# A USER-ORIENTED CONCEPTUAL FRAMEWORK FOR ELECTRIC BUS ADOPTION IN INDONESIA URBAN PUBLIC TRANSPORT

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**Abstract**

Electric buses are increasingly promoted as a sustainable public transportation solution in Indonesia's urban areas, yet their adoption rate from the user perspective remains relatively limited. This study aims to develop a user-oriented conceptual framework to explain the adoption process of electric bus services within Indonesia's urban public transportation system. The study employs a systematic literature review approach following PRISMA guidelines, analysing scientific articles published from 2015 to 2025, with a total of 30 studies examined in depth. Through content analysis, 13 main constructs were identified that integrate behavioral, psychological, technology acceptance, service attribute, and risk perception dimensions, based on the Technology Acceptance Model and the Theory of Planned Behaviour. Based on this synthesis, this study proposes a process-based conceptual framework that maps the stages of electric bus adoption, from evaluating service attributes to actual usage. To strengthen its empirical applicability, the constructs were operationalized into measurable questionnaire indicators adapted from prior studies and supported through expert review and pilot testing with electric bus users. This framework is positioned as an exploratory model to support the identification of factor structures and serve as a basis for empirical Research and the formulation of sustainable public transportation policies in Indonesia.

***Keywords: Conceptual Framework; Electric Bus Adoption; Public Transportation; Systematic Literature Review Sustainable Mobilitya.***

## INTRODUCTION

The implementation of electric buses in Indonesian cities continues to increase, but the adoption rate from the users' perspective still varies. This indicates that the success of public transportation electrification is influenced not only by technological and policy factors but also by users' evaluations of the service and perceived risks. Based on this, this study develops a user-oriented conceptual framework to explain the adoption process of electric buses in Indonesian urban public transportation. Public transportation is the backbone of mobility for people in urban areas. However, most transportation services in Indonesia still rely on fossil-fuel-powered vehicles, which significantly contribute to increased greenhouse gas (GHG) emissions, air pollution, and the deterioration of urban health quality (Madrid, 2023). Land transportation accounts for about 88% of energy consumption in the transportation sector. It could produce more than 114 million tons of $CO_2$ by 2030 if a systemic transition to low-emission transportation modes is not carried out (Albuquerque et al., 2020).

This has prompted the government to enact various policies to accelerate the adoption of battery-electric vehicles, such as Presidential Regulation No. 55/2019 and Presidential Regulation No. 79/2023, as part of climate change mitigation strategies and efforts to achieve the 2060 Net Zero Emission target (Setiawan, Indarto, and Deendarlianto 2019) (Pambudi & Juwono 2023). One strategic step in realizing this transformation is by implementing electric bus services in major cities. Electric bus technology is considered capable of providing environmental and social benefits such as energy efficiency, noise reduction, and improved air quality, thereby potentially enhancing the quality of life for urban residents (Setiawan et al., 2019). Nevertheless, public transportation use in Indonesia remains low. Around 60% of urban residents still prefer private vehicles due to perceptions of inadequate comfort, incomplete safety, non-punctuality, and unreliability (Albuquerque et al., 2020). Three major cities, namely Jakarta, Surabaya, and Medan, have begun implementing electric bus fleets with different infrastructure characteristics, policy readiness, and user behaviors. Jakarta has been the first to adopt electric buses commercially, supported by increasingly developed operational routes (Hidayat & Cowie 2023). Surabaya is currently strengthening a corridor-based transportation system to support fleet electrification (Sarie, Tahir, and

Pahrijal 2023). Meanwhile, Medan is in the early phase of service transformation, making understanding public acceptance very crucial (Boedisantoso et al., 2019). These contextual differences indicate the need for a theoretical approach that explains the variation in factors influencing the adoption of electric bus services across different implementation scales. Various studies suggest that the success of adopting sustainable transportation modes is determined not only by the technical aspects of the service, but also by users' psychological and social factors, such as attitudes toward innovation, social norms, perceived benefits, perceived ease of use, and environmental awareness. In addition, risk perception and safety assurance also Influence people's decisions to switch to new, more environmentally friendly services (Simanihuruk, Munthe, and Sitinjak 2024). However, most previous Research still tends to examine these factors separately. It has not integrated them into a systematic adoption evaluation framework, especially in the context of multiple cities in Indonesia. Therefore, this study proposes a user-oriented conceptual framework that integrates psychological and social factors, service attributes, and risk perceptions into a single model for evaluating the adoption of electric buses in the context of urban public transportation in Indonesia.

Literature based on the Technology Acceptance Model (TAM) generally emphasizes the role of perceived usefulness and ease of use in explaining technology adoption. However, it tends to underconsider social factors, service experience, and the context of public transportation risks (Saputra and Andajani 2023). Conversely, studies using the Theory of Planned Behavior (TPB) place more emphasis on the dimensions of attitude, subjective norms, and perceived behavioral control, but often do not explicitly integrate service attributes and technology characteristics (Martin, 2022). In addition, Research on service quality, comfort, and public transportation safety is often studied separately, without being directly linked to the formation of usage intentions and behavior (Napitupulu, Joewono, and Belgiawan 2023). This situation indicates a conceptual gap in the literature, particularly regarding the need for an integrative model that comprehensively maps the electric bus adoption process.

Based on this gap, this study aims to develop a comprehensive conceptual framework that explains the process of forming intentions and decisions to use electric buses through five main stages, namely: service attributes, initial user evaluation, adoption intention, risk evaluation, and final adoption decision. This framework combines service technical dimensions, users' psychological-behavioral factors, and risk perceptions into a structured decision flow, grounded in current literature and relevant to the context of major cities in Indonesia. The conceptual framework in this study serves as a guide for grouping constructs and mapping conceptual stages, not for testing causal relationships, as the empirical analysis is limited to an exploratory factor analysis. In addition to providing theoretical contributions by integrating adoption-determinant factors into a single model, this framework also serves as a foundation for further empirical Research to test the validity and relationships among variables in the context of electric bus implementation in Jakarta, Surabaya, and Medan. Thus, this study is expected to support the formulation of more effective, sustainable public transportation adoption strategies that align with users' needs in Indonesia.

## LITERATURE REVIEW

This study uses a theory-based conceptual approach with the Systematic Literature Review (SLR) method to identify and synthesize the factors influencing the intention to use electric buses in Indonesia. This approach was chosen because the study focuses on developing a conceptual framework that explains the relationships between relevant variables in shaping user behavior towards sustainable public transportation. The Research procedure was conducted systematically, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, to ensure transparency and replicability of the literature selection process. The analysis stages include identification, screening, eligibility assessment, and final inclusion of relevant articles.

### 2.1 Stages of Literature Search and Selection

Literature search was conducted through six main databases, namely Scopus, ScienceDirect, MDPI, Emerald Insight, ResearchGate, and SpringerLink, considering that these databases have high academic reputation, multidisciplinary coverage, and access to the latest scientific publications in the fields of technology, user behavior, and sustainable transportation. The keywords used included combinations of the terms: "electric bus", "public electric buses", "user experience", "willingness to use", "TPB", and "TAM". The search was limited to peer-reviewed English-language articles published between 2015 and 2025. The initial process resulted in 258 potentially relevant articles. All articles were evaluated for relevance to the Research focus based on their titles and abstracts. A total of 80 articles passed the initial screening stage; a full-text review was then conducted to assess the suitability of the context, theory, and variables used. Articles that discussed only the technical aspects of electric vehicles or macro policies, unrelated to user behavior, were excluded from the list. The final selection process yielded 30 articles that met all inclusion criteria and were used in the conceptual analysis.

## 2.2 Inclusion and Exclusion Criteria

Inclusion criteria include:

1. Articles discussing behavioral factors, perceptions, or intentions regarding the use of electric vehicles or sustainable public transportation.
2. Articles that utilize behavioral theories such as the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), or their developments.
3. Articles that are accessible in full-text and published in indexed academic journals.
4. Articles that use an empirical or conceptual approach relevant to the theme of transportation technology adoption.

Exclusion criteria include:

1. Articles whose discussion does not concern user behavior.
2. Non-journal publications.
3. Articles that are not accessible in full-text.

## METHOD

The analysis stage begins with data extraction from 30 selected articles to identify the underlying theories, Research constructs, and relationships between variables. A content analysis approach is used to group similar constructs into conceptual themes and align them with theoretical models. The analysis results indicate that 13 main constructs consistently appear in the literature and are relevant to the context of electric bus usage behavior in Indonesia. These thirteen constructs include: Attitude, subjective norm, perceived usefulness, perceived ease of use, perceived behavioral control, environmental awareness, satisfaction, comfort, tangible barrier, perceived risk, security measures, usage intention, and actual behavior. These constructs are then integrated into a conceptual framework that illustrates the relationship between cognitive, social, emotional, and situational factors and the intention to use (usage intention) and actual behavior (actual behavior) of electric bus usage. The process of systematically selecting articles is illustrated in Figure 1 using a PRISMA diagram, which depicts the flow from identification to final inclusion.

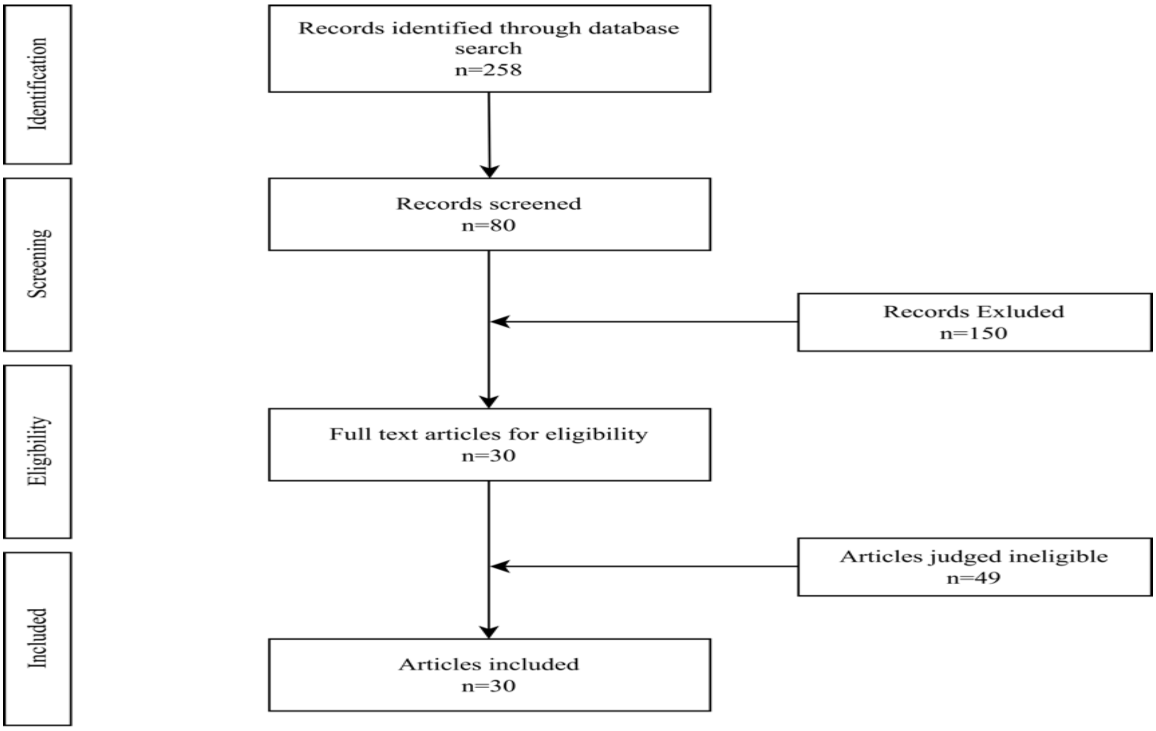


Figure 1. PRISMA flow diagram

## RESULTS AND DISCUSSION

### 4.1 Key findings

The results of the literature search across six selected databases (Scopus, ScienceDirect, MDPI, Emerald Insight, ResearchGate, and SpringerLink) yielded 258 articles relevant to electric bus adoption and user behavior towards sustainable public transportation. After screening based on titles and abstracts, 80 articles met the initial criteria. Subsequently, through the full-text selection stage, 30 articles met the inclusion criteria. These articles were systematically analyzed to identify the constructs underlying the intention to use electric buses. The identification of 30 selected articles yielded 13 main constructs deemed the most relevant and comprehensive for explaining electric bus usage behavior in Indonesia. These thirteen constructs are the result of an integration of the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), as well as the expansion of constructs from social, environmental, and user experience dimensions. All constructs, along with their indicators and supporting references, are presented in the following table.

| Number. | Variable | Question Code | Statement | Reference |
|---|---|---|---|---|
| 1. | Attitude (AT) | AT1 | Using an electric bus for traveling is a great idea. | (Shi, Wang, and Zhao 2017)(Molinillo et al. 2024) |
| | | AT2 | In my opinion, using electric buses can send a positive message to the public. | (Molinillo et al. 2024)(Adnan et al. 2018) |
| | | AT3 | Using an electric bus for traveling is an enjoyable experience. | (Shi et al. 2017)(Molinillo et al. 2024)(Adnan et al. 2018)(Fu and Juan 2017) |
| | | AT4 | Using electric buses is beneficial because it reduces the negative impact that motor vehicles have on the environment. | (Shi et al. 2017)(Adnan et al. 2018)(Rodrigues and Seixas 2022)(Ribeiro, Dias, and Mendes 2024)(Khong, Tong, and Bui 2023)(Butler, Yigitcanlar, and Paz 2021) |
| 2. | Subjective Norm (SN) | SN1 | People who are important to me encourage me to use electric buses. | (Shi et al. 2017)(Molinillo et al. 2024)(Adnan et al. 2018)(Jain, Bhaskar, and Jain 2022)(Fu and Juan 2017) |
| | | SN2 | People whose opinions I value encourage me to use electric buses. | (Molinillo et al. 2024)(Jain et al. 2022) |
| | | SN3 | People around me encourage me to use electric buses. | (Molinillo et al. 2024)(Jain et al. 2022)(Mohd Yahya et al. 2024)(Fu and Juan 2017) |
| | | SN4 | Using electric buses will give a good impression of me to others. | (Jain et al. 2022) |
| | | SN5 | People who influence my behavior encourage me to use electric buses. | (Molinillo et al. 2024)(Jain et al. 2022) |
| 3. | Perceived Behavioral Control (PBC) | PBC1 | I am concerned whether electric buses really perform as well as diesel-powered buses. | (Jain et al. 2022)(Munim and Noor 2020)(Koskinen, Mallat, and Raj Upreti 2024)(Mohamed, Ferguson, and |

| | | | | |
|---|---|---|---|---|
| | | | | Kanaroglou 2018)(Avenali et al. 2024) |
| | | PBC2 | I have the time, energy, and opportunity to use electric buses to travel. | (Shi et al. 2017)(Molinillo et al. 2024)(Jain et al. 2022) |
| | | PBC3 | The choice to use electric buses entirely depends on my own decision. | (Shi et al. 2017) |
| | | PBC4 | I am confident that I can use electric buses to travel. | (Shi et al. 2017) |
| | | PBC5 | I feel that the bus fares are quite affordable. | (Sogbe, Susilawati, and Pin 2024)(Mohd Yahya et al. 2024)(Oviedo et al. 2019)(Javid et al. 2024)(Altarifi et al. 2023)(Butler et al. 2021) |
| 4. | Environmental (E) | E1 | I am concerned about the issue of climate change. | (Nguyen and Pojani 2023)(Adnan et al. 2018)(Avenali et al. 2024) |
| | | E2 | I consider myself responsible for the environment. | (Shi et al. 2017)(Adnan et al. 2018) |
| | | E3 | I am willing to feel uncomfortable if using an electric bus becomes more environmentally friendly. | (Nguyen and Pojani 2023) |
| | | E4 | When making decisions, I will consider the impact of my activities on the environment. | (Shi et al. 2017)(Jain et al. 2022) |
| 5. | Perceived Usefulness (PU) | PU1 | Using an electric bus will make me more relaxed during the trip. | (Nguyen and Pojani 2023) |
| | | PU2 | Using an electric bus will reduce noise. | (Nguyen and Pojani 2023)(Rodrigues and Seixas 2022)(Ribeiro et al. 2024)(Javid et al. 2024)(Karjalainen and Juhola 2019) (Anthony Jnr 2024)(Manzolli, Trovão, and Antunes 2022) |
| | | PU3 | Using an electric bus will reduce greenhouse gas emissions. | (Nguyen and Pojani 2023)(Rodrigues and Seixas 2022)(Ribeiro et al. 2024)(Munim and Noor 2020)(Molinillo et al. 2024)(Karjalainen and Juhola 2019) (Butler et al. 2021) |
| | | PU4 | Using an electric bus will reduce air pollution. | (Shi et al. 2017)(Rodrigues and Seixas 2022)(Ribeiro et al. 2024)(Munim and Noor 2020)(Molinillo et al. 2024)(Khong et al. 2023) (Javid et al. 2024)(Karjalainen and Juhola 2019)(Anthony Jnr |

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|---|---|---|---|---|
| | | | | 2024)(Manzolli et al. 2022)(Butler et al. 2021)(Avenali et al. 2024) |
| | | PU5 | Electric buses can help reduce traffic congestion. | (Nguyen and Pojani 2023)(Khong et al. 2023)(Anthony Jnr 2024)(Butler et al. 2021) |
| 6. | Satisfaction (SF) | SF1 | I like traveling by bus | (Molinillo et al. 2024)(Jain et al. 2022) |
| | | SF2 | I am satisfied with the bus service | (Wei et al. 2020)(Mohd Yahya et al. 2024)(Norhisham et al. 2022)(Munim and Noor 2020)(Javid et al. 2024)(Karjalainen and Juhola 2019) |
| | | SF3 | I have a positive impression of the bus service | (Shi et al. 2017)(Mohd Yahya et al. 2024)(Norhisham et al. 2022)(Munim and Noor 2020) |
| 7. | Tangible (TN) | TN1 | The bus stop location is close to my residence | (Adhvaryu and Kumar 2021)(Mohd Yahya et al. 2024)(Oviedo et al. 2019)(Altarifi et al. 2023) |
| | | TN2 | The bus stop location is close to my travel destination | (Adhvaryu and Kumar 2021)(Mohd Yahya et al. 2024)(Oviedo et al. 2019)(Altarifi et al. 2023) |
| | | TN3 | The bus physical facilities look modern | (Adnan et al. 2018)(Mohd Yahya et al. 2024)(Munim and Noor 2020) |
| | | TN4 | There is no noise from the bus engine while sitting inside the bus | (Nguyen and Pojani 2023)(Munim and Noor 2020)(Avenali et al. 2024) |
| | | TN5 | A complete set of safety equipment is available inside the electric bus (e.g., glass breaker, emergency door, etc.) with instructional signs | (Nguyen and Pojani 2023)(Munim and Noor 2020) |
| | | TN6 | The electric bus facilities are suitable for users with special needs (e.g., wheelchair users, strollers, heavy luggage, etc.) | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Munim and Noor 2020)(Javid et al. 2024)(Ranceva, Ušpalytė-Vitkūnienė, and Vaišis 2022) |
| 8. | Perceived Ease of Use (EU) | EU1 | It's easy for me when using the electric bus. | (Molinillo et al. 2024)(Nguyen and Pojani 2023)(Koskinen et al. 2024) |
| | | EU2 | It's simple for me when using the electric bus. | (Nguyen and Pojani 2023) |
| | | EU3 | I won't encounter any problems when using the electric bus. | (Molinillo et al. 2024)(Nguyen and Pojani 2023) |

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| 9. | Perceived Risk (PR) | PR1 | I am concerned about the risk of sexual harassment at bus stops. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Quinones 2020) |
| | | PR2 | | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Quinones 2020) |
| | | PR3 | I am concerned about the risk of sexual harassment when getting on and off the bus. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Quinones 2020) |
| | | PR4 | I am concerned about the risk of sexual harassment inside the bus. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Li et al. 2024)(Altarifi et al. 2023) |
| | | PR5 | I am concerned about the risk of theft at bus stops. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Li et al. 2024)(Altarifi et al. 2023) |
| | | PR6 | I am concerned about the risk of theft when getting on and off the bus. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Li et al. 2024) |
| | | PR7 | I am concerned about the risk of theft inside the bus. | (Molinillo et al. 2024)(Nguyen and Pojani 2023)(Khong et al. 2023)(Butler et al. 2021) |
| | | PR8 | I feel that using the electric bus can reduce the number of accidents. | (Nguyen and Pojani 2023)(Altarifi et al. 2023) |
| 10. | Security Measure (SM) | SM1 | CCTV cameras are available inside the bus. | (Nguyen and Pojani 2023)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | SM2 | CCTV cameras are available at many bus stops. | (Nguyen and Pojani 2023)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | SM3 | The lighting inside the bus is adequate. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | SM4 | The lighting at the bus stop is adequate. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| 11. | Comfort (CF) | CF1 | In my opinion, the cleanliness inside the bus is well maintained. | (Sogbe et al. 2024)(Mohd Yahya et al. 2024)(Norhisham et al. 2022)(Munim and Noor 2020)(Li et al. 2024)(Javid et al. 2024)(Ranceva et al. 2022) |
| | | CF2 | In my opinion, the cleanliness at the bus stop is well maintained. | (Sogbe et al. 2024)(Mohd Yahya et al. |

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|---|---|---|---|---|
| | | | | 2024)(Altarifi et al. 2023) |
| | | CF3 | I feel the bus passenger waiting area is comfortable. | (Adu-Gyamfi et al. 2023)(Sogbe et al. 2024)(Mohd Yahya et al. 2024)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | CF4 | I feel the temperature inside the bus is comfortable. | (Adu-Gyamfi et al. 2023)(Sogbe et al. 2024)(Norhisham et al. 2022)(Munim and Noor 2020)(Li et al. 2024)(Javid et al. 2024)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | CF5 | I feel the bus seats are adequate and comfortable. | (Adu-Gyamfi et al. 2023)(Sogbe et al. 2024)(Mohd Yahya et al. 2024)(Li et al. 2024)(Javid et al. 2024)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | CF6 | I feel the air circulation inside the bus is good. | (Adu-Gyamfi et al. 2023)(Sogbe et al. 2024)(Li et al. 2024)(Altarifi et al. 2023)(Ranceva et al. 2022) |
| | | CF7 | In my opinion, a crowded or busy atmosphere inside the bus reduces comfort. | (Sogbe et al. 2024)(Javid et al. 2024)(Bernhard et al. 2020) |
| 12. | Usage Intention (UI) | UI1 | I intend to use electric buses as a mode of transportation in the near future. | (Nguyen and Pojani 2023)(Shi et al. 2017) |
| | | UI2 | I am willing to use electric buses for traveling. | (Nguyen and Pojani 2023)(Shi et al. 2017)(Mohd Yahya et al. 2024)(Molinillo et al. 2024) |
| | | UI3 | I intend to use electric buses as my daily mode of transportation. | (Nguyen and Pojani 2023)(Mohd Yahya et al. 2024)(Molinillo et al. 2024)(Fu and Juan 2017) |
| 13. | Actual Behavior (AB) | AB1 | I use the bus more often than other modes of transportation in my daily mobility. | (Jain et al. 2022)(Molinillo et al. 2024)(Fu and Juan 2017) |
| | | AB2 | I always use the bus to support my mobility. | (Jain et al. 2022)(Fu and Juan 2017) |
| | | AB3 | The bus is my main mode of transportation. | (Jain et al. 2022)(Javid et al. 2024) |

Based on the results of the literature synthesis mapped in the previous table, the following section outlines the analysis per construct to review the characteristics, indicators, and theoretical basis of each variable. This approach aims to provide a comprehensive understanding of the factors influencing the use of electric buses.

#### 4.1.1 Attitude (AT)

Attitude represents an individual's cognitive and affective evaluation of the use of electric buses. Literature findings show that a positive attitude is formed from the belief that electric buses are a good choice, provide a positive social image, offer an enjoyable experience, and deliver significant ecological benefits (Ribeiro et al., 2024) (Ndhlovu, Mhlanga, and Duri 2025) (Leichter et al., 2022) (Madrid, 2023). The AT1 indicator emphasizes the cognitive assessment that using electric buses is a good idea, while AT2 highlights the social value related to the positive image generated by environmentally friendly behavior (Ndhlovu et al., 2025) (Leichter et al., 2022). The affective dimension is reflected in AT3 when users find the experience of using electric buses enjoyable (Ribeiro et al., 2024) (Ndhlovu et al., 2025) (Leichter et al., 2022) (Madrid, 2023). AT4 shows that the perception of environmental benefits becomes a fundamental component in forming a positive attitude (Ribeiro et al., 2024) (Leichter et al., 2022) (Albuquerque et al., 2020) (Setiawan et al., 2019) (Pambudi & Juwono 2023) (Hidayat & Cowie 2023). Overall, these four indicators confirm that attitude is a strong determinant of the intention to use sustainable transportation.

#### 4.1.2 Subjective Norm (SN)

Subjective norm describes the social Influence perceived by an individual from significant people in their life. In a collectivist society, social norms play an important role in shaping user intention (Ribeiro et al., 2024) (Ndhlovu et al., 2025) (Leichter et al., 2022) (Sarie et al., 2023). SN1 and SN2 indicate that encouragement from important people and those whose opinions are valued motivates the use of electric buses (Ndhlovu et al., 2025) (Sarie et al., 2023). SN3 emphasizes the role of the surrounding environment as an agent in shaping behavior (Ndhlovu et al., 2025) (Sarie et al., 2023) (Boedisantoso et al., 2019) (Madrid, 2023). Meanwhile, SN4 and SN5 show how self-image perception and direct social Influence can strengthen the intention to behave consistently with social expectations (Sarie et al., 2023). These findings reinforce the idea that the subjective norm is an important factor in decision-making about using new public transportation.

#### 4.1.3 Perceived Behavioral Control (PBC)

PBC explains an individual's perception of their ability and control to use electric buses. PBC1 reflects concerns regarding the technical performance of electric buses, which can lower an individual's perception of control (Sarie et al., 2023) (Simanihuruk et al., 2024) (Saputra & Andajani 2023) (Martin, 2022) (Napitupulu et al., 2023). Conversely, PBC2, PBC3, and PBC4 indicate dimensions of internal control and self-efficacy, meaning the belief that users have the time, opportunity, and capability to operate this mode (Ribeiro et al., 2024) (Ndhlovu et al., 2025) (Sarie et al., 2023). Fares considered affordable (PBC5) also enhance the perception of control in the context of public transportation (Hidayat and Cowie 2023) (Boedisantoso et al., 2019) (Base, Ong, and Cahigas 2024) (Shi et al., 2017) (Molinillo et al., 2024) (Adnan et al., 2018). Overall, PBC mediates the relationship between intention and actual behavior through users' perceptions of their ability.

#### 4.1.4 Environmental Awareness (E)

Environmental awareness reflects an individual's level of concern for ecological issues and moral responsibility toward the environment. E1 and E2 indicate that attention to climate change and a sense of personal responsibility are fundamental elements in decisions to behave in an environmentally friendly manner (Leichter et al., 2022) (Napitupulu et al., 2023) (Fu & Juan 2017). E3 emphasizes that some individuals are willing to accept discomfort for ecological contributions (Fu & Juan 2017), while E4 shows that consideration of environmental impact has been integrated into everyday decision-making processes (Ribeiro et al., 2024) (Sarie et al., 2023). Overall, the indicators affirm the role of environmental awareness as an important driver of the intention to use electric buses.

#### 4.1.5 Perceived Usefulness (PU)

Perceived usefulness refers to the perceived functional and ecological benefits of electric buses. PU1 indicates that electric buses are perceived as providing a more relaxed travel experience (Fu & Juan 2017). PU2, PU3, and PU4 emphasize the advantages of electric buses in reducing noise, greenhouse gas emissions, and air pollution (Albuquerque et al., 2020) (Setiawan et al., 2019) (Molinillo et al., 2024) (Fu & Juan 2017) (Rodrigues & Seixas 2022) (Khong et al., 2023) (Butler et al., 2021). PU5 adds a macro dimension that the use of electric buses is believed to contribute to congestion reduction (Pambudi & Juwono 2023) (Hidayat & Cowie 2023) (Fu & Juan 2017)

(Khong et al., 2023). These findings suggest that utilitarian and environmental benefits are key factors that strengthen the intention to use.

### 4.1.6 Satisfaction (SF)

Satisfaction reflects users' evaluation of their bus service experience. SF1 measures basic preference for the bus mode (Ndhlovu et al., 2025) (Sarie et al., 2023), while SF2 and SF3 reflect positive evaluations of service aspects such as comfort, punctuality, and operational quality (Boedisantoso et al., 2019) (Simanihuruk et al., 2024) (Molinillo et al., 2024) (Rodrigues & Seixas 2022) (Jain et al., 2022) (Mohd Yahya et al., 2024). This level of satisfaction directly contributes to reuse and public support for electric bus services.

### 4.1.7 Tangible (TN)

Tangible relates to physical barriers and infrastructure that affect user accessibility and comfort. TN1 and TN2 confirm that the proximity of stops to residences and destinations is a key determinant in the decision to use (Boedisantoso et al., 2019) (Shi et al, 2017) (Adnan et al., 2018) (Munim & Noor 2020). TN3 and TN4 emphasize the role of modern facilities and low noise levels as factors supporting comfort (Leichter et al., 2022) (Boedisantoso et al., 2019) (Simanihuruk et al., 2024) (Napitupulu et al., 2023) (Fu & Juan 2017). TN5 and TN6 indicate that the presence of safety equipment and facilities that are people-friendly enhances perceptions of system reliability (Boedisantoso et al., 2019) (Simanihuruk et al., 2024) (Molinillo et al., 2024) (Fu & Juan 2017) (Koskinen et al., 2024). Unmet physical barriers can reduce interest in usage even when psychological perceptions are positive.

### 4.1.8 Perceived Ease of Use (EU)

The EU describes users' perceptions regarding the ease of accessing and using electric buses. EU1 and EU2 indicate that users feel the process of using electric buses is simple and not complicated (Ndhlovu et al., 2025) (Saputra & Andajani 2023) (Fu & Juan 2017). EU3 emphasizes that minimal operational barriers enhance the perception of ease (Ndhlovu et al., 2025) (Fu & Juan 2017). This construct reinforces the role of TAM in understanding the adoption of public transportation technology.

### 4.1.9 Perceived Risk (PR)

Perceived risk encompasses concerns about physical, social, and personal safety. PR1–PR3 show worries about the risk of sexual harassment at bus stops, when getting on and off, and inside the bus, especially for vulnerable groups (Boedisantoso et al. 2019) (Fu & Juan 2017) (Mohamed et al., 2018). PR4–PR6 highlight the risk of theft, which can reduce comfort and security (Boedisantoso et al., 2019) (Adnan et al., 2018) (Fu & Juan 2017) (Avenali et al., 2024). On the other hand, PR7 and PR8 indicate a positive perception that electric buses can improve safety and reduce accidents (Ndhlovu et al., 2025) (Pambudi & Juwono 2023) (Hidayat & Cowie 2023) (Adnan et al., 2018) (Fu & Juan 2017). Overall, negative risks tend to lower intention, while the risk reduction dimension increases confidence.

### 4.1.10 Security Measures (SM)

Security measures are security facilities provided by operators to reduce risks. SM1 and SM2 indicate that the availability of CCTV on buses and at stops increases the public sense of safety (Adnan et al., 2018) (Fu & Juan 2017) (Koskinen et al., 2024). SM3 and SM4 emphasize the importance of adequate lighting in mitigating crime risk (Boedisantoso et al., 2019) (Adnan et al., 2018) (Fu & Juan 2017) (Koskinen et al., 2024). The implementation of these security measures has been proven to reduce risk perception and support increased adoption.

### 4.1.11 Comfort (CF)

Comfort reflects physical conditions and travel experiences. CF1–CF3 indicate that cleanliness, the comfort of waiting areas, and the condition of bus stops are important aspects in enhancing the user experience (Boedisantoso et al., 2019) (Simanihuruk et al., 2024) (Base et al., 2024) (Molinillo et al., 2024) (Mohd Yahya et al., 2024) (Koskinen et al., 2024) (Avenali et al., 2024). CF4–CF6 highlight the role of temperature, seat comfort, and air circulation in creating a pleasant journey (Simanihuruk et al., 2024) (Base et al., 2024) (Molinillo et al., 2024) (Adnan et al., 2018) (Mohd Yahya et al., 2024) (Koskinen et al., 2024) (Avenali et al., 2024) (Sogbe et al., 2024). CF7 confirms that passenger density significantly reduces comfort (Base et al., 2024) (Molinillo et al., 2024) (Oviedo et al., 2019). Comfort has been shown to have a strong Influence on the intention to use repeatedly.

### 4.1.12 Usage Intention (UI)

Usage intention describes an individual's readiness and willingness to use electric buses. UI1 indicates short-term readiness, while UI2 reflects willingness to use electric buses for various mobility needs (Ribeiro et al., 2024) (Ndhlovu et al., 2025) (Boedisantoso et al., 2019) (Fu & Juan 2017). UI3 is the strongest indicator, reflecting the intention to make electric buses a daily mode of transportation (Ndhlovu et al., 2025) (Madrid, 2023) (Boedisantoso et al., 2019) (Fu & Juan 2017). This construct is a primary predictor of actual behavior.

### 4.1.13 Actual Behavior (AB)

Actual behavior measures actual use of electric buses. AB1 indicates an increased frequency of use compared to other modes (Ndhlovu et al., 2025) (Madrid, 2023) (Sarie et al., 2023), AB2 reflects consistent use for routine mobility (Madrid, 2023) (Sarie et al., 2023), and AB3 shows full adoption when the bus becomes the main mode (Sarie et al., 2023) (Molinillo et al., 2024). The interaction between intention and tangible barriers, risks, and infrastructure strongly influences the realization of actual behavior. The synthesis of the 30 articles shows that the behavior of using electric buses is shaped by a combination of psychological, social, cognitive, and situational factors. Attitude serves as the starting point for forming behavioral intention, as individuals with a positive view of electric buses tend to have a stronger intention to use them. This view is reinforced by perceptions of environmental benefits and the social value of using low-emission transportation. Attitude is an individual's psychological tendency to evaluate an object, behavior, or idea positively or negatively, which then influences their intention and actual behavior. In the context of consumer behavior toward environmentally friendly technologies such as electric buses, attitude reflects the extent to which a person has a positive view, feels enjoyment, and perceives the use of electric buses as beneficial (Adu-Gyamfi et al., 2023).

## 4.2 Conceptual Framework

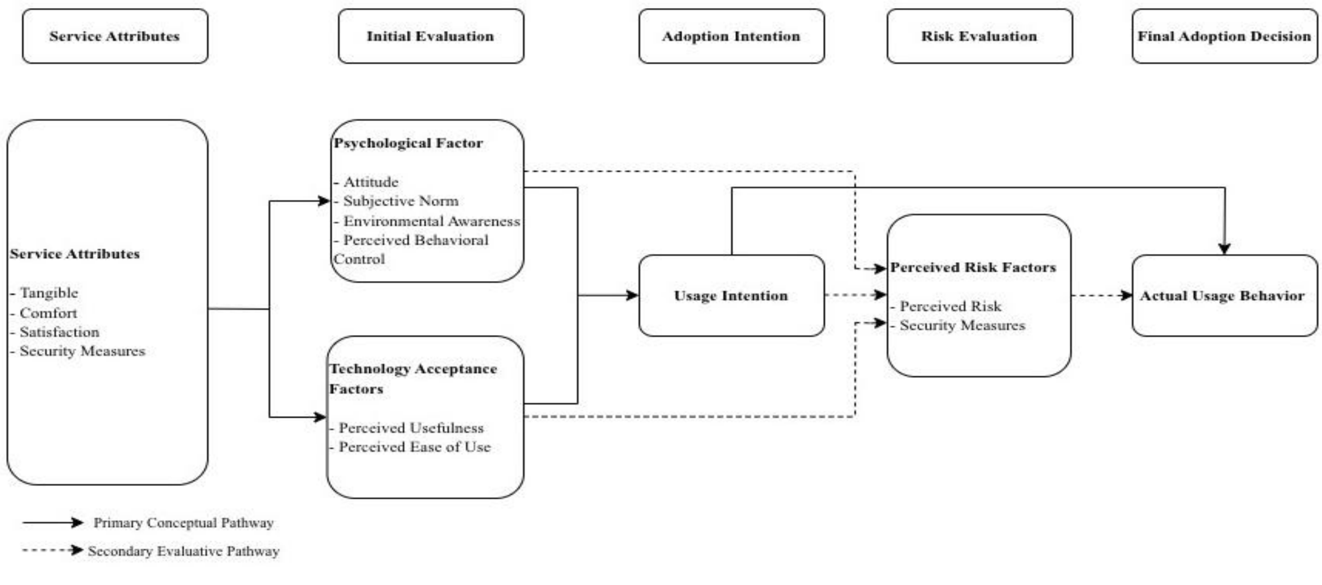


Figure 2. User-Oriented Conceptual Framework for Electric Bus Adoption

The conceptual framework in this study explains how users evaluate and ultimately decide to use electric buses as a mode of public transportation. This framework is not designed to test causal relationships between variables, but rather to describe the user evaluation process step by step. This approach is used because the adoption of electric buses in Indonesia is still at an early stage, so the main focus of the study is to understand the structure of factors and the flow of user evaluation, not to test the strength of causal relationships. An overview of the conceptual framework proposed in this study is presented in Figure 2. As shown in Figure 2, the initial stage in this framework is service attributes, which are the characteristics of electric bus services directly perceived by users. These attributes include physical and operational aspects, such as bus and bus stop facilities, travel comfort, service satisfaction, and basic safety. Service attributes serve as the initial experience that shapes users' impressions of electric buses before deeper psychological and cognitive considerations emerge.

Experience with these service attributes then affects the internal evaluations of two user groups. The first group is psychological factors, which reflect users' psychological assessments based on the Theory of Planned Behavior. These factors include attitudes towards using electric buses, social Influence from the surrounding environment, the level of environmental concern, and perceived control in using the service. These factors illustrate how users evaluate electric buses from the perspective of personal, social, and self-efficacy values. The second internal evaluation group shown in Figure 2 is the technology acceptance factors, which originate from the Technology Acceptance Model. This factor includes perceptions of usefulness and ease of use of electric buses as a transportation innovation. This evaluation focuses on the extent to which users perceive electric buses as beneficial, practical, and not complicating their daily travel.

Both evaluation groups together form the usage intention, as shown in Figure 2. Usage intention reflects an individual's readiness to use electric buses as part of their mobility, but it does not necessarily translate directly into actual behavior. Therefore, this framework clearly distinguishes between usage intention and actual usage behavior. After the intention is formed, users still make additional considerations before actually using electric buses regularly. At this stage, risk evaluation serves as a further assessment. As illustrated in Figure 2 (dashed line), risk perceptions, such as concerns about safety and security, can hinder use even after intention has formed. Conversely, the presence of security measures such as CCTV and adequate lighting can reduce these concerns and support the actual decision to use. Within this framework, risk and security factors are not positioned as primary determinants of intention formation, but rather as supporting or inhibiting factors that are conditional. Therefore, the relationship between risk and security is depicted as an additional evaluative pathway rather than a main pathway in the adoption process.

To ensure that this conceptual framework is not only theoretically grounded but also empirically supportable, each construct included in Figure 2 was operationalized into measurable questionnaire indicators. All variables—ranging from service attributes, psychological factors, and technology acceptance to perceived risk, security measures, and usage intention and actual behavior—were translated into specific statements adapted from prior, validated studies. This measurement development process establishes content validity and demonstrates that the proposed framework is grounded in constructs that have been empirically examined in the literature. Furthermore, the questionnaire items were reviewed by academic experts and practitioners to ensure clarity, relevance, and contextual appropriateness for the Indonesian electric bus setting. A pilot test was also conducted with electric bus users to assess the comprehensibility and initial reliability of the instrument before the main survey distribution.

Given the exploratory nature of electric bus adoption in Indonesia, this study applies Exploratory Factor Analysis (EFA) as the primary analytical approach to empirically verify whether the observed indicators cluster into coherent factors consistent with the conceptual structure proposed in Figure 2. Therefore, the framework serves not only as a descriptive evaluation framework but also as a foundation for empirical validation and future Research. Overall, Figure 2 illustrates the adoption of electric buses as a gradual process, starting with service experience, followed by the formation of psychological assessments and technology perceptions, and culminating in intention and actual usage behavior. This framework provides a simple yet comprehensive overview of how various factors interact in influencing the adoption of electric buses in the context of urban public transportation in Indonesia. Additionally, this framework also serves as a conceptual basis for exploratory analysis using Exploratory Factor Analysis (EFA) and as a foundation for further empirical Research.

## CONCLUSION

This study develops a conceptual framework for the adoption of electric buses as a sustainable public transportation mode in Indonesia using a PRISMA-based Systematic Literature Review. The literature synthesis identifies thirteen main constructs representing psychological, social, and cognitive factors, service experience, and risk perception that play a role in shaping usage intention and actual usage behavior. This framework maps the adoption process into structured user evaluation stages, from service attributes to actual usage decisions. The main contribution of this Research lies in integrating psychological and technology acceptance factors as the primary conceptual pathway, with risk evaluation as a secondary evaluative pathway. This framework is designed as an exploratory conceptual model to support Exploratory Factor Analysis, rather than as a structural causal model. To strengthen its empirical applicability, the proposed constructs have been operationalized into measurable questionnaire indicators adapted from validated prior studies, supported through expert review and pilot testing with electric bus users. Therefore, this framework provides not only a conceptual contribution but also a measurable foundation for exploratory validation and further empirical Research. In practice, the findings underscore that strategies to increase electric bus adoption need to combine improvements in service quality, reinforcement of perceived benefits and ease of use, and risk mitigation through adequate safety systems. This conceptual framework is expected to serve as a foundation for further empirical Research and the formulation of sustainable public transportation policies in Indonesia.

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