

ECONOMIC, PSYCHOLOGICAL, AND POLICY DRIVERS OF BIOETHANOL FUEL ACCEPTANCE: A SYSTEMATIC REVIEW

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The transition from fossil fuels to renewable transportation energy increasingly depends on consumer acceptance of bioethanol fuel. Although previous studies have examined consumer responses to bioethanol and ethanol-blended fuels, the evidence remains fragmented across economic, psychological, and policy perspectives. This study systematically reviews the factors influencing consumer acceptance of bioethanol fuel and identifies gaps for future research. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Database searches identified 65 records. After removing seven duplicates and six records for other reasons, 52 records were screened. Ten records were excluded during title and abstract screening, while two reports could not be retrieved. Of the 40 full-text reports assessed for eligibility, three were excluded because of an irrelevant advertising context, the absence of empirical or conceptual evidence, and language limitations or unclear findings. Consequently, 37 studies were included in the final synthesis. The findings reveal that consumer acceptance is shaped by the interaction of three major categories of determinants. Economic drivers include fuel price, price competitiveness, affordability, perceived economic value, vehicle-related costs, and willingness to pay. Psychological drivers encompass environmental concern, knowledge, perceived benefits, perceived risks, trust, product familiarity, and vehicle compatibility. Policy-related drivers include government incentives, blending mandates, infrastructure readiness, certification, information provision, and policy credibility. The review indicates that environmental benefits alone are insufficient to ensure acceptance when consumers perceive bioethanol fuel as costly, risky, incompatible, or inadequately supported by public policy. This study develops an integrative framework explaining bioethanol fuel acceptance and provides implications for policymakers, fuel producers, and researchers seeking to accelerate the transition toward sustainable transportation energy.

Keyword: Bioethanol fuel, consumer acceptance, economic drivers, psychological drivers, policy drivers

Introduction

The transition toward low-carbon transportation has increased global interest in renewable fuels that can reduce dependence on fossil energy and mitigate greenhouse gas emissions. Among the available alternatives, bioethanol has become an important renewable transportation fuel because it can be blended with conventional gasoline and distributed through existing fuel systems. Ethanol blends such as E5, E10, E20, and E85 have been introduced in several countries as part of broader strategies to improve energy security, reduce transportation-related emissions, and support the development of renewable energy industries. Nevertheless, the technical availability and environmental advantages of bioethanol do not automatically guarantee its successful adoption. The effectiveness of the transition also depends on consumers' willingness to purchase, use, and support bioethanol-based fuel products.

Consumer acceptance represents a critical component of bioethanol fuel adoption because consumers evaluate alternative fuels differently from conventional gasoline. Their decisions may involve considerations regarding price, fuel efficiency, vehicle compatibility, availability, safety, environmental benefits, and confidence in the policies governing the product. Early evidence indicates that cost, environmental impacts, and vehicle performance are among the main considerations affecting consumer acceptance of ethanol-blended gasoline (Ulmer et al., 2004). Accordingly, bioethanol adoption should not be regarded merely as a technological or environmental issue, but also as a consumer decision involving economic evaluation, psychological perception, and institutional support.

Economic considerations are particularly important because consumers generally compare the monetary and functional value of bioethanol fuel with that of conventional gasoline. Price differences, purchasing power, fuel efficiency, maintenance costs, and vehicle modification requirements may affect the perceived attractiveness of ethanol-based fuels. Solomon and Johnson (2009) demonstrated that willingness to pay for biomass ethanol is associated with consumers' evaluation of environmental and climate-related benefits. Jensen et al. (2010) further found that willingness to pay for E85 differed according to the type of feedstock used, suggesting that consumer valuation is influenced not only by price but also by how the fuel is produced. Evidence concerning second-generation bioethanol also shows that some consumers are willing to pay a price premium when the product is perceived as environmentally beneficial and technologically advanced (Li et al.,

2017; Mamadzhanov et al., 2019). However, consumers may reject bioethanol when its higher price is not accompanied by clear personal or environmental benefits. Price competitiveness, affordability, and perceived economic value are therefore essential for understanding consumer acceptance.

In addition to economic evaluations, psychological factors influence how consumers interpret the benefits and risks of bioethanol fuel. These factors include environmental concern, product knowledge, awareness, perceived benefits, perceived risks, trust, familiarity, and attitudes toward renewable energy. Savvanidou et al. (2010) found that public knowledge about biofuels remained limited despite relatively positive perceptions of renewable energy and climate protection. Limited knowledge can create uncertainty regarding fuel safety, energy performance, and vehicle compatibility. Radics et al. (2016) similarly showed that price and vehicle compatibility were important in consumer fuel choices, while knowledge and trustworthy information affected the broader acceptance of bioenergy. Consumers who understand the environmental and functional benefits of bioethanol may be more willing to adopt it, whereas those who perceive technological, financial, or performance risks may prefer conventional fuel.

Trust is also important because many environmental characteristics of bioethanol cannot be directly evaluated by consumers before purchase. Consumers must rely on information provided by governments, fuel companies, vehicle manufacturers, certification institutions, and the media. When these sources are perceived as credible, information about emissions reduction, fuel quality, and vehicle compatibility can reduce uncertainty and strengthen consumer confidence. Conversely, inconsistent messages, unclear product information, or doubts about environmental claims can weaken acceptance. Public opinion toward biofuels may therefore be shaped by dominant information, media framing, public knowledge, and perceived fairness in their implementation (Løkke et al., 2021).

Policy-related factors constitute another major dimension of consumer acceptance. Governments influence the bioethanol market through blending mandates, tax incentives, subsidies, pricing regulations, infrastructure development, fuel standards, certification, and public communication. These instruments can improve product accessibility and price competitiveness, but their effectiveness depends on how consumers perceive the policy. A mandatory blending policy may receive limited support when consumers believe it increases fuel prices, reduces vehicle performance, or distributes costs and benefits unfairly. By contrast, transparent policies supported by credible information, adequate infrastructure, and appropriate consumer protection may strengthen public support. Thus, policy success depends not only on the formal introduction of bioethanol but also on whether consumers consider the policy credible, consistent, beneficial, and fair.

Despite the growing literature, the factors influencing bioethanol acceptance remain fragmented. Some studies focus primarily on willingness to pay and price premiums, while others examine environmental attitudes, product knowledge, risk perceptions, government support, or public policy. Moreover, the literature employs different concepts, including consumer acceptance, public acceptance, purchase intention, willingness to use, willingness to pay, and policy support. These conceptual and methodological differences make it difficult to determine which factors consistently encourage or inhibit consumer acceptance. Previous reviews have provided valuable insights into public opinion on liquid biofuels, particularly in European and North American contexts (Løkke et al., 2021). Nevertheless, an integrative synthesis that explicitly classifies the determinants of consumer acceptance into economic, psychological, and policy-related drivers remains limited.

Addressing this gap is particularly relevant for emerging economies, where consumers are often highly sensitive to fuel prices and where renewable fuel policies depend heavily on government credibility, infrastructure readiness, and public communication. Understanding consumer acceptance can assist policymakers and fuel companies in designing bioethanol strategies that combine environmental objectives with consumer affordability, perceived value, technological confidence, and institutional trust. Such understanding is also relevant to Indonesia as the country expands the use of ethanol-blended gasoline and promotes products such as Pertamina Green 95.

Therefore, this study systematically reviews the literature on consumer acceptance of bioethanol fuel by applying the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The review classifies the determinants identified in previous studies into three principal categories: economic, psychological, and policy-related drivers. Specifically, this study addresses the following research questions:

1. How has research on consumer acceptance of bioethanol fuel developed over time?
2. What theoretical and methodological approaches have been employed in previous studies?
3. What economic factors influence consumer acceptance of bioethanol fuel?
4. What psychological and policy-related factors influence consumer acceptance?
5. What gaps and future research opportunities can be identified?

By integrating these perspectives, this review is expected to provide a more comprehensive explanation of bioethanol fuel acceptance, develop an organizing framework for future studies, and offer practical insights for governments, fuel producers, and other stakeholders seeking to accelerate the adoption of sustainable transportation fuels.

2. Theoretical Background

Consumer Acceptance of Bioethanol Fuel

Consumer acceptance refers to consumers' willingness to support, purchase, and use a product or innovation. In renewable energy research, acceptance can be reflected through attitudes, purchase intention, willingness to use, willingness to pay, product preference, and actual adoption. Market acceptance is important because the successful implementation of renewable energy depends not only on technological feasibility but also on consumer participation (Wüstenhagen et al., 2007).

Bioethanol is a renewable fuel produced from biological materials and commonly blended with gasoline in different concentrations, including E5, E10, E20, and E85. Although bioethanol offers environmental and energy-security benefits, consumers may be concerned about its price, fuel efficiency, availability, and vehicle compatibility. Consumer acceptance should therefore be examined from economic, psychological, and policy perspectives.

The Theory of Planned Behavior explains that behavioral intention is influenced by attitude, subjective norms, and perceived behavioral control (Ajzen, 1991). In the bioethanol context, attitude represents consumers' evaluations of the fuel, subjective norms reflect social expectations regarding sustainable consumption, and perceived behavioral control reflects affordability, accessibility, and compatibility. However, the original theory may not fully explain the influence of price, perceived value, trust, and government policy. Accordingly, this review applies a broader framework comprising three categories of drivers.

Economic Drivers

Economic drivers include fuel price, affordability, price fairness, fuel efficiency, vehicle-related costs, perceived value, and willingness to pay. Consumers generally compare the costs and benefits of bioethanol with those of conventional gasoline.

Perceived value represents consumers' overall assessment of the benefits received relative to the sacrifices made (Zeithaml, 1988). The benefits of bioethanol may include lower emissions, energy security, and reduced dependence on fossil fuels. The sacrifices may include higher prices, lower mileage, limited availability, and uncertainty regarding vehicle performance.

Previous studies indicate that consumers may accept a price premium when they perceive meaningful environmental benefits (Solomon & Johnson, 2009). Willingness to pay may also vary according to feedstock type, sustainability attributes, and fuel performance (Jensen et al., 2010; Li et al., 2017). Therefore, consumer acceptance depends not only on the absolute price but also on whether the price is considered fair and proportional to the benefits offered.

Psychological Drivers

Psychological drivers include environmental concern, knowledge, awareness, perceived benefits, perceived risks, trust, product familiarity, and vehicle compatibility. Consumers with stronger environmental concern may develop favorable attitudes toward bioethanol, but environmental concern does not always result in adoption when economic or technical barriers remain.

Knowledge reduces uncertainty about blending levels, environmental benefits, and vehicle compatibility. However, public understanding of biofuels remains limited in many markets (Savvanidou et al., 2010; Løkke et al., 2021). Consumers may also perceive risks related to engine performance, fuel efficiency, food–fuel competition, and the credibility of environmental claims.

Trust is therefore essential. Consumers depend on information from governments, fuel companies, vehicle manufacturers, and certification institutions. Consistent with Signaling Theory, credible labels, certifications, and compatibility information can reduce information asymmetry and strengthen consumer confidence (Spence, 1973).

Policy-Related Drivers

Policy-related drivers include financial incentives, blending mandates, fuel standards, infrastructure, certification, public communication, policy credibility, and regulatory consistency. Government policies can

improve product availability and price competitiveness, but they may also produce resistance when consumers perceive implementation as unfair or unclear.

Infrastructure readiness affects consumers' ability to use bioethanol. Even consumers with positive attitudes may not adopt it when fuel stations are limited or vehicle information is unavailable. Policy credibility and transparent communication are therefore necessary to ensure that incentives and mandates translate into market acceptance.

3. Method

Review Design

This study employed a systematic literature review to identify and synthesize evidence concerning consumer acceptance of bioethanol fuel. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (Page et al., 2021). A thematic synthesis was used to classify the identified determinants into economic, psychological, and policy-related drivers.

The review addressed the following questions:

1. What economic factors influence consumer acceptance of bioethanol fuel?
2. What psychological factors influence consumer acceptance?
3. What policy-related factors influence consumer acceptance?
4. What theoretical and methodological gaps remain in the literature?

Search Strategy

A structured search was conducted in July 2026 using Scopus and Web of Science as the principal databases. Supplementary searches were performed through ScienceDirect, SpringerLink, Emerald Insight, Taylor & Francis, and Google Scholar.

The main keywords included: ("bioethanol fuel" OR "ethanol fuel" OR "ethanol-blended fuel" OR "ethanol blended gasoline" OR "cellulosic ethanol" OR E5 OR E10 OR E20 OR E85) AND ("consumer acceptance" OR "public acceptance" OR "purchase intention" OR "adoption intention" OR "consumer preference" OR "willingness to use" OR "willingness to pay" OR attitude)

Backward and forward citation searches were also conducted to identify additional relevant studies.

Eligibility Criteria

Studies were included when they:

1. Examined bioethanol or ethanol-blended fuel for transportation;
2. Involved consumers, motorists, households, or the general public;
3. Investigated acceptance, purchase intention, attitude, preference, willingness to use, or willingness to pay;
4. Examined economic, psychological, or policy-related determinants;
5. Were peer-reviewed journal articles or complete conference papers;
6. Were published in English between January 2000 and July 2026.

Studies were excluded when they focused exclusively on production technology, chemical processes, combustion, engine performance, or emissions without examining consumer responses. Editorials, news articles, abstract-only proceedings, inaccessible full texts, and duplicate publications were also excluded.

Study Selection

The searches identified 65 records. Seven duplicate records and six records that did not meet the initial document requirements were removed, leaving 52 records for title and abstract screening. Ten records were excluded during this stage.

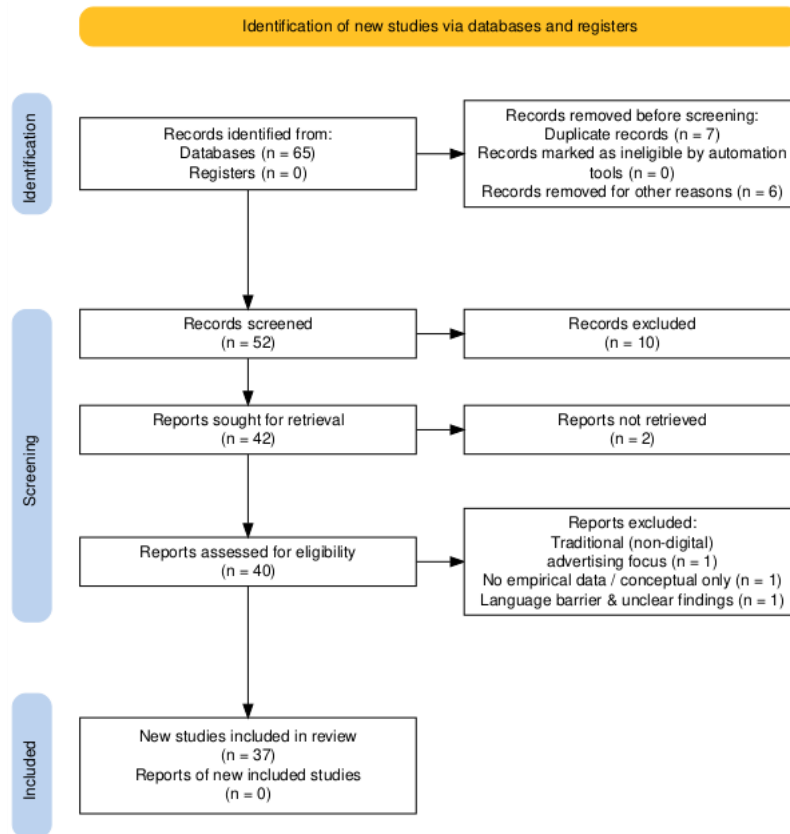


Figure 1. PRISMA Flow Diagram of the Study Selection Process

The full texts of 42 reports were sought, but two could not be retrieved. Of the 40 reports assessed for eligibility, three were excluded because of an irrelevant context, insufficient empirical or conceptual evidence, and language limitations or unclear findings. Consequently, 37 studies were included in the final review, as presented in Figure 1.

Data Extraction and Analysis

Information extracted from each study included author, year, country, research design, theoretical foundation, sample, fuel type, acceptance outcome, determinants, and main findings. Because the studies differed in design, measurements, fuel type, and research context, a statistical meta-analysis was not conducted. Instead, descriptive and thematic analyses were employed. Similar factors were grouped into economic, psychological, and policy-related categories. The synthesis also examined consistent findings, contradictory evidence, and research gaps.

4. Results

General Characteristics

The 37 included studies showed increasing academic interest in the demand side of renewable transportation fuels. Earlier studies primarily examined willingness to pay, fuel prices, feedstock preferences, and public awareness. More recent studies included environmental concern, perceived risk, trust, infrastructure readiness, policy incentives, and behavioral intention.

Most studies used quantitative surveys, contingent valuation, or discrete choice experiments. Purchase intention and willingness to pay were the most common acceptance outcomes. The literature was concentrated mainly in Europe and North America, although studies from Asia and emerging economies have increased.

Economic Drivers

Price, affordability, fuel efficiency, and willingness to pay were the main economic drivers. Consumers generally compared the retail price and expected performance of bioethanol with conventional gasoline. Positive environmental attitudes did not necessarily translate into purchase intention when bioethanol was perceived as more expensive or less efficient.

Consumers were more willing to accept a premium when they recognized meaningful environmental and societal benefits. The sustainability of feedstocks also influenced willingness to pay (Jensen et al., 2010; Li et al., 2017). These findings indicate that perceived value and price fairness are more informative than absolute price alone.

Psychological Drivers

Environmental concern generally supported favorable attitudes toward bioethanol. However, its effect became weaker when consumers perceived high prices, technical risks, or limited availability.

Knowledge and familiarity reduced uncertainty about environmental benefits and vehicle compatibility. In contrast, limited knowledge increased concerns about engine damage, lower mileage, fuel quality, and food–fuel competition. Trust in government, fuel companies, vehicle manufacturers, and certification institutions also influenced whether consumers accepted environmental and technical information.

Policy-Related Drivers

Financial incentives, blending mandates, infrastructure, fuel standards, and communication affected consumer acceptance. Incentives could improve affordability, while infrastructure increased product accessibility. However, mandatory policies did not automatically generate consumer support.

Consumers were more receptive when policies were accompanied by quality assurance, credible information, clear compatibility guidance, and consistent implementation. Policy uncertainty and contradictory communication reduced trust and increased perceived risk.

Overall, consumer acceptance was strongest when bioethanol was affordable, environmentally valuable, technically reliable, widely available, and supported by credible public policy.

5. Discussion

The findings demonstrate that consumer acceptance of bioethanol is multidimensional. Environmental benefits alone are insufficient when consumers perceive the product as expensive, risky, incompatible, or difficult to obtain.

Economic findings confirm that consumers evaluate bioethanol through a value–cost comparison. Consumers may support renewable energy but remain unwilling to bear additional costs when the private benefits are unclear. Pricing strategies should therefore explain both environmental benefits and practical consumer value, including performance, fuel efficiency, and long-term costs.

The findings also reveal a gap between environmental concern and behavioral intention. According to the Theory of Planned Behavior, favorable attitudes may not produce adoption when perceived behavioral control is weak. Consumers may support sustainable fuel but feel unable to purchase it because of price, limited availability, or compatibility concerns.

Trust connects psychological perceptions with policy implementation. Because consumers cannot independently verify fuel quality and environmental claims, they rely on institutional information. Credible certification, transparent labeling, and vehicle-manufacturer approval can function as signals that reduce uncertainty.

Policy should therefore create market readiness rather than focus only on blending mandates. Market readiness includes competitive prices, product availability, vehicle compatibility, infrastructure, public knowledge, and institutional coordination. Mandatory introduction without these supporting conditions may generate resistance.

For Indonesia, the acceptance of Pertamax Green 95 may depend on transparent pricing, clear information about E5 compatibility, credible environmental evidence, and broader distribution. Collaboration among the government, PT Pertamina, vehicle manufacturers, and independent certification bodies can strengthen consumer confidence.

6. Future Research Agenda

Future studies should develop integrated models combining economic, psychological, and policy-related drivers. Existing studies frequently examine price, environmental concern, or government support separately, despite their interdependence.

Greater attention should be given to actual purchasing behavior because most studies measure intention or willingness to pay. Longitudinal research is also needed to observe changes in acceptance as consumers gain experience with bioethanol.

Research in emerging economies remains limited. Comparative studies could examine how income, fuel subsidies, infrastructure, institutional trust, and vehicle characteristics influence acceptance across countries.

Future research should also distinguish among fuel price, affordability, price fairness, and perceived value. Policy-related constructs such as policy trust, communication credibility, perceived policy consistency, and market readiness deserve further investigation.

Table 1. Future Research Agenda

Research gap	Future direction
Fragmented acceptance models	Integrate economic, psychological, and policy factors
Emphasis on behavioral intention	Examine actual and repeated fuel purchases
Limited emerging-market evidence	Conduct cross-country and developing-economy studies
Limited price evaluation	Distinguish price, fairness, affordability, and value
Underdeveloped policy perspective	Examine trust, credibility, and policy consistency
Limited longitudinal research	Observe acceptance before and after policy implementation
Homogeneous consumer assumptions	Compare consumer segments and vehicle-user groups

7. Conclusion

This systematic review examined 37 studies concerning consumer acceptance of bioethanol fuel. The findings show that acceptance is shaped by interactions among economic, psychological, and policy-related drivers.

Economic acceptance depends on price, affordability, fuel performance, price fairness, and perceived value. Psychological acceptance is influenced by environmental concern, knowledge, perceived benefits, perceived risks, vehicle compatibility, and trust. Policy-related acceptance depends on incentives, blending mandates, infrastructure, communication, certification, and regulatory consistency.

The study contributes to the literature by integrating these three perspectives within a single framework. It demonstrates that positive environmental attitudes do not automatically lead to adoption when economic, technical, and institutional barriers remain.

For Indonesia, increasing the acceptance of Pertamax Green 95 requires competitive pricing, clear vehicle compatibility information, credible environmental communication, adequate distribution, and consistent policy support. Future studies should test integrated acceptance models, examine actual behavior, and provide more evidence from emerging economies.

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