



Determinants of Household Waste Management in Urban Kerala: An Econometric Approach

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/sajsse/2025/v22i4999>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://pr.sdiarticle5.com/review-history/133952>

Original Research Article

Received: 01/02/2025

Accepted: 03/04/2025

Published: 07/04/2025

ABSTRACT

Solid waste generation has grown critical recently, emphasizing the need for civic involvement for ensuring waste management thereby environmental quality. This study uses the dichotomous choice approach of contingent valuation to investigate the willingness of urban Kerala families to pay for enhanced waste management. Secondly, the research investigates the factors determining households' readiness to pay for better waste management by employing multiple regression model. The study gathered information relating to waste management from 384 sample households of Calicut Municipal Corporation of Kerala through a stratified random sampling. The study found that the average household willingness to pay for better waste management is Rs.201 per month

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Cite as: C A, Rejuna, Shabeer K P, Retheesh P K, and Midhun V P. 2025. "Determinants of Household Waste Management in Urban Kerala: An Econometric Approach". *South Asian Journal of Social Studies and Economics* 22 (4):265-74. <https://doi.org/10.9734/sajsse/2025/v22i4999>.

which is the market price placed by the households for a clean environment. The findings also indicate that households are indeed ready to pay for improved waste management and along with socio economics determinants, the waste generation level, proximity to dumping ground, and the availability of availability of a service for collecting waste are identified as the critical correlates of willingness.

Keywords: Solid waste; waste management; dichotomous choice method; market price.

1. INTRODUCTION

Solid waste has emerged as a significant environmental challenge in urban areas across the globe. Solid waste management (SWM) has become a critical issue for both developed and developing economies, as improper waste disposal is a major contributor to hazardous air pollution, environmental degradation, and serious health risks (Iyamu et al., 2020). Sustainable solid waste management is crucial for achieving multiple UN Sustainable Development Goals (SDGs) as it addresses urban waste challenges and promotes environmental sustainability (Abubaker, 2022). Efficient solid waste management is a global concern, especially for developing countries (Fadhullah, 2022). A key challenge of waste management in developing nations revolves around the establishment of sustainable financing.

Kerala, one of the most densely inhabited states in India, has long been struggling with issues of waste disposal. Most Kerala towns collect only a small portion of the total waste generated and a large volume of the collected waste is dumped improperly on the pavements and public areas. Urban public authorities are found to have instituted waste treatment plants in collaboration with the private service providers for effective waste management. However, a notable segment of the population lacks access to these government-provided waste collection services. In addition to polluting water, land, and air, poor collection and disposal endangers human health and the ecosystem in multiple ways.

Kerala stands out among the Indian states due to its proactive approach to tackle waste management issues, as demonstrated by the launch of the Clean Kerala Mission in 2002. In 2004, this mission aimed to transform Kerala into a garbage-free region, providing technical and financial support to local governments for compliance with the Municipal Solid Waste (Management and Handling) Rules of 2000. Despite of these measures taken by local self-government bodies in implementing institutional

reforms to preserve environmental quality, a substantial number of households in Kerala still lack regular waste collection services. Consequently, a comprehensive examination is imperative to address the multifaceted factors and practices influencing effective waste management by urban municipalities.

Several studies have also examined the willingness to pay (WTP) for improved waste management. Kayamo (2022) employed the contingent valuation method to estimate residents' WTP and found that waste minimization practices, such as reuse, recycling, and composting, were uncommon at the household level. The study recommended that local authorities incorporate residents' willingness into policy decisions to mitigate public health risks and environmental issues. Chinh et al. (2021) identified factors such as income, education, age, occupation, and waste volume as significant determinants of WTP. Similarly, Ray et al. (2023) found that schooling years, income, awareness of the Swachh Bharat Abhiyan, and proximity to community bins positively influenced WTP, while gender had a negative impact. Fattah et al. (2022) further corroborated these findings, indicating that income, education, and employment had positive influences, whereas age, household size, and satisfaction levels negatively affected WTP.

Effective solid waste management has become a significant global challenge (Khan et al., 2022), highlighting the urgent need for innovative approaches to enhance resource recovery and prevent environmental pollution. India being the most populous country the rate of waste generation is also increasing rapidly and the problem of waste management has become a serious issue due to improper disposal of waste Rani et al (2022). Efficient waste management is a critical concern in urban areas, with various studies highlighting the role of smart technologies, adaptive systems, and community participation in enhancing waste management practices. Ganesh et al. (2024) emphasized the significance of smart technologies, public-private

partnerships, and circular economy principles in improving municipal solid waste management (MSWM). Similarly, Hasan et al. (2022) pointed out the necessity of renewable and clean environments, advocating for waste classification techniques at collection plants to facilitate recycling. In alignment with these findings, Suryawan and Lee (2023) proposed three adaptive MSWM scenarios: optimizing system infrastructure, implementing community-based MSWM, and adopting smart MSWM systems to ensure sustainable waste management services. Household solid waste can be turned into a resource through source segregation, as long as people are supported with proper mechanisms and the burden is shared based on waste generation levels (Sujauddin et al., 2008). Knowledge of current practices and perception of household solid waste management is necessary for accurate decision making in the move towards a more sustainable approach Fadhullah (2022). These studies collectively emphasize the need for an integrated approach to waste management, combining smart technologies, policy interventions, and public engagement to enhance sustainability and efficiency in urban waste systems.

Effectively managing municipal solid waste necessitates significant financial resources. The responsibility for planning, implementing, and investing in solid waste management primarily rests with local governments. To cover the ongoing expenses of Municipal Solid Waste Management (MSWM), user fees are typically employed as a common practice. However, local authorities often encounter operational challenges related to community willingness and participation when it comes to collecting these user charges. Consequently, a crucial question arises: What proportion of households is actually ready to contribute for the improved environmental quality? It becomes essential to estimate the level of willingness and identify the critical factors influencing it. This information is crucial during the implementation phase to determine an appropriate user charge. In this context, the current study's significance becomes evident.

2. OBJECTIVES

This research aims to gauge community support for better waste management services and quantify its monetary value that urban households in Kerala place on the preservation of a clean and sustainable environment.

Furthermore, the study intends to provide a thorough examination of the socioeconomic determinants, like education, expenditure, age, gender, size of household, and homestead size that affect willingness to pay for environmental improvements. Additionally, it intends to explore specific enabling factors, such as the volume of garbage generation, availability of disposal services, and the proximity of residences to disposal sites and its relation with households' willingness.

3. MATERIALS AND METHODS

3.1 Data

The present study gathered information relating to waste management from 384 sample households of Calicut Municipal Corporation of Kerala are identified through a stratified random sampling. Calicut Corporation comprises of 75 wards which are divided into two strata based on their mean distance (8 km) from waste treatment plant. Stratum 1 comprised 33 wards within mean distance, while Stratum II comprised 42 wards further away from the mean distance. Seven wards are randomly selected from Stratum I, and eight from Stratum II. Each wards represents 24-28 households, in a proportion to the total households in that ward.

3.2 Theoretical Framework

Environmental quality is widely seen as a non-rival and non-excludable public benefit in terms of consumption. As such, it leads to the inherent possibility of market failure and consequent absence of price signals. In such cases, government interventions through public policy measures such as taxation, regulations, incentives, public projects etc. might be necessary. However, due to policy failure, all government interventions may not be socially acceptable. That is to say, government interventions distort a well- functioning market or fails to establish the foundations for the market to function efficiently (Callen and Thomas 2013) leading to market failure and government failure, necessitating an alternative method for evaluating non- market goods and services is required.

Owing to the absence of market data, the study employed an alternative estimation methodology predicated upon hypothetical market conditions. Surveys are commonly used to determine people's willingness to pay for a particular

environmental effort utilise the Contingent Valuation Method because the results are dependent, or contingent, on the devised hypothetical market (Callen and Thomas 2013). The contingent valuation method entails asking individuals the greatest amount they are ready to pay for a benefit, as well as the least amount they are willing to accept if they do not want the benefit (Callen and Thomas 2013). This method is also known as the stated preference technique, as the people are directly asked to state their value rather than inferring values from the actual choice and the willingness to pay will reflect the value of the particular environmental quality (Walsh et al. 1984, Mitchell & Carson 2013). The main aim of the contingent valuation survey is to create a hypothetical market, as close to a real market, to obtain hypothetical bids 'that conform to actual bids if the actual market had existed (Mitchell & Carson 2013).

3.3 Dichotomous Choice Methods

The present study utilizes the dichotomous choice method of contingent valuation to elicit publics' willingness towards enhanced waste management. Initially, respondents are queried about their willingness to contribute financially, even if it's a nominal amount, towards the described waste management improvements. If they answer affirmatively to this initial question, a dichotomous valuation format is employed. In this format, households are initially presented with a specific monetary bid and asked them to express willingness to that specific amount. If they agree, a higher bid is then presented, and respondents are further queried about their willingness to pay that sum. Conversely, if they decline the initial bid, a lower bid is proposed and questioned whether they would be prepared to pay that reduced bid. Following this double-bounded approach, an open-ended follow-up question is posed to determine the maximum amount households are ready to contribute. For those who respond negatively to the participation question, an additional inquiry is made to understand the reasons behind their unwillingness to contribute.

3.4 Econometric Methods

OLS regression is utilised to look into the dominant factors that determine the WTP towards enhanced garbage management among urban households. The maximum willingness to pay of households is regressed on explanatory variables including monthly

household expenditure, household size, education level, gender, age, quantity of waste generation, proximity to dumping ground and availability of waste disposal service. The model for determining factors influencing willingness to pay of household is defined as

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + u_i \dots \dots \quad (1)$$

Where,

Y = WTP (Maximum willingness to pay in Rs)

X₁ = Household monthly expenditure (In Rs)

X₂ = Size of household (In number)

X₃ = Educational category (1 if above primary; 0 if, below primary)

X₄ = Gender (1 if female; 0 if, male)

X₅ = Age (In years)

X₆ = Quantity of waste generation (In kg/ week)

X₇ = Availability of waste disposal service (1 if available: 0 if, otherwise)

X₈ = Proximity to waste treatment plant (In Km).

u_i = Error variable

The study checked the basic assumptions such as linearity, multivariate normality, no multicollinearity, homoscedasticity and no auto correlation to ensure that the obtained data can be subjected to multiple regression. Scatter plots of the dependent variable against independent variables are generated to check for linearity and found that the model satisfy the assumption of linearity. The residuals are plotted in a standard P-P plot to check normality and found that none of the data points are far from the slope line, indicating that the residuals are normally distributed. Pearson's correlation coefficient matrix is employed to test multicollinearity and it shows that there is some moderate correlation between certain independent variables, but there does not appear to be a severe problem of multicollinearity.

The White test is utilised to check the problem of homoscedasticity and the results show that the

variances for the errors are not equal that is heteroscedasticity is present. Thus, it is found that the collected data satisfied with all the basic assumptions of the Ordinary Least Square (OLS) except homoscedasticity. As a result, the study employed a heteroscedasticity corrected model to investigate the critical correlates of willingness to pay for better waste management.

4. RESULTS AND DISCUSSION

4.1 Estimation of WTP: Contingent Valuation Methods

Endalew & Tassie (2018) pointed out that willingness to pay of the household can be treated as one of the sources to finance waste management. The contingent valuation survey asked the households regarding their readiness to pay of any amount per month for waste management and thereby environmental quality. It shows the value that households attach on a clean environment. As the research outcome of Fonta et al. (2008), Banga et al. (2011), Joel et al. (2012), and Ojo et al. (2015), this study found that a substantial percentage of households (83.3 per cent) are willing to pay for door to door waste collection service and, as a result, a good and clean environment.

The dichotomous choice method of contingent valuation is used to estimate the household's actual willingness to pay for environmental quality. A dichotomous format was shown to respondents who indicated in the affirmative when asked if they would be willing to pay. They were first asked if they would be willing to pay Rs. 100 and made an offer of that sum. Once they accepted, a bid that was twice as high as the first, Rs. 200, was made, and their desire to pay this sum was questioned. A lower bid of Rs. 50—half the original amount—was made available in the event that the first bid was rejected. Then, an open-ended follow-up question asking for the highest sum the household was willing to pay took the place of the double-bounded structure. The purpose of the follow-up question is to help detect outliers and inconsistent responses. Two different bids

(Rs.100 and Rs.200) were used in this study and households were given with anyone of these bids randomly.

Table 1 illustrates that as the amount is raised, the percentage of 'yes-yes' responses decreases. At the first bid of Rs. 100, 55.73 per cent of households were ready to pay at least Rs. 200 for the garbage collection system, whereas only a small group of respondents were ready to pay Rs. 400 at the second bid of Rs. 200. In a well-developed contingent valuation survey, the number of yes answers should decline as the bid amount increases and the proportion of "no-no" answers increases as the bid amount is increased. (Carson 2000). At bid amount of Rs 100, there are 16.67 per cent "no-no" households, implying that they are not willing to pay at least Rs 50 and 18.75 per cent replied "no-no" to the highest bid Rs.200. The response patterns of "yes-no" and "no-yes" indicate that the maximum willingness to pay for respondents falls between the starting bid and the higher amount for "yes" responses, and between the initial bid and the reduced bid for "no" responses.

Participants who choose "no" are prompted to provide a justification for their inability to make a payment. The inability to pay is the main explanation cited by sample households for their unwillingness. This result is in line with the findings of Ojo et al. (2015), who contend that unwillingness is mostly caused by low income. Households cite a variety of causes for their unwillingness, including satisfaction regarding current management praxis, the unimportance of the scheme, responsibility of Corporation, and a lack of faith in collection agencies. The willingness to pay will reflect the value of the particular environmental quality (Walsh et al., 1984; Mitchell and Carson, 1989).

As each individual has different set of priorities, willingness to pay is differs from one individual to another and to secure a total, an average of the aggregate willingness to pay should be calculated (Mitchel and Carson, 1989). Fig. 1 shows the actual willingness to pay for improved waste management by urban families in Kerala.

Table 1. Willingness to pay on different bids: Dichotomous choice approach

Initial bid (In Rs/Month)	Yes-Yes (in %)	Yes- No (in %)	No- Yes (in %)	No-No (in %)	Total
100	55.73	25.52	2.08	16.67	384
200	13.80	41.93	25.52	18.75	384

Source: computed from primary data

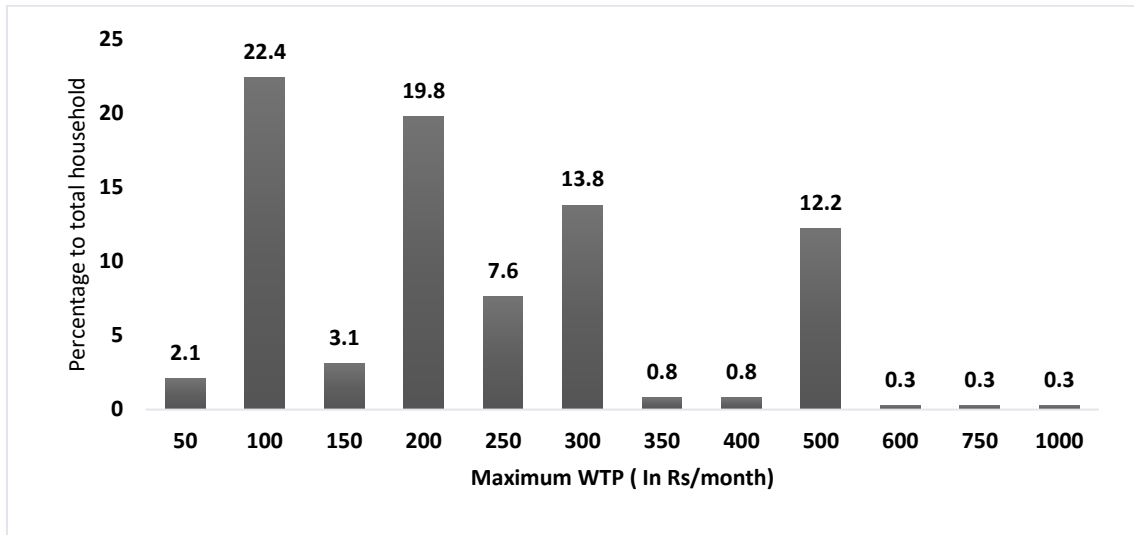


Fig. 1. Maximum willingness to pay towards waste management

Source: Estimated from primary data

As a solution to this escalating solid waste problem, the families are requested to indicate the monthly service price they are ready to pay up to the maximum amount. The results show that the maximum WTP lies between Rs.50 and Rs.1000. The amount with the highest occurrences is Rs.100 followed by Rs.200. The average household willingness to pay for better waste management is Rs.201 per month which indicates that on an average, Rs.201 is the market price placed by the households for a clean environment and this amount shows the willingness of the households for better domestic solid waste management as a commodity.

4.2 Willingness to Pay: Econometric Approach

The study uses a multivariate regression model to examine the variables that influence willingness to pay for better waste management, based on solid theory and empirical data. The regression result elucidates the discernible impact of various explanatory variables on the maximum willingness to pay within the context of waste management.

First, it is evident that monthly expenditure exerts a noteworthy influence on willingness to pay. This finding underscores the notion that households with higher monthly expenditures are inclined to allocate a greater portion of their resources towards environmental quality. This result is in line with that of the previous studies (Altaf & Deshazo 1996, Basili et al. 2006, Fonta et al., 2008) that affordability is critical in

determining individuals' willingness to pay for waste management. Low-income households may prioritize primary needs like food, shelter, and healthcare, over environmental improvements. Consequently, they may have limited discretionary income available for environmental expenditures. This economic reality ensures the importance of designing waste management policies and programs that take into account the financial circumstances of different income groups.

The inverse relationship between size of household and willingness to pay lies in the role that extended family networks may play in waste disposal practices (Adebo and Ajewole, 2012). Besides, there is a possibility that poor income group possess large family and they are not ready to pay more for environmental quality due to the overburden. These findings align with prior research conducted by Adebo and Ajewole (2012), Ojo et al. (2015), all of whom have independently recognized the significance of family size as a pivotal determinant of willingness to pay for environmental services. The empirical evidence on positive association between willingness to pay and the availability of waste disposal services suggests that when households have access to waste disposal services, they are more inclined to express willingness for the enhanced management of waste. In certain coastal wards, collection services are directly given by a corporation, employing sanitary workers for this purpose. Conversely, in other wards, the services are facilitated with the assistance of a

Table 2. Willingness to pay: Determinants

Variables	β	Std. Error	t	P
(Constant)	147.43	42.89	3.44	0.00
Monthly expenditure	0.00	0.00	8.77	0.00
Household size	-18.25	4.25	-4.29	0.00
Availability of collection service	28.06	13.16	2.13	0.03
Age	-2.36	0.61	-3.88	0.00
Quantity of waste generated	22.49	4.25	5.29	0.00
Gender	34.05	10.95	3.11	0.00
Education category	-2.96	13.15	-0.23	0.82
Proximity to dumping ground	2.42	1.19	2.03	0.04
	$R^2 = 0.48$		$F = 43.76$	

Source: Estimated from the primary data

community-driven organization known as 'Kudumbasree¹.' Furthermore, for the collection of inorganic waste, residential associations take the lead, collaborating with an agency called 'Niravu².' By fostering partnerships between local communities, governmental bodies, and specialized agencies, it becomes possible to enhance waste disposal services and, consequently, elicit greater willingness from households to invest in sustainable waste management practices.

Additionally, it is observed that the age of respondents exerts statistically significant negative influence. Specifically, this implies that as respondents advance in age, their propensity to allocate financial resources towards environmental quality improvements diminishes.. Furthermore, older individuals might perceive waste collection as a government responsibility and, consequently, exhibit a reduced inclination to make financial contributions for it. This finding aligns with previous research conducted by Afroz et al. (2009), Banga et al. (2011), and Joel et al. (2012), which reported similar results.

The results shows a positive and statistically significant connection between the volume of

waste generated and the willingness to financially support waste management initiatives which is alignment with the findings from Hagos et al. (2013) that reinforces the notion that households with greater solid waste generation tend to exhibit a heightened demand for improved solid waste management services. In essence, households that produce larger amounts of waste appear to be more motivated to invest in better waste management solutions.

Regression results indicate that households in close proximity to the treatment plant exhibit a low willingness to pay compared to their counterparts residing away from the treatment plant. It is of paramount importance to emphasize that this divergence in willingness to pay is not underpinned by a disparity in their willingness to contribute financially or their differential perceptions of environmental quality. Rather, it can be ascribed to a fundamental economic factor namely, income disparities. They are really interested in projects that guarantee environmental quality because they are exposed to a lot of pollutants. As a result, they tend to acknowledge the significance of environmental initiatives, given the pronounced pollution levels prevalent in their immediate surroundings. Conversely, households residing further away from the treatment plant often find themselves in closer proximity to urban centers and may lack viable alternative mechanisms for waste disposal. Many of these households are already subscribers to Kudumbasree's waste management services. Consequently, they exhibit a preference for devised waste management projects that are both comprehensive and efficacious.

The result substantiates the expectation that female respondents exhibit a greater interest to

¹ Kudumbasree is the poverty eradication and women empowerment programme implemented by the Kerala State Poverty Eradication Mission of the Government of Kerala, launched on 1998. In Kozhikode Corporation, Kudumbasree actively involved in the household waste management as a self-employment programme with the support of government.

² Niravu started as a community based organization collectively engaged in promoting organic farming and zero waste management in Vengeri, Kozhikode in 2006. Now, it extent its service as a private service provider in the collection of inorganic waste from different parts of the Corporation.

contribute financially towards enhanced waste management services when compared to their male counterparts. This can be attributed to several plausible factors. Firstly, it is not uncommon for females to assume primary responsibility for managing solid waste issues within households, particularly if they are homemakers. This domestic role places them in closer proximity to waste-related matters, thereby enhancing their awareness and sensitivity to waste management concerns. Furthermore, women residing in proximity to the treatment plant often bear a disproportionate burden when it comes to solid waste disposal. Empirical evidence from studies conducted by Fonta et al. (2008) corroborates the findings of the present study by establishing a significant influence of the respondent's gender on household willingness to pay.

The theoretical expectation regarding the positive influence of household education on decision-making concerning environmental quality and its subsequent positive impact on willingness to pay was not supported by the empirical findings in this study. Contrary to this expectation, the level of education within households was found to be statistically insignificant in its effect on willingness to pay for environmental quality. This unexpected outcome contrasts with the research findings reported in prior studies conducted by Fonta et al. (2008), Hango et al. (2013), and Joel et al. (2012). The inconsistency between the current study's results and those of previous research raises questions and calls for further exploration into the specific factors or contextual variables that may be contributing to this deviation.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The current economic activities and development practices associated with solid waste pose a significant threat to environmental quality. Waste generation and management practices in urban households in Kerala require special attention, particularly regarding household involvement in enhancing garbage management and environmental quality. The study finds that households' willingness to pay for improved waste management exceeds their actual payments. Therefore, fixing a cost that is socially acceptable and that most people are prepared to pay, is recommended. Implementing a user charge as a general policy to cover waste management costs is suggested to ensure

environmental quality. Moving away from a single-rate payment system to charging different rates based on the quantity of waste is recommended, as it appears affordable and can generate more revenue for authorities. Consequently, society's contribution to improved solid waste management can be viewed as a reflection of societal aspirations toward environmental quality and sustainable living. Along with this, the newly instituted Haritha Karmasena Project by Government of Kerala instills hope for Kerala's waste management by offering a comprehensive strategy that encompasses solid waste management, water resource rejuvenation, and organic cultivation. This study provides valuable insights into urban household waste management in Kerala through the application of the contingent valuation method (CVM). By assessing households' willingness to pay for improved waste disposal services, it offers a data-driven approach to policymaking and resource allocation, contributing to more effective and sustainable waste management strategies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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