variable on a component. Values near zero are indicated by white or neutral hues, which suggest little to no influence. Darker colours indicate stronger links, and this colour coding makes it easier to see how each variable affects the corresponding components. The result shows that component 1 of the consciousness index is related to variables X2 (0.35), X3 (0.42), X5 (0.37), X8 (0.44), and X10 (0.37). Component 1 can be called 'eco-friendly practices.' The second component is associated with X1 (0.34), X5 (0.34), and X10 (0.51). Component 2 can be called 'green responsibility.' Component 3 is named 'environmental care' and is related to X7 (0.51) and X9 (0.54). Component 4 is more stressed on X4 (0.76), and the component is named 'sustainable duty.' Finally, component 5 is related to X1 (0.56), X6 (0.47), and X9 (0.37) and is named 'commitment to sustainability'.

Component 1 of the attitude index is primarily influenced by X11 (0.70), X12 (0.63), and X13 (0.34), and it can be named 'sustainable attitude'. Component 1 of the health index is influenced by X15 (0.63), X16 (0.64), and X17 (0.41). Component 1 is named 'eco-healthy surroundings.' Component 2 of the health index is related to X14 (0.81) and called as 'healthy environmental conditions'. Component 1 of the income index is related

to X19 (0.52), X20 (0.58), and X21 (0.62), and it is named a 'monetary-based environment.' Finally, Component 2 of the income index is related to X18 (0.83) and X22 (0.42) and is called an "economically driven environment". Figure 7 explains the key variables related to each component.

5.3. Regression results

The regression results are shown in Table 6. We evaluate the variance inflation factors (VIF) in order to verify the multicollinearity issue. It is verified that there is no multicollinearity in the regression findings because the OLS regression's VIF values are less than 10. All three independent variables impact the dependent variable, which is both favourable and statistically significant. The results indicate a one-unit increase in the attitude index, and the environmental consciousness index increases by 0.54 units. Therefore, we reject the null hypothesis and conclude that there is a positive relationship between attitude and environmental consciousness among informal sector workers. Similarly, with a one-unit increase in the health index, the environmental consciousness index increases by 0.19 units. With a one-unit increase in the income index, the environmental consciousness index rises by 0.18. The regression results show that attitude, health, and income indices all have a significant positive relationship with environmental consciousness among informal sector workers. These findings suggest that informal sector workers who exhibit positive attitudes, good health, and higher income levels are more likely to demonstrate high environmental consciousness. Therefore, efforts to foster positive attitudes, improve health conditions, and enhance income opportunities among this demographic could promote environmental awareness and

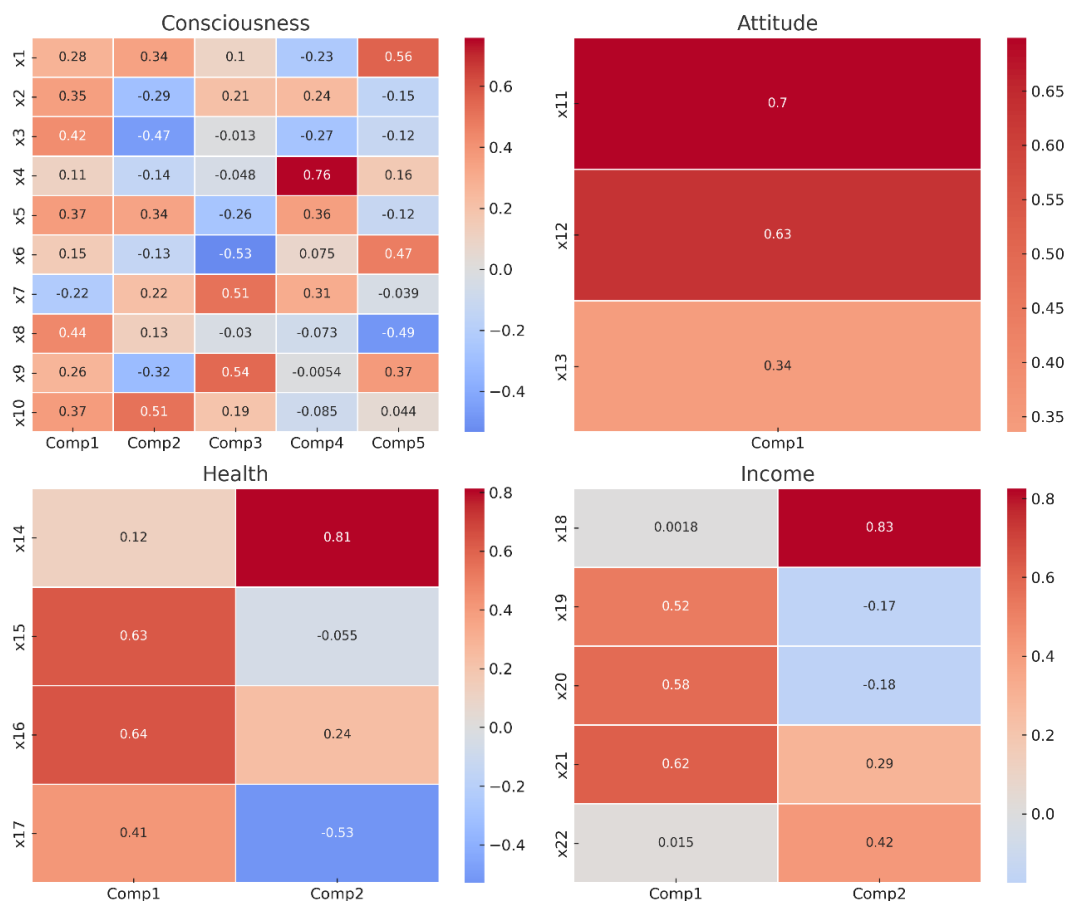


Figure 7. Heatmap of scoring coefficients for orthogonal varimax rotation (Weights)

Source: Authors' estimation based on primary data

sustainable practices within the informal sector. However, the results should be taken with a little caution as the R^2 value is about 0.35. This indicates that the informal workers' attitude, health, and income explain 35% of the variance in environmental consciousness. The remaining 65% is due to other factors not included in the model. Therefore, regression models may account for little confounders or biases.

6. Conclusion and policy implications

The study provided valuable insights into the factors influencing awareness and concern regarding environmental issues within this demographic. This sheds light on the relationship between individual characteristics and environmental consciousness levels—the dependent variable, consciousness, measured individuals' levels of awareness and concern regarding environmental issues. The independent variables, including attitude, health, and income, were categorized

Table 6. Multiple regression analysis findings

VARIABLES	Dependent variable: Environmental consciousness index	VIF
	Model 1	
Attitude index	0.54*** (0.06)	1.09
Health index	0.19*** (0.04)	1.09
Income index	0.18*** (0.05)	1.00
Constant	-0.00 (0.07)	
F values	46.11***	
Observations	208	
R-squared	0.35	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimation based on primary data

Table 7. Results of hypothesis testing

Srl. No.	Hypothesis	Results
H1	<i>There is a positive relationship between the attitude of informal sector workers and environmental consciousness.</i>	Yes, an attitude, which is measured by waste reduction practices, methods, and community initiatives, has a positive impact on environmental consciousness.
H2	<i>There is a positive relationship between the health of workers and environmental consciousness.</i>	Yes, the worker's health, as measured by the work environment, positively affects environmental consciousness.
H3	<i>There is a positive relationship between environmental awareness and workers' income in the unorganized sector.</i>	Yes, the income of the informal worker, which is measured by level of income and perception about higher income for demand for a better environment, has a positive effect on environmental awareness.

Source: Authors' compilation

differently, but all demonstrated significant positive relationships with environmental consciousness among informal sector workers. These findings indicate that workers with positive attitudes, good health, and higher income levels are likelier to exhibit

high environmental consciousness. Table 7 presents the results of the hypothesis testing.

Our results show a wide variation in environmental consciousness among the informal workers in Pune, India. Results support the findings of Cvetković et al. (2024).

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The study showed that students in Montenegro and North Macedonia differ significantly in their environmental awareness and knowledge perceptions. Distinct attitudes and behaviours about environmental issues and safety procedures are influenced by variations in educational systems and socioeconomic variables for these two countries.

A positive attitude increases environmental consciousness. Several studies also find similar results. For example, Wu et al. (2023) argued that attitude through environmental education increases communities' awareness of environmental issues and businesses' drive to provide cleaner products through environmental pressure. According to Liu et al. (2022), formal environmental education successfully fosters favourable changes in environmental attitudes, especially when it stresses experiential learning. Other studies (e.g., Shah et al., 2021; Calculli et al., 2021; Simanjuntak et al., 2023) emphasized the relationship between people's attitudes and environmental consciousness. However, our study is different in terms of focusing on the informal workers at the city level. This is a demographic often characterized by economic vulnerability, lower educational qualifications, and exposure to challenging work environments (Mukhtar & Gotmare, 2021; Sheik & Gaura, 2020), also a less-studied demographic, indicating that even with limited resources and education, improvements in attitudes, health, and income can foster environmental awareness. Furthermore, the results suggest that attitude-driven actions are universal for fostering environmental awareness, regardless of demographics.

The link between health and environmental consciousness highlights the importance of addressing health disparities among informal sector workers. Access to healthcare

services, sanitation facilities, and occupational safety measures is essential for improving health outcomes and promoting a healthier workforce. Government interventions, public health campaigns, and partnerships with healthcare providers can help address health-related challenges within the informal sector. The positive relationship between health and environmental consciousness is found in Castellini et al. (2023), Iqbal et al. (2021), and Ahmed et al. (2021). However, these studies, for example, Castellini et al. (2023), focused on the country rather than the city level. All studies affirm that health consciousness is a key driver of pro-environmental behaviours, whether broadly defined or specifically tied to organic food purchases. This study extends the health-consciousness-environmental behaviour link to urban informal sector workers, a more specified and marginalised group. This implies that health-conscious people likely see environmental protection as enhancing their wellness because they are more likely to take actions that are environmentally conscious, regardless of their socio-economic conditions. The results also highlight the possibility of community-focused programs or interventions to promote *sustainability* in vulnerable populations.

Higher-income levels were associated with increased environmental consciousness among informal sector workers, contrasting with Akhtar et al. (2021), who find that green attitude significantly influences willingness to consume green products, which mediates actual green consumption but disproved the influence of income groups on the relationship between consumers' willingness to consume green products and actual green consumption. Policies focused on enhancing income opportunities, such as skills training, entrepreneurship support, and access to

financial resources, can empower workers economically and contribute to sustainable livelihoods. Initiatives promoting fair wages, decent working conditions, and access to formal employment opportunities can also uplift the economic status of informal sector workers and foster environmental consciousness. The results are supported by Liang et al. (2024), Chang et al. (2022), and Alam & Zakaria (2021). However, though very few studies, such as Alam & Zakaria's (2021) study, are based in Sylhet City, Bangladesh, the consideration of the informal sector is highly neglected. This study attempts to address this critical yet understudied population, especially in developing economies.

Regarding policy suggestions, encouraging positive attitudes towards environmental issues among informal sector workers is essential. In this context, collaborations with community leaders, non-governmental organizations (NGOs), and educational institutions can facilitate the dissemination of information and promote a culture of environmental stewardship. Most importantly, NGOs can raise awareness among informal workers by holding educational workshops, using social media campaigns, encouraging sustainable living habits, pushing for legislative reforms, and actively interacting with local communities. The "SankalpTaru Foundation" is an example of an NGO that greatly raises environmental awareness in Indian cities. It focuses on tree planting initiatives throughout India, especially in contaminated urban areas, teaching communities the value of greenery and actively encouraging them to plant and care for trees. We need more NGOs for this purpose.

When it comes to particular policy initiatives, we must encourage sustainable consumption patterns, such promoting zero waste practices

to reduce waste in informal marketplaces. It is crucial to use environmentally friendly resources in the creation of goods, such as organic and biodegradable materials. Local governments can play a significant role in this scenario by offering modest financial incentives, such tax breaks or subsidies, to unorganised workers who follow sustainable business practices. Additionally, informal workers who wish to invest in green technologies like water-saving devices or energy-efficient machines may be eligible for subsidies or loans from the government or bank. Establishing resource centres where unorganised workers can obtain training and knowledge to adopt more sustainable work practices is also necessary. Enhancing the ability of public local administrations and the local ward—a local government area typically used for elections—is also crucial. These administrations should be founded on the principles of responsibility, coordination, cooperation, partnership, prevention and proactive action to increase environmental awareness among informal workers (Cvetković et al., 2021). Additionally, duties should be incorporated into family culture and associated conversations rather than limited to different educational programs (Cvetković et al., 2019). Engaging in eco-friendly activities like cutting back on waste, utilising energy-efficient equipment, and implementing sustainable practices will benefit informal workers.

Regarding the best case studies in Indian cities, environmental consciousness policies do not cover the informal sector specifically. One example is the Bengaluru Green & Solid Waste Management Program. The programme has stretched the city's green space and reduced the effects of pollution. The younger generation is being taught the

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value of green spaces through the increasing number of schools and institutions that now hold their tree-planting events. This kind of endeavour is more needed than ever. However, environmental consciousness programs should pay particular attention to the informal sector to increase its effectiveness.

In the context of international perspective, case studies of Harare and Masvingo, Zimbabwe, highlight environmental consciousness policies in the informal sector through community-driven waste management, health clubs for waste-pickers, collaborations with local authorities for waste-to-energy and climate-proofed markets, and education for sustainable urban agriculture (Dodman et al., 2023). These initiatives reflect efforts to integrate environmental *sustainability* into informal sector activities and promote environmental consciousness among informal sector workers and show ways how potentially India can do the same.

However, consideration of other socio-economic factors, such as gender, education, and working conditions, to gain a more holistic understanding of environmental awareness determinants is left for future research. Most importantly, consideration of confounding variables for better and robust regression results is left for future research. It is crucial to acknowledge that the interviewee sample was somewhat very small. Future studies must thus expand on current studies and delve further into environmental consciousness among the informal workers in other cities and towns in India. The potential longitudinal studies to track changes in environmental awareness among informal workers over time is also an important topic for future research. Additionally, the role of digital interventions (e.g., social media campaigns) in improving environmental consciousness is essential

to assess in future studies. Therefore, this study should be regarded as preliminary but significant.

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