

Original Article

Perceptions of Robotic Car Wash Systems in Maharashtra: A Study of Economic Feasibility, Sustainability, and Cultural Familiarity

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Abstract - Due to an increase in car ownership and purchase in Maharashtra, there has been a very high growth in the number of people demanding car washes in this state. Most of these are highly dependent on the use of conventional techniques in car washing, which causes heavy consumption of water along with its wastage. For promoting sustainable solutions, the use of automated car washing systems using high-pressure air as a substitute for water is being suggested. However, there is still insufficient literature about the cultural perceptions of automated car-washing technology. This is a qualitative-dominant mixed-method research based on the phenomenological approach and has been conducted on 80 individuals living in Maharashtra and ten informal car washers by using interviews and survey techniques. This research identifies socio-cultural and economic factors as well as consumer perceptions that significantly affect the adoption of such technologies. The gap between the creation of sustainable innovations and the local socioeconomic circumstances has allowed the research to add to the ongoing discussion about sustainable services and water consumption. The cost aspect becomes a determining factor (and an obstacle) for many consumers in adopting the new technology of automatic car washing. The worries about the effectiveness of the automated process (one lacking the custom service provision) become another constraint in that regard. This research shows that in order to successfully adopt sustainable service technologies, one needs both technical effectiveness and cost effectiveness.

Keywords - Automated Technology, Car Wash, Maharashtra, Sustainability, Water Conservation.

1. Introduction

Over the past decade, Maharashtra has experienced sustained growth in private automobile ownership, driven by rising disposable incomes, expanding urbanisation and increased dependence on personal mobility in metropolitan and semi-urban regions such as Mumbai, Pune and Thane. Vehicle registration data indicates a consistent year-on-year increase in passenger vehicles, particularly two-wheelers and private cars, which together account for a majority share of new registrations in the state. [1] This expansion has led to a parallel rise in demand for vehicle maintenance services, including routine car washing, which is now embedded in everyday urban consumption practices.

Maharashtra also deals with ongoing water scarcity. Due to erratic monsoons, a surge in population, and overstressed water systems, many places face serious water shortages, especially in cities. Reports show several districts suffering from droughts, and big cities need water tankers more often to meet everyday needs. [2] The amount of available water for each person in urban Maharashtra keeps going down, adding strain to water use at home and work. [3]

In this challenging scenario, traditional car washing becomes particularly prominent due to the use of up to 300 litres of water during each wash cycle. [4, 5] In light of rising numbers of car owners in developing economies and diminishing resources of fresh water, concerns arise regarding the sustainability of traditional car washing techniques in the long run. Consequently, robotic and automated car wash systems have started to emerge. These washing facilities are based on water recycling and even air washing techniques and are marketed as environmentally friendly.

Current discussions of automated car washes in India are primarily focused on their efficiency and cost-effectiveness, while ignoring actual attitudes to such machines. It should be stressed that technological innovations are not necessarily adopted because of their efficiency and benefits.

In the case of automated washing facilities, individuals take into account various factors in their decision-making process, such as cost benefits, attitude to technology, culture, labour relations, and informal services, especially in the Global South.



Hand washing of vehicles in the Indian state of Maharashtra is entrenched in labour networks that are informal, affordable, and consistent with user practice. This makes the process of moving towards automated car wash services difficult. There is limited information in the literature concerning the perceptions of regular users of vehicles and owners of small car wash firms.

The research is aimed at finding out the perceptions of people in the state of Maharashtra about the use of robotic car wash services. The research aims to find out four things: (1) the attitudes of locals towards the new convenience offered by these systems and the level of trust in them; (2) the perceptions of the service providers concerning the cost implications and risks involved; (3) the views of the stakeholders on the benefits of sustainability and conservation; and (4) the role played by tradition, culture and existing employment structure in the acceptance or rejection of these technologies.

This work will contribute to applied sustainability science and to technology policy in cities.

2. Literature Review

During the last ten years, there has been an increase in the ownership of automobiles and motorcycles in Maharashtra state as a result of increasing income levels and increased urbanisation. Data provided by the government demonstrate that there has been an increase in registration of new vehicles, especially in the case of motorcycles and private cars. [1]

As a consequence, a need has been created for the development of vehicle washing infrastructure. Vehicle cleaning has become a regular practice in the cities. One of the limitations is associated with the water stress of the region, where the growth of the population is not supported by a sufficient water supply.

There are areas that experience such water scarcity that they are forced to use water tanker trucks. [2] Besides, the per capita availability of water is low in urban India. [3] Furthermore, an average regular car wash consumes 150 to 300 litres of water per car. [4, 5] Hence, it can be seen that increased demand for clean cars leads to higher water consumption, and water is a scarce resource in India.

The growing popularity of car washes due to increasing numbers of car owners and water shortage makes one question the sustainability of conventional car washing techniques. In order to address the problem, robotic and automatic car wash systems have appeared in Indian cities. They work with the use of controlled water recycling technology or high-pressure air technology and are considered to be water-efficient and eco-friendly options. [6, 7] The issue of robotic and automatic car wash systems in India is discussed mostly within the frame of efficiency or return on investment rather than social perceptions.

According to Kulkarni, Rao, and Patil [8], in order to comprehend sustainability within the context of the automobile industry, one needs to pay attention not only to the efficiency of vehicles. One should take into account the usage and waste generation related to services and daily activities. The authors acknowledge that there is a positive contribution of auto industries to economic development.

However, there are more issues that need to be discussed. First of all, automobiles consume many non-renewable materials, and secondly, there is no adequate waste management system. There is a need for innovations that will contribute to the assessment of everyday automobile activities.

One of the important observations from the data on Vehicle Registrations of Maharashtra is the obvious positive trend over time in vehicle registrations, indicating the gradual increase in the number of cars. The importance of researching vehicle utilisation not only as an economic factor but also as a socio-environmental factor influencing demands on water and labour in service industries is demonstrated by this data.

In a similar manner, the NITI Aayog Composite Water Management Index [2] presents the level of water stress affecting the Indian population. The report does not consider water shortages as rare drought periods but as a problem of a social and economic nature throughout different regions of the country. In order to tackle this problem, new technological methods focus on reusing water, since a properly engineered setup is able to recycle 85–98% of the wash water, significantly reducing the need for fresh water. [7]

2.1. Consumer Perception About Sustainability

Wang and Tian [9] further argue that despite the understanding among consumers on the need to conserve water, adoption of any measures might be slow due to risks associated with making a decision, as opposed to environmental considerations. Factors that limit purchase include the performance and economic viability of water-saving items, despite the fact that the consumer understands the importance of sustainability.

Another problem among consumers is wrong assumptions about the cost of using water, since they think that water costs less than it actually does, owing to wrong knowledge of prices and tariffs. [10] This shows that habits on the use of water depend greatly on how the information is communicated to consumers.

Along with this, research shows that people save more water when doing so fits their personal identity and what they believe others expect of them. [11, 12] Studies using the Theory of Planned Behaviour support this, highlighting how much conservation is a social choice.

2.2. Economic Feasibility Towards Producers of Sustainable Products

Eco-innovation does not fail mainly because business owners “do not care”; it fails because Small and Medium Firms (SMEs) face capability and readiness constraints. Feasibility depends on internal resources, operational maturity, and the ability to redesign processes. [13, 14] Even if a sustainable product could be theoretically profitable, firms may avoid it if implementation requires capital or coordination they lack. [15] Furthermore, firms adopt eco-innovations primarily when there is a clear economic or regulatory incentive. [16, 17] Regulations and direct cost savings are the strongest drivers of eco-innovation across sectors, explaining why some technologies struggle to be adopted by producers without specific financial motivations. [18]

2.3. Labour Practices and Cultural Perceptions of Automation

Employees do not simply adopt or oppose algorithmic management systems; rather, they devise ways of resisting these systems in their everyday practice. [19] Often, such resistance results from what is known as status quo bias, because employees do not like changes that would threaten their dignity and self-control. [20]

Automation becomes especially controversial when it not only substitutes manual actions but also excludes any human involvement in making decisions. The reason behind employees' hesitation is that they have no faith in these systems, cannot pinpoint accountability and cannot maintain authentic relations. [21, 22] The automation of work is especially frightening for those employees whose job involves creating connections. Automation does not eradicate but only transforms occupations, since it entails the disappearance of some activities. In this context, the change of job functions and employees' uncertainty regarding the work environment of the future is inevitable. [23, 24] As a result, it is natural for workers' unions to resist automation and preserve their jobs and activities.

2.4. Research Gap

Despite growing awareness related to sustainable technology in services, not enough research is conducted on the ways of water conservation in car washes. The majority of current literature focuses on vendor claims and laboratory studies without taking into account customers' experience of using particular services. In particular, not many studies take into account the economic diversity of people in Maharashtra. In addition, even though numerous data about household water conservation and its influence by habits exist, little is known about the effect of cultural factors on people's attitudes to car washing.

The problem of consumer unwillingness to accept innovative technologies is connected with their belief in the inefficiency of competing systems. Regrettably, there is no

information available concerning the efficiency and safety of competing systems in comparison with consumers' beliefs. This question reflects the more serious problem of consumer confidence, which is not paid much attention to in the course of the discussion. In most of the studies, it is implied that the only thing needed to make consumers change their preferences is the claim of ecological effect. There is hardly any research done in order to find out what needs to be done to establish consumers' trust.

Moreover, the previous literature lacks analysis of the supply-side dynamics of the informal sector. Most studies on technology adoption are related to big companies and ignore small, informal firms like car wash firms and workers in places like Maharashtra. Hence, little consideration is given to the peculiarities of such firms in terms of investment capacity, risk-taking capacity, and maintenance capacity. While it is clear that automation threatens jobs, there is no empirical evidence at the micro level of the negative consequences of adopting such technology with regard to such firms.

3. Materials and Methods

3.1. Survey

The research used a combination of primary and secondary data. The primary data collection was done to assess the state of the local market and gain a more insightful view of the local community in Mumbai. The primary research was conducted through purposive sampling. The survey or questionnaire was circulated across as many social networks as possible (with an initial target of reaching 150 individuals), who were then asked to forward it to as many other people as they could. Ultimately, the paper reports a final achieved sample of 80 respondents; this shortfall from the initial target was primarily due to a lower-than-expected rate of onward sharing within personal networks and general survey non-response.

This distribution method aimed to maximise the number of questionnaires responded to so that the findings could be generalised for a larger population or to a larger geographical extent, as well as to understand the entire picture happening throughout the metropolitan city, not only a part of it. A limitation of this method of sampling data was that people are typically friends with people who share similar characteristics or think in a similar way, so it may have led to more similar answer profiles. Additionally, since this method was not random, it may have led to discussion of answers while passing the survey on, which again may have triggered a bias for some while filling out the questionnaire. Primary data was used to obtain information which was unavailable on the internet or could not be obtained through other methods. It was solely to address the gaps in the available information within this domain.

Secondary research was carried out so as to have information about which studies had been done in the past and

published, and thus prevent unnecessary loss of time looking for information that was already available. Such information was derived from published academic papers, surveys done by institutions, and experiments verified online using trusted web databases. Data reliability was ensured by assessing the validity of the secondary data sources, prioritising peer-reviewed sources and data from trusted industry experts.

The main questionnaire focused on collecting mostly subjective qualitative data in the form of opinions based on several aspects such as income, social status, culture, and demographics. In contrast, the research paper in question adopted the use of both qualitative and quantitative data in the research process. The respondents used in the data collection process fell under the age category of 18 years and above, because it is the minimum legal age to drive a car in India.

In addition, these participants were selected from Mumbai, Maharashtra. Mumbai happens to be the largest and most populous city in Maharashtra, and also has the largest number of registered cars within the state; selecting this city, therefore, meant ensuring high efficiency of the data collection process.

Ethically, the confidentiality of survey participants was ensured. Apart from recording only the responses to the survey questions, no other personally identifiable information, such as names, addresses and any other identifiable information, was obtained.

Surveys and interviews were conducted manually by the researcher, who did not use artificial intelligence or any other technology to generate text or collect data directly from respondents. The research paradigm adopted in this study is the phenomenological one, because this study aimed at generating social meaning out of people's everyday actions, particularly their attitudes towards using new technologies. Methods used in this research study include structured interviews and surveys, using interview guides and survey questionnaires, respectively.

3.2. Interviews with Informal Car Washers

Interviews were conducted with ten car washers working in the researcher's residential building in Mumbai. The interviews took place in the building between 5 am and 7 am and lasted approximately seven minutes each. They were conducted in Hindi and translated into English by the researcher.

Consent was obtained by informing the participants that their answers would be shared in a research paper, but that their names and identities would not be disclosed. Responses were recorded through written notes and video recordings on a phone. Each participant was asked how many litres of water they use per wash, how much time it takes to wash a car, how much it costs them to perform a car wash, and how much they charge per car.

4. Results

4.1. Survey Results

The responses to some of the key survey questions posed to the research participants are presented in Table 1, Table 2 and Table 3.

Survey Question: Would you change your car wash method if you knew it could save a large amount of water?

Table 1. Responses to water conservation question (n = 78)

Response Category	Number of Respondents (n)	Percentage (%)
Yes	66	84.6
No	5	6.4
Unsure	7	9.0
Total Valid Responses	78	100

Survey Question: Have you witnessed any automated or semi-automated car wash systems?

Table 2. Responses to question on witnessing automated car wash systems (n = 78)

Response Category	Number of Respondents (n)	Percentage (%)
No	61	82.0
Yes	12	15.4
Not Really	2	2.6
Total Valid Responses	75	100

Survey Question: Are price or efficiency important factors in not switching to an automated car wash system?

Table 3. Barriers to switching to automated car wash (n = 55)

Response Category	Number of Respondents (n)	Percentage (%)
Both (Price & Efficiency)	45	81.8
Efficiency Only	3	5.5
Price Only	3	5.5
No	4	7.3
Total Valid Responses	55	100

4.2. Interviews with Informal Car Washers

The responses of the ten car washers interviewed are summarised in Table 4.

Table 4. Responses from interviews with informal car washers (n = 10)

Question	Response
Water used per wash	Approximately 20 litres (one bucket)
Time taken to wash a car	Approximately 15 minutes
Cost to perform a wash (water, soap, mop and bucket)	Approximately ₹20
Charge per car	₹100 per day

5. Discussion

It can be clearly seen from the results that there is a wide gap between the intentions of people to go green and the actual decisions taken when choosing a car wash. While 84.6% of people showed an inclination to adopt water-saving methods when washing their cars (Table 1), there seems to be much more to their buying decisions. Over 70% of the respondents claimed that they did not try to figure out whether the car wash was an environmentally friendly one or not.

Price stands among the most prominent obstacles in the case of using advanced automated and high-pressure air-based washers. In fact, as per the survey conducted, people pay around ₹500–₹2000 for getting a manual cleaning of the car at home every day. It thus becomes difficult for people to shift towards an automated system, which fails to pass the test of cost-effectiveness in comparison to the manual system. When asked about the reason behind not choosing automation, the majority responded that they had cost, efficiency, or both in mind (Table 3).

The other problem that lies deep within the statistics is the limited awareness of the consumers themselves. This new technology works on the principle of “high-pressure air to conserve water.” However, according to the results of the survey, there are people who do not know about it. There were people who mentioned “the wastage of water” as their initial impression of the automated car wash technology. It was based on their assumptions that any car wash machine uses plenty of water for washing the car. Also, the fact that more than 70% of the participants did not even check if the car wash saved water suggests a serious problem with the promotion of this technology. Clearly, if consumers are unaware of the way the technology uses high-pressure air to save water, they do not consider it eco-friendly.

It is necessary to highlight the urgency of this issue. As stated above, the number of cars that people possess in the area is rising every year. With each new car, the need for the resource will become even greater. While the traditional method of washing one’s car with plenty of water daily could be effective some ten years ago, now, with the number of cars growing, it will eventually lead to water scarcity in the area. Due to the lack of water available for consumption and its inefficient use, it is very important to find better ways of car maintenance.

Table 4 shows car washers in your building use only about 20 litres per wash, much less than the 150–300 litres mentioned above. What does this mean? For example, is doorstep bucket washing already water-efficient compared with hose washing, and how does that affect the case for automated systems?

Such attitudes on the part of consumers pose great challenges to entrepreneurs. The change to using high-

pressure air is rather expensive. If consumers choose to keep washing their cars at home cheaply and regularly, it will be too risky to invest money in creating an automated system for car washing. Entrepreneurs are concerned about losing their regular customers and, therefore, do nothing about going green.

Overall, it can be stated that the introduction of a sustainable car washing service in Maharashtra is not possible only because of the availability of new technologies. The problem that does not allow sustainability to be achieved in this case is the gap between the innovative services offered and the mentality of people who need affordable car washing services. It is necessary to think of a new business model in which an automated car wash becomes a mobile one, or equals the cost of a manual one.

6. Conclusion

What made the adoption rate of this sustainable and automated technology so low in the region? In order to analyse this issue, a combination of primary and secondary sources of information was used. The secondary sources consisted of the findings of the literature review, and one important finding should be highlighted: the previous research confirmed the effectiveness of the water-saving technology but did not provide any information about its applicability within the local culture. The primary sources of data were extremely helpful in finding the answer to the stated research question. In total, 80 respondents in the state of Maharashtra took part in the survey, and it was possible to find out the answer to the posed question without speculation. According to the results, the main reasons for rejecting this innovation lie in its high cost, the perceived poor efficiency of washing machines, and the cultural tradition of having the service provided daily at home.

6.1. Limitations of the Research

In spite of the informative aspect of the current paper, there are certain limitations that need to be outlined:

6.1.1. Sample Size

The total number of participants in the study was 80 people. While a qualitative methodology contributed to the collection of a considerable amount of information concerning the emotions and actions of the respondents, the sample used for the research cannot be considered representative enough, taking into account the wide variety of socio-economic backgrounds of the different regions of the state of Maharashtra.

6.1.2. Social Desirability Bias

The primary information is collected by means of surveys and interviews. It should be noted that people’s intentions regarding the purchase of environmentally friendly goods differ from their actual actions. This is why some of the respondents could have provided answers according to social desirability.

6.1.3. Limited Data on Informal Workers' Views

The ten car washers were asked about water, time and money, but not about their views on automation, so their willingness to adapt to new equipment is still unknown.

6.2. Future Directions of Research

This research can be taken forward in the following ways:

6.2.1. Practical Test of Effectiveness

In future research, it would be required to conduct practical comparative tests to determine the effectiveness of high-pressure air in terms of its cleaning capacity (removing dirt) and safety of paint. Publication of the results of such a scientific study would fill the trust gap that has been highlighted in this study.

6.2.2. Impact of Automation on the Informal Economy

There is a need for comprehensive socio-economic research to investigate the impact of automation on the

informal economy. It could include an investigation of possible business models where traditional workers could collaborate with modern technology.

6.2.3. Decentralisation Models Testing

Since “doorstep convenience” is acknowledged as one of the biggest barriers, further research should consider the possibility of using mobile car washing stations. It would be interesting to test the effectiveness of bringing the technology directly into residential areas.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

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