

**Exploring the Role of Energy-Saving Awareness on Stated Behavior under the Context of
Carbon Neutrality: A Case Study of Frontline Pilots in Chinese Civil Aviation**

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DMan Thesis

May, 2026

Abstract

With ongoing economic and social development, sustainability and environmental protection have become major global concerns. In response to the United Nations' call for sustainable development, China has adopted the long-term "Dual Carbon Goal" to address climate change and promote a greener economy and a more environmentally balanced society. This goal contains two parts: carbon peaking and carbon neutrality. It aims to bring carbon dioxide emissions to their highest level by 2030 and to achieve carbon neutrality by 2060, meaning that carbon dioxide emissions from human activities will be offset through measures such as afforestation, so that net-zero emissions can be reached (State Council of the People's Republic of China, 2022).

The introduction of China's Dual Carbon Goal has had a significant impact on most industries, imposing more stringent requirements. Civil aviation enterprises, among all, are urged to adopt optimized measures to reduce carbon emissions, improve energy utilization and promote the industry's development toward a greener and more environmentally friendly direction. This includes increasing aircraft fuel efficiency, optimizing the aviation transportation system, and strengthening training on sustainability for employees. In this context, frontline pilots need to strengthen their energy-saving awareness and engagement in energy-efficient flight operations to meet the new requirements of the development of the civil aviation industry. This proactive approach is expected to contribute to achieving the Dual Carbon Goal, promoting low-carbon development in flight, and providing positive momentum for enterprises.

Drawing mainly on Social Cognitive Theory, complemented by Theory of Planned Behavior and related behavioral theories used in a supporting role, this study examines Energy-Saving Awareness (ESA) among frontline pilots in China and the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB). Based on a review of the

literature, this study develops a theoretical framework on the pathway of ESA-ESI-SESB. A survey of 200 frontline pilots from Chinese civil aviation enterprises was then used to examine the associations among the three terms.

Quantitative results demonstrate that:

1. Energy-Saving Awareness (ESA) is positively associated with Energy-Saving Intention (ESI), indicating that pilots with stronger energy-saving awareness also report stronger motivation to make fuel-efficient and environmentally responsible decisions during flight operations.

2. Energy-Saving Awareness (ESA) is positively associated with Stated Energy-Saving Behavior (SESB), indicating that pilots with higher awareness scores also report more frequent use of energy-saving and fuel-efficient operating practices.

3. Energy-Saving Intention (ESI) is positively associated with Stated Energy-Saving Behavior (SESB), indicating that pilots with a stronger self-reported intention to save energy also report greater engagement in energy-saving operational practices. To clarify the two concepts, Energy-Saving Intention (ESI) refers to an individual's psychological willingness to perform energy-saving practices, while Stated Energy-Saving Behavior (SESB) refers to the self-reported physical actions aimed at reducing energy consumption or improving efficiency, such as optimized flight procedures, reduced taxiing, and fuel-efficient climb profiles. SESB serves as the dependent variable in this study, representing pilots' self-reported behavioral practices related to awareness and intention.

4. Energy-Saving Intention (ESI) partly explains the association between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB), indicating that awareness is related to stated behavior partly through pilots' energy-saving intention.

5. Psychological Factors (PF) moderate the association between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI), with higher self-efficacy and stronger personal norms strengthening the positive relationship between awareness and intention.

6. Situational Factors (SF) moderate the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB), indicating that supportive organizational and policy conditions strengthen the relationship between intention and stated behavior.

Conclusion: In this sample, energy-saving awareness, intention, and stated behavior are closely related. Energy-saving awareness is associated with stated behavior both directly and indirectly through energy-saving intention. Psychological factors are associated with the strength of the awareness–intention link, while situational factors are related to the strength of the intention–stated behavior link. Given the cross-sectional and self-reported nature of the data, these findings should be interpreted as statistically supported associations within the proposed model, not as evidence of a temporal or causal sequence.

Finally, in light of the empirical findings and the broader need for sustainable and low-carbon development, this study proposes practical recommendations for strengthening pilots' energy-saving intention, improving organizational support and policy incentives, and fostering a stronger culture of energy conservation within civil aviation enterprises.

Keywords: frontline pilots, energy-saving awareness, energy-saving intention, stated energy-saving behavior, Dual Carbon

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Chapter 1. Introduction

1.1 Research Background and Significance

1.1.1 Research Background

Internationally, the continuing rise in global temperatures and the growing frequency of extreme weather events have seriously affected human life (IPCC, 2023). In response, countries under the United Nations climate framework have adopted policy documents such as the Paris Agreement, a legally binding international treaty that calls for joint efforts to limit greenhouse gas emissions. This agreement provides important guidance for the achievement of sustainable development goals (UNFCCC, 2015).

In China, the domestic context is also highly significant. As one of the world's largest countries in both population and land area, and as a major carbon dioxide emitter, China has long relied heavily on fossil fuels in its energy structure. Its large population and strong energy demand have further increased the pressure for a low-carbon transition (State Council of the People's Republic of China, 2022). Against this background, achieving China's "Dual Carbon Goal" is both a challenge and an opportunity. "Dual Carbon" refers to the country's long-term strategy of carbon peaking and carbon neutrality, introduced to respond to global climate change and promote sustainable low-carbon development. More specifically, carbon peaking means reaching the historical highest level of carbon dioxide emissions by 2030, while carbon neutrality means reaching net-zero carbon dioxide emissions by 2060 through balancing emissions and absorption, including afforestation and other carbon offset measures (State Council of the People's Republic of China, 2022). Reaching the Dual Carbon Goal can help drive economic transformation and upgrading, improve the ecological environment, and raise quality of life. It is therefore an important step for China to take an active part in global climate governance, meet its international

responsibilities, and promote high-quality development in a more environmentally friendly way (State Council of the People's Republic of China, 2022; Yang & Wang, 2023).

To achieve carbon peaking at the national level, each industry should set sector-specific carbon targets, including indicators such as the timing and intensity of emissions. Each sector needs to advance the green and low-carbon transformation of energy, construction, transportation, and other related fields, so as to reduce carbon emission intensity. To achieve overall carbon neutrality, it is necessary to optimize the energy structure, further expand renewable energy, improve energy efficiency, strengthen the carbon emissions trading system, and continue to enhance carbon sink capacity. At the same time, policy design needs to be coordinated so that the Dual Carbon strategy is aligned with ecological benefits, sustainable development, energy transition, and technological innovation (State Council of the People's Republic of China, 2022; Yang & Wang, 2023). International cooperation in knowledge and resources is also essential for achieving the Dual Carbon Goal, including the sharing of decarbonization policies, fuel-efficiency management practices, emissions accounting standards, and low-carbon aviation technologies such as sustainable aviation fuels and operational optimization (UNFCCC, 2015; Civil Aviation Administration of China, 2021).

The development of Dual Carbon policies can support the adjustment of China's economic structure. By shifting from a high-energy-use, high-emission model to a low-carbon and green model, these policies can reduce energy use and improve the quality of economic development. They can also speed up the optimization of the energy structure by promoting the shift from non-renewable to renewable energy sources (State Council of the People's Republic of China, 2022). In addition, these policies can improve environmental quality and thus benefit people's quality of life. The implementation of Dual Carbon measures can reduce air pollutant emissions, improve the

ecological environment, and strengthen China's role in global climate governance (IPCC, 2023; UNFCCC, 2015; State Council of the People's Republic of China, 2022).

Efforts to optimize industrial structure include developing industries with a stronger focus on high-tech and green sectors, while reducing carbon emissions in energy-intensive industries such as coal mining and heavy manufacturing. At the same time, there is a continued emphasis on innovation in green and low-carbon technologies in order to create new sources of economic growth and promote environmentally friendly industrial development (State Council of the People's Republic of China, 2022).

The transport sector accounts for about 23% of global energy-related CO₂ emissions and 10% of China's national carbon emissions (IPCC, 2022; Jia & Ren, 2024). For this reason, promoting green transportation and low-carbon practices is essential to meeting emission reduction targets. This includes promoting cleaner transport technologies, building efficient and convenient public transport systems, and continuing efforts to strengthen energy conservation and emission reduction across the transport sector (IEA, 2023).

As an important part of the transport sector, China's civil aviation industry has grown substantially. Fleet size and airport numbers have continued to increase, airport grades have improved, and energy demand has risen steadily. In January 2022, the Civil Aviation Administration of China issued the "14th Five-Year Plan Special Plan for Green Development of Civil Aviation", which clearly stated the need to advance carbon peaking and carbon neutrality in the sector (Civil Aviation Administration of China, 2021). This plan is intended to guide and launch the overall green transformation of civil aviation. There is therefore an urgent need for new development strategies in China's civil aviation industry in the post-pandemic period. Such innovation should focus not only on flight safety, but also on wider sustainability goals, including

the development and use of sustainable aviation fuels, the adoption of green technologies, and the reduction of carbon emissions across the full life cycle of aviation operations (Civil Aviation Administration of China, 2021; IEA, 2025).

At the international level, the International Civil Aviation Organization (ICAO, 2025) also treats operational improvements and flight operations as part of aviation's response to climate change. This means that aviation sustainability depends not only on cleaner fuels and new aircraft technologies, but also on how flights and daily operations are managed. In a similar way, Calvet (2024) shows that sustainable aviation includes operational optimization, such as airline operations, airport operations, flight operations, and disruption management. These studies support the focus of the present research on pilots, because pilots' awareness and stated energy-saving behavior are closely related to the operational side of aviation sustainability.

Two main strategies can be identified for achieving these goals. First, it is important to improve the operational capability of civil aviation departments. This can be done by optimizing fleet and route planning through scheduling calculations, route optimization, preferred alternate airport selection, and secondary dispatch. These measures aim to bring actual fuel use as close as possible to the theoretical minimum, which is the most direct way to reduce carbon emissions in civil aviation. Second, it is essential to strengthen the energy-saving awareness of frontline pilots in order to encourage energy-efficient behavior. This includes making use of fuel-saving technologies at different stages of flight operations, including parking, pre-flight preparation, takeoff, landing, and cruising. At the same time, the rebound effect should not be ignored: improvements in fuel efficiency and energy-saving practice may reduce operating costs, which may then increase demand and partly offset environmental gains. It is therefore important to

recognize and manage this effect so that energy-saving measures can lead to sustained reductions in total carbon emissions (IEA, 2023; Civil Aviation Administration of China, 2021).

Analysis of energy use in civil aviation shows that human and organizational factors have a material effect on energy-saving outcomes, including the execution of fuel-saving procedures, the consistency of operational practice, and the level of energy-saving awareness and training. These behavioral and operational factors can strongly affect fuel use and overall efficiency. Frontline pilots are therefore widely seen as key actors in reducing avoidable energy waste in civil aviation. In 2017, the Civil Aviation Administration of China revised the “Rules for the Certification of Operation Qualification of Large Aircraft Public Air Transport Carriers” (CCAR-121-R5), stressing the need to manage frontline pilots through better regulation, stronger training, and stricter supervision. This management approach is intended to strengthen pilots’ energy-saving awareness and encourage energy-efficient behavior through practices such as single-engine taxiing and maintaining optimal cruising altitude (Ministry of Transport of the People’s Republic of China, 2017). Since civil aviation is a high-risk industry, it is necessary to address not only the technical factors that affect frontline pilots, but also the broader psychological capacities of aviation personnel. From a Social-Cognitive perspective, cognition plays a coordinating role between environmental cues, self-regulation, and action. This makes it important to examine the energy-saving awareness of frontline pilots through a behavioral framework grounded mainly in Social Cognitive Theory (Bandura, 1991, 2001; Kotsopoulos et al., 2023).

Based on this framework, this paper examines the energy-saving awareness and stated energy-saving behavior of frontline pilots in Chinese civil aviation. It examines how employees’ energy-saving awareness is associated with stated energy-saving behavior and also discusses the role of industry regulation and organizational systems in shaping such behavior (Civil Aviation

Administration of China, 2021; Ministry of Transport of the People's Republic of China, 2017). The paper then puts forward suggestions for improving the stated energy-saving behavior of frontline pilots, with the aim of changing misunderstandings about energy and reshaping behavioral habits. The study aims to support the implementation of energy-saving measures in the Dual Carbon context of China's civil aviation sector and thus contribute to the sector's overall green transformation.

Studying the energy-saving awareness of frontline pilots in the context of the Dual Carbon strategy is of great importance for Chinese civil aviation enterprises. Frontline pilots are key decision-makers in the aviation transport process, and their flight operations and decisions directly affect aircraft energy use and emissions. Understanding their energy-saving awareness helps reveal how pilots perceive energy efficiency in operational settings and how they report the adoption of corresponding energy-saving practices. In addition, pilots have deep technical knowledge and practical experience in aircraft operation. Their awareness and practical ability in energy saving are important for improving fuel efficiency, optimizing flight plans, and reducing carbon emissions. Research on the energy-saving awareness of frontline pilots therefore helps to better understand and make use of their influence at the technical level (Civil Aviation Administration of China, 2021).

As members of the aviation industry, frontline pilots represent a part of the workforce with high technical competence and unique professional characteristics. Their energy-saving awareness and practices can to some extent reflect the attitudes and behaviors of the entire workforce, providing a foundation for developing carbon reduction plans involving the entire staff. The aviation industry itself is energy-intensive, and its carbon emissions directly impact the atmospheric environment. Studying the energy-saving awareness of frontline pilots helps

formulate more precise and practical carbon reduction strategies, thereby steering the entire civil aviation enterprise towards a more sustainable development path. It is also likely to set an example for other employees and relevant stakeholders. By inspiring the energy-saving enthusiasm of frontline pilots, the entire enterprise can foster a more environmentally friendly working atmosphere.

1.1.2 Research Significance

As economic and societal development advances rapidly, the demand for civil aviation transportation has notably escalated, leading to an increase in energy consumption. In today's era of rapid scientific and technological progress, frontline pilots in civil aviation require more solid comprehensive qualities. They must enhance their energy-saving awareness and understanding of green development, effectively implement Dual Carbon actions, and adapt to the new demands of the civil aviation industry in this new period.

In terms of practical significance, this paper, grounded mainly in Social Cognitive Theory, explores the current state of energy-saving awareness among frontline pilots in Chinese civil aviation. It examines how pilots' energy-saving awareness is associated with their stated energy-saving behavior and discusses how intention, psychological factors, and situational factors may help explain these associations. It also puts forward suggestions for strengthening reported energy-saving practices among frontline pilots. This endeavor aims to inspire each frontline pilot to continually heighten their sense of responsibility and mission regarding low-carbon and green development and contribute to the sustainable development of their enterprises.

1.2 Research Objectives

This study examines the association between energy-saving awareness and stated energy-saving behavior among frontline pilots in China's civil aviation sector. It also explores the patterns,

characteristics, and factors associated with pilots' stated energy-saving behavior. Starting from the operational context of frontline pilots in China's civil aviation, this study systematically examines the association between pilots' energy-saving awareness and their stated energy-saving behavior within the framework of Social Cognitive Theory. Existing research suggests that awareness alone does not automatically translate into behavior, and that intention and contextual factors often mediate or moderate this relationship (Ajzen, 1991; Stern, 2000). However, few empirical studies have explored these mechanisms among aviation professionals, whose operational decisions have direct and measurable impacts on fuel consumption and carbon emissions. To address this research gap, the present study develops a conceptual model that integrates psychological and situational dimensions of pilots' energy-saving behavior, building on theoretical foundations from the Theory of Planned Behavior (TPB) and the Value-Belief-Norm (VBN) model. The model hypothesizes that energy-saving awareness is associated with stated behavior both directly and indirectly through energy-saving intention, and that this relationship is further shaped by individual psychological factors (e.g., self-efficacy and personal norms) and external situational factors (e.g., organizational culture, policy incentives, and operational subcultures). Using a standardized empirical approach, this research combines quantitative survey methods and statistical modeling techniques to examine the proposed associations among awareness, intention, psychological factors, situational factors, and stated behavioral outcomes. By doing so, the study not only establishes a theoretically grounded link between awareness, intention, and stated behavior but also contributes to filling the empirical gap in existing aviation sustainability research by demonstrating how these variables are statistically related to pilots' pro-environmental decision-making patterns. By identifying these associations, this study provides a theoretical basis and practical reference for governments, companies, and organizations to guide pilots' reported

energy-saving practices and support the green transformation of civil aviation under the Dual Carbon context. Therefore, the main research objectives of this paper are as follows:

Firstly, to integrate insights from disciplines such as social psychology and behavioral science, and to adopt a Social Cognitive Theory perspective as the main framework, while using the Theory of Planned Behavior, the Value-Belief-Norm framework, and related behavioral perspectives in a supporting role, to examine how energy-saving awareness, intention and stated behaviors are associated among frontline pilots in Chinese civil aviation. This includes identifying key psychological, organizational, and situational factors that are associated with the link between awareness and stated energy-saving behavior.

Secondly, to assess the current state of energy-saving awareness and stated energy-saving behaviors among frontline pilots in Chinese civil aviation. This will be achieved through a questionnaire designed to gather information about stated energy-saving behaviors and energy-saving awareness among frontline pilots. The study aims to determine the extent to which energy-saving awareness is associated with stated energy-saving behavior. Based on the research outcomes, the study aims to provide relevant policy suggestions to guide the formulation and optimization of incentive policies related to self-reported energy-saving behaviors among frontline pilots in Chinese civil aviation.

1.3 Research Gap and Aim

Although previous studies have examined energy-saving behavior in households, office settings, and general enterprise contexts, limited attention has been given to frontline pilots in the civil aviation industry. Existing research on energy conservation has examined the roles of knowledge, values, norms and intention in households and workplaces. Research on pilots has also begun to address fuel-saving intentions, including the study of military pilots by Gaitan et al.

(2024). Less is known about how these relationships operate among frontline civil aviation pilots in China, whose opportunities to save fuel depend on organizational procedures and operational requirements. The unresolved question concerns both the relationship between awareness and intention and the conditions under which intention is associated with pilots' responses concerning energy-saving practices.

This study therefore aims to examine the relationships among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI) and the questionnaire-based indicator termed Stated Energy-Saving Behavior (SESB) among frontline pilots in Chinese civil aviation. It tests the indirect association through ESI and examines whether psychological factors moderate the ESA–ESI relationship and situational factors moderate the ESI–SESB relationship. The analysis concerns cross-sectional associations; it does not establish changes in operational behavior or fuel consumption.

1.4 Current State of Domestic and International Research

1.4.1 Current State of Research on Factors Influencing Energy-Saving Behavior

To identify factors associated with frontline pilots, this study first draws on current literature on energy-saving behavior, which has predominantly examined the general population (e.g., households and ordinary consumers). This provides a useful baseline framework for classifying relevant determinants before adapting them to the aviation operational context.

Demographic Factors. Demographic factors have long been studied as influencing environmental behavior. Previous research has mainly explored individual characteristics such as age, gender, education level, and occupation type, as well as family characteristics including household size, structure, property ownership type, and income level.

Sardianou (2007) found that older respondents were willing to adopt fewer energy conservation measures in a study of Greek households. Yet, some researchers argue that there is a significant positive correlation between age and pro-environmental behavior. For instance, Poortinga found in a study of urban residents in the Netherlands that residents aged 65 and above prefer behavior-based energy-saving, while those aged 20-39 and 40-64 prefer technology-based energy-saving. Furthermore, the younger the age group, the higher the acceptance of technology-based energy-saving (Poortinga, Steg, Vlek, & Wiersma, 2003). Chinese scholar Hua Jian (2013) suggests that older individuals are more inclined to engage in energy-saving behaviors (Hua et al., 2013). Xie et al. (2013) proposed that residents aged 55 and above demonstrate better energy-saving behaviors than those in other age groups. Recent research also indicates that individuals in higher age groups are more likely to engage in energy-saving behaviors (Casaló & Escario, 2018; Patel et al., 2017). Researchers have found that the relationship between age and environmental behavior follows a non-linear, inverted U-shaped pattern. Zhu Hongge and Tong Lizhi demonstrated through analysis of variance that residents between the ages of 30 and 44 show the highest willingness to pay for ecological consumption, while those below 29 and above 45 exhibit slightly lower willingness to pay for ecological consumption (Zhu & Tong, 2009). Belaïd and Garcia categorized their research sample into four age groups, revealing that energy-saving potential follows an inverted U-shaped distribution with age. In other words, middle-aged individuals tend to be more energy-efficient. The explanation for this inverted U-shaped pattern may partly relate to household composition. However, an explanation based on having children is valid only for studies that do not control for the number (or age) of children in the household, because the observed age effect may otherwise reflect differences in household structure rather than age per se. In such cases, younger parents with children may prioritize comfort-related

behaviors that increase energy use, resulting in fewer energy-saving actions. As children grow up, household routines may change and parents may become more inclined to adopt environmentally friendly practices. In later life stages, preferences for comfort may increase again, which may be associated with a decline in energy-saving behaviors (Belaïd & Garcia, 2016).

Regarding gender, most existing studies suggest that gender has no significant effect on low-carbon consumption behavior (Shi, 2015). However, some studies show that women are more concerned with environmentally friendly behavior, although such behavior is shaped by many factors. Because men and women differ in social roles and lifestyles, gender affects these factors to some extent (Vicente-Molina, Fernández-Sainz, & Izagirre-Olaizola, 2018). Empirical research by Thøgersen et al. (as cited in Webb, 2010) also shows that gender has a significant effect on energy-saving behavior. Compared with age, gender may better explain such patterns of energy use (Bélaïd & Garcia, 2016; Piao & Managi, 2023; Eakins et al., 2025). Women are more likely to engage actively in energy-saving behavior and may also encourage men to follow similar practices. Gong Wenjuan (2008) argues that women participate less than men in pro-environmental behavior in public spaces. Cheng Chao (2014), in a study of residents in Beijing, Shanghai, and Guangzhou, found that gender and other control variables have only a limited effect on energy-saving behavior.

In terms of education level, some researchers contend that individuals with higher education possess more extensive environmental knowledge. There is a strong association between environmental knowledge and the adoption of pro-environmental behavior techniques and practices. In other words, education level has a significant positive influence on the adoption and implementation of energy-saving technologies (Nair et al., 2010; Mills & Schleich, 2012). Empirical findings by Poortinga (2003) indicate that residents with higher levels of education tend

to prefer energy-saving measures. Individuals with higher levels of education are more inclined towards technology-based energy-saving, while those with lower levels of education prefer behavior-based energy-saving (Poortinga et al., 2003). However, some scholars have challenged the relationship between education level and environmental behavior. Their research suggests that an increase in residents' education level may improve their access to social resources, social status, and income levels. In such cases, they are more likely to adopt luxurious lifestyles, which can lead to increased consumption of commodities such as cars and higher energy consumption in terms of fuel, electricity, and natural gas (Paco & Lavrador, 2017).

Regarding household characteristics, Trotta (2018) found that income and dwelling type relate differently to routine energy-saving behaviors and energy-efficiency investments. Liang found, based on survey research, that homeowners show greater willingness than tenants to pay for energy-efficiency projects (Liang et al., 2017). Whereas Shi (2016) argues that higher income levels are associated with weaker and less proactive energy-saving behavior. Trotta (2018), based on a survey of British households, found that investment in energy-saving renovations is driven by income level. Compared with low-income households, middle- and high-income households are less likely to achieve energy savings through daily activities but are more likely to invest in energy-related facilities and equipment.

Regarding the impact of family structure on energy-saving behavior, some studies suggest a positive correlation between the number of children in a family and the energy-saving behavior of family members. The relationship between family structure and energy-saving behavior seems to be context-dependent. While some studies suggest that families with children may be more likely to adopt visible environmentally friendly behaviors to set a positive example for their offspring (Poortinga et al., 2003; Casaló & Escario, 2018), other research indicates that younger

parents often prioritize household comfort, especially when children are small, which can lead to higher energy use and fewer energy-saving actions (Bélaïd & Garcia, 2016). These contrasting tendencies may help explain the mixed empirical evidence and the observed inverted U-shaped relationship between age and energy-saving behavior, depending on whether household composition variables—such as the number and age of children—are controlled. Research of Parker and Scott indicates that the presence of children under the age of 12 can increase the energy-saving behavior of family members. However, if there are elderly people aged 65 and above in the family, the family's energy-saving index may decrease. Parker noted in the study that families with children and high-income levels have significantly higher energy consumption than other types of families (Parker et al., 2005). Sardanou's research suggests that families with a larger number of members tend to adopt energy-saving measures (Sardanou, 2007). Black pointed out that homeownership is the most important factor influencing residents to take energy-saving measures. Renters typically engage less in home energy efficiency improvements and mostly reduce energy use by changing their behavior (Black et al., 1985). However, Ndiaye indicated that homeownership is also a decisive factor in indirect energy-saving behaviors, such as deciding whether to invest in energy efficiency. Still, its impact on other more direct energy-saving measures is weaker (Ndiaye & Gabriel, 2011).

In summary, existing literature presents divergent conclusions regarding the differentiation of household energy-saving behavior based on demographic factors. There is no conclusive evidence about the impact of demographic factors on behavior. Thus, further investigation is required to uncover the mechanisms through which demographic factors influence energy-saving behavior under different circumstances.

Psychological Factors. Psychological factors refer to emotional and motivational processes that affect how individuals understand information, form intentions, and make decisions (Steg & Vlek, 2009; Carrus et al., 2021). In research on energy-saving behavior, these factors are often examined within broader frameworks in social and environmental psychology, such as the Theory of Planned Behavior (TPB) and related approaches. These frameworks explain how beliefs, norms, values, and awareness shape both behavioral intentions and actual behavior. For example, TPB explains behavior through attitudes toward the behavior, perceived social pressure, and perceived behavioral control, and suggests that internal psychological processes influence how cognition is translated into action. TPB has been widely used in studies of energy-saving behavior and has been shown to explain a substantial share of variation in energy-saving intentions and behavior across different settings (Liu et al., 2020; Greaves et al., 2013).

Knowledge is a foundational psychological construct that represents an individual's understanding of energy issues, relevant technologies, and the consequences of different behaviors. It shapes how people evaluate the costs and benefits of engaging in energy-saving actions and underlies more complex beliefs and attitudes (Bishoge et al., 2021). Research shows that energy efficiency knowledge correlates positively with energy-saving attitudes, although its direct effect on behavior can be mediated by other factors such as perceived efficacy and social norms. In many models, knowledge provides the cognitive basis for recognizing the importance of energy conservation and motivates deliberate decision-making.

Awareness refers to an individual's recognition and understanding of environmental problems and the consequences of their own energy use. Awareness is considered a key cognitive precursor to attitude formation and intention development. Meta-analyses in environmental psychology have found that awareness of the consequences of one's behavior and beliefs about

climate change are consistently associated with energy-saving intentions, even though the strength of these associations can vary depending on behavior measurement and context (Carrus et al., 2021). Awareness interacts with other psychological determinants—such as attitudes and perceived control—to influence decision making, making it a core dimension in theories of pro-environmental behavior.

Values are stable beliefs about what is important or desirable, and they provide a basic motive for behavior. Eco-centric values, which place greater importance on environmental protection and collective welfare, have been found to promote energy-saving behavior by shaping attitudes and personal norms (Carrus et al., 2021; Piao & Managi, 2023). For example, people who value universalism or global citizenship are usually more willing to adopt conservation practices than those who place greater value on self-interest or material success. In psychological models, values are treated as major drivers that affect how people evaluate energy-saving behavior and how pro-environmental intentions are formed.

Intention refers to an individual's psychological willingness and determination to carry out a certain action. According to Ajzen's Theory of Planned Behavior (TPB) (Ajzen, 1991), behavioral intention is the most direct antecedent of behavior and mediates the effects of attitudes, norms, and perceived behavioral control. In this dissertation, however, the behavioral outcome is treated as stated or self-reported behavior rather than directly observed behavior. For this reason, the gap between behavioral intention and actual action needs to be clarified, as it has been a central issue in research on pro-environmental behavior. Jacobs et al. (2018) argued that in some situations, individuals place their own needs first and act in self-interested ways, which reduces the likelihood of prosocial behavior even when prosocial intentions are present. This pattern is especially clear in the field of environmental sustainability, where people may intend to save energy or adopt

greener technologies but fail to do so because of personal or situational constraints. Recent studies have examined this intention–behavior gap in more detail. They show that even when individuals report strong pro-environmental or energy-saving intentions, factors such as price, convenience, information frictions, and perceived effort may weaken the move from intention to reported behavior (Sheeran & Webb, 2016; Piao & Managi, 2023). Guo Yuenan et al. (2018) further pointed out that difficulty in obtaining relevant information or dealing with complex environmental policies can widen this gap, because individuals may not know how to put their intentions into practice. The intention–behavior gap is therefore shaped by both individual psychological factors and external situational barriers, including limited access to resources, knowledge, and technology. These findings highlight the need for targeted interventions that address both informational and psychological barriers, so that individuals can move from environmental intention to concrete behavior. This is particularly important in sectors such as civil aviation, where operational constraints and decision-making complexity may limit the effect of energy-saving measures.

All of the aforementioned factors are integrated within psychological theories that explain how internal mental processes guide energy-saving decisions. TPB and related models conceptualize these constructs as cognitive antecedents that shape intention formation, while other perspectives such as the Value–Belief–Norm framework tie values and awareness more directly to personal moral commitments and subsequent action. Meta-analytic evidence shows that psychological constructs are often more predictive of energy-saving behavior than demographic variables alone, highlighting the need to examine motivational processes when studying pro-environmental behaviors in specific populations, such as frontline pilots.

As individuals are the recipients of public policies, energy-saving behavior stimulated by external aspects, such as policy, information, and pricing incentives, may not persist if the above-

mentioned psychological conditions for behavior implementation are absent. Hence, when studying energy-saving and environmentally friendly behavior within the context of households, focusing solely on external factors is insufficient. Researchers need to delve deeper into the realm of human psychology. Therefore, applying social psychology research paradigms to the study of energy-saving behavior can better explore the necessary conditions for sustained implementation of energy-saving behavior and how to formulate more targeted energy policies.

In a study of Beijing residents, Wang et al. (2014) found that energy knowledge was indirectly associated with energy-saving intention through environmental attitudes. Other studies in China have also examined the relationship between energy-saving knowledge, intention and behavior. Their findings show that energy-saving knowledge is a key factor in shaping energy-saving intentions, and energy-saving behavior is closely related to such intentions. In other words, environmental knowledge can significantly promote the transformation of residents' environmental awareness into actual environmental behavior (Yue, 2014; He & Xu, 2017; Xi & Teng, 2017).

Concerning environmental values, most studies both domestically and internationally believe that values play a promoting role in energy-saving behavior. Hua Jian (2013) believes that urban residents' values indirectly influence energy-saving behavior through their willingness to engage in low-carbon consumption. Shi Hongjing's (2016) study asserts that values have a positive impact on residents adopting low-carbon energy-saving behavior. Regarding the study of energy-saving behavior among corporate employees, Li Wenjie suggests that environmental values not only have a significant impact on employees' complete environmental behavior but also exert an important influence on the latter through the mediating variable of environmental attitudes (Li et al., 2016). Shi et al. (2019) conducted a survey and research on 234 college students in Beijing

using the VBN model and structural equation model. They concluded that values significantly affect energy-saving beliefs, and values indirectly affect individual energy-saving norms through energy-saving beliefs. Zhang Yizhi's study on the impact of rural residents' values on energy-saving behavior concluded that the impact is positive (Zhang et al., 2020). The results showed that different environmental values play a moderating role between consumer thinking decision-making styles and willingness to engage in green behavior (Meng et al., 2020).

In the context of energy-saving awareness, "awareness" refers to the psychological process through which individuals receive, understand, and process information about energy conservation. Energy-saving awareness includes several cognitive and attitudinal dimensions that together affect individuals' motivation and decision-making in relation to sustainable energy use. It includes awareness of energy-conservation measures, namely an understanding of the necessity and importance of saving energy (Steg & Vlek, 2009); beliefs about energy-saving behavior, that is, knowledge of which actions or technologies can effectively reduce energy use and what environmental and economic effects they may produce (Steg & Vlek, 2009; Zhang et al., 2020); attitudes toward energy conservation, meaning whether individuals see energy conservation as a valuable and achievable goal and whether they are willing to make related behavioral choices or devote personal effort to it (Liu et al., 2020; Carrus et al., 2021); and knowledge related to energy use, such as knowing how to reduce energy consumption in daily operations or understanding how energy-efficient technologies contribute to environmental protection and cost reduction (Bishoge et al., 2021; Stikvoort et al., 2018). In general, energy-saving awareness reflects how individuals perceive, understand, and internalize the idea of energy conservation. This, in turn, affects their intention to save energy and is related to their actual behavior in daily life (Piao & Managi, 2023; Carrus et al., 2021). Scholars have pointed out that higher awareness often leads to stronger pro-

environmental attitudes and intentions and therefore forms an important psychological basis for behavioral change (Steg & Vlek, 2009; Liu et al., 2020).

Regarding energy-saving awareness, Carlsson-Kanyama et al. studied the energy-related behavior of 600 Swedish households, including laundry, dishwashing, and indoor temperature management (Carlsson-Kanyama et al., 2005). They found that even when residents had strong energy-saving awareness, this did not always lead to reported energy-saving behavior in practice, and that additional energy-saving knowledge could help improve this situation. Linda Steg (2008) also pointed out that norms and awareness of environmental problems play an important role in the acceptance of energy-saving policies. Cognitive bias in relation to energy use is an important barrier to residents' energy-saving behavior. Zhan et al. (2009) examined the factors affecting homebuyers' energy-saving behavior and identified attitude, discrimination, psychological expectation, and willingness to pay as internal factors. They found that most homebuyers had limited awareness of energy-saving buildings (Zhan et al., 2009). Energy-saving factors had not yet become a major criterion in home purchase decisions, which reflects a weak level of consumer awareness of energy conservation.

Situational factors. Situational factors refer to external contextual conditions, including social norms, incentive policies, and organizational culture, that may support or restrict the adoption of energy-saving behavior. Research by Stern (2000) and Guagnano et al. (1995) shows that contextual factors interact with individual intentions in shaping behavior. Through learning and imitation, individuals gradually form an awareness of social values and moral standards, which then affects their actions.

Before reviewing the findings on social norms, it is necessary to clarify the difference between social norms and subjective norms. The two concepts are closely related, but they differ

in psychological focus and level of abstraction. Both describe the social influence on behavior, but they come from different theoretical traditions. Social norms refer broadly to the shared expectations within a social group or society about what kinds of behavior are appropriate or common. They can be divided into injunctive norms, which refer to what people believe should be done, and descriptive norms, which refer to what people actually do (Cialdini, Reno, & Kallgren, 1990). Social norms exist outside the individual and represent collective standards of behavior. They can influence behavior through conformity, social approval, and the desire to avoid sanctions. For example, if energy-saving behavior is widely practiced or valued within an organization, individuals are more likely to adopt similar behavior in order to meet group expectations (Steg & Vlek, 2009).

By contrast, subjective norms come from the Theory of Planned Behavior (TPB) (Ajzen, 1991) and refer to an individual's perception of social pressure to perform or not perform a specific behavior. While social norms describe the group's expectations, subjective norms describe how strongly an individual feels those expectations personally. In TPB, subjective norms interact with attitudes and perceived behavioral control to shape behavioral intentions.

In short, social norms are collective concepts that describe the social environment, while subjective norms are individual perceptions of the pressure created by that environment. Both are important for explaining pro-environmental and energy-saving behavior, because together they affect whether awareness and intentions are turned into actual action (Steg & Vlek, 2009; Carrus et al., 2021).

In relation to social norms, existing studies show that they also affect energy-saving behavior, and that such normative expectations may come from family, friends, and wider society. Martinsson suggested that people's behavioral tendencies are related to their beliefs about how

others behave (Nilsson, Hansla, Heiling, Bergstad, & Martinsson, 2016). First, when people believe that their neighbors can recover the costs of energy-saving measures, this can encourage other neighbors who have not yet adopted such measures to do the same (Jorgensen et al., 2009; Nyborg et al., 2006). In addition, active participation in social networks, such as a high level of social integration, also has a positive effect on the acceptance of energy-saving behavior (Barr et al., 2005). People who often discuss energy-saving measures with neighbors and friends are more likely to save energy (Ek & Söderholm, 2010). Sorkun's empirical study of household recycling behavior found that social norms are a strong predictor of recycling behavior, and that their effect is moderated by perceived behavioral control (Sorkun, 2018). Based on the extended value-belief-norm theory, Shi and Zhang found a significant positive relationship between social norms and farmers' adoption of green production behavior (Shi & Zhang, 2020).

With regard to incentive policies and organizational culture, a mixed subsidy mechanism based on government-enterprise balance has been proposed, and research suggests that it can effectively reduce carbon emissions and save energy (State Council of the People's Republic of China, 2022). Based on a survey of 470 residents in Fuzhou, Shi Hongjing suggested that different policies have different effects on energy-saving behavior, and that the best results depend on their interaction with factors such as values and conformity psychology (Shi, 2016). Teng Yuhua et al. found that subsidy policies have a significant positive effect on farmers' purchase and use of clean energy (Xi & Teng, 2017). Xiang Nan et al. studied residents' electricity consumption behavior through economic interventions and found that economic measures are the most effective way to encourage residents to take part in energy-saving behavior (Xiang & Xu, 2017). Beyond policy measures, Mi et al. (2016) examined psychological motivations for low-carbon energy consumption among urban residents in Xuzhou, China, and found that the number of policies

related to residential energy conservation and their effectiveness were positively related, although with clear fluctuations.

As for environmental atmosphere, Handgraaf et al. (2013) found that long-term motivation for employees' energy-saving behavior comes more from social incentives than from monetary incentives. Organizational atmosphere reflects the social incentives within an organization. Zhang et al. (2013) found through empirical research that the energy-saving atmosphere within an organization directly affects employees' intentions and behaviors related to energy conservation. Zhang Yixiang (2012), focusing on knowledge workers in office buildings, proposed that an organizational energy-saving atmosphere has a positive effect on employees' intentions to engage in energy-saving behavior (Zhang Yixiang, Guo Xusheng, & Wang Zhaohua, 2013). This is relevant to the study of how the energy-saving atmosphere in business organizations affects employees' energy-saving behavior and intentions (Lu et al., 2019).

1.4.2 Current State of Research on Energy-Saving Behavior Models

Under the domain of energy conservation behavior models, scholars have developed various theoretical models based on different theories, including the Theory of Planned Behavior (TPB), Norm Activation Theory, and the ABC model (Attitude-Behavior-Context).

The Theory of Planned Behavior (TPB), proposed by psychologist Icek Ajzen, aims to explain and predict the occurrence of individual behavior. The theory posits that an individual's behavioral intention is the most direct factor that determines whether a behavior is likely to occur, and that behavioral intention is influenced by three major factors: the individual's attitude (positive or negative evaluation of a behavior), subjective norms (the individual's perceived expectations of others and social pressure on the behavior), and perceived behavioral control (the individual's confidence and sense of control over whether the behavior can be successfully performed). TPB

emphasizes that when individuals have a positive attitude towards a behavior, perceive support from others, and believe that they have the ability to perform the behavior, they are more likely to form a strong behavioral intention. In this study, TPB is used in a supporting role to explain how intention is formed, whereas the dissertation as a whole is grounded mainly in social cognitive theory, which allows broader attention to the reciprocal relationships among cognition, environment, and behavior.

The Norm Activation Theory is a commonly used theoretical model for studying energy-saving behavior. This theory states that individuals' internal moral norms, and its three variables (consequence awareness, responsibility attribution, and personal norm) can be classified as internal factors. Wittenberg et al. used an adapted Norm Activation Theory model to examine the impact of environmental motivation, psychological factors, technology, and costs on self-reported energy-saving behavior in solar households, finding that the theory is suitable for explaining energy-saving behavior in solar households (Wittenberg et al., 2018). Song et al., building on the Norm Activation Theory, added factors such as environmental concern, perceived consumer efficacy, conformity mentality, and policy promotion to study urban residents' consumption of energy-efficient appliances (Song et al., 2019).

In recent years, there has been an increasing focus on studying energy-saving behavior based on the attitude behavior context (ABC) model, which incorporates contextual factors with behavior theory models. In the study of energy-saving behavior based on the ABC model contextual factors refer to a large variety of external influences that can affect one's behavior (Guagnano et al., 1995; Stern et al., 1999). Contextual factors can include the following points: First, the social norms and cultural background in which the individual lives, the general environmental protection concept and cultural identity in the society, such as the green policies of

the national or local government, environmental protection advocacy in public activities, and support for energy-saving behavior by social groups. For example, in a community that advocates green living, residents may be more inclined to take energy-saving measures. Secondly, economic factors such as the price of energy-saving equipment and energy prices affect whether individuals are willing to take energy-saving behaviors. For example, rising electricity prices may encourage households or businesses to take more effective energy-saving measures. Thirdly, the advocacy of relevant policies and regulations, that is, energy-saving policies, incentives or regulatory requirements issued by the government. For example, the government provides subsidies for high-efficiency energy-saving home appliances or imposes emission restrictions on industries with high energy consumption. These policies will directly affect the energy-saving behavior of individuals and enterprises. In addition, with the development of digitization, the emergence of intelligent automation products has also deeply affected the energy-saving behavior of individuals. For example, smart home technology can help residents manage and reduce energy consumption more conveniently, or the convenience of public transportation systems has prompted more people to choose public transportation instead of private cars. Finally, the dissemination and popularization of information at the social level also play a vital role in energy-saving behavior. For example, the media and public sector spread energy-saving knowledge, or the mutual support and advocacy of families and neighbors can promote the implementation of energy-saving behavior. These factors usually exceed the individual's own cognition and willingness, but to a large extent determine whether the individual can put energy-saving behavior into practice. Together with the individual's attitude, behavioral intention and perceived control, they all affect whether the individual implements his energy-saving behavior.

Based on the ABC theory, sociologists investigated the correlation between attitude factors (energy-saving beliefs) and background factors (group norms and organizational support) with employees' willingness to save energy (Xu et al., 2017). Other research studied the impact of Psychological Factors (self-efficacy, personal attitude and so on) and policy factors (mandatory policies, economic incentive policies, and information guidance policies) on individual behaviors to reduce PM2.5, building on the ABC theory (Shi et al., 2019).

Simultaneously, more researchers are adopting a theory integration perspective for its strong explanatory power in understanding energy-saving behavior. Guo et al. emphasized that no single theory could explain all environmental behaviors, and each theory has its limitations. They suggested that combining multiple theories can compensate for these limitations (Guo et al., 2018). For example, in the context of volunteer tourism, Meng et al. (2020) integrated TPB with the Norm Activation Model. Shi Zhiheng and Zhang Heng, based on the extended Value-Belief-Norm theory, investigated farmers' green production behavior, revealing a significant positive correlation between social norms and farmers' adoption of green production behavior (Shi & Zhang, 2020). Chen Lishun, using a comprehensive model that included individual, family, and environmental factors based on the Theory of Planned Behavior, the Value-Belief-Norm theory, and the ABC theory, identified various factors influencing and affecting residents' energy consumption behaviors (Chen, 2009). Liu Nannan, considering individual characteristics, sociological learning factors, and habit factors as influencing factors, established a comprehensive model of influencing factors on urban residents' low-carbon consumption behavior. Through a questionnaire of urban residents in different cities in Shandong Province and using standardized empirical research methods, the study validated the mechanism and path relationships of the main factors influencing urban residents' low-carbon consumption behavior (Liu, 2013).

1.4.3 Current State of Research on Enterprise Employees' Energy Saving Behavior

In recent years, with the deepening of research on energy-saving behavior, scholars have turned their attention to the energy-saving behavior of employees in organizations. This paper reviews the literature on the energy-saving behavior of employees in domestic and international enterprises, finding that most studies focus on both organizational and individual levels of energy-saving behavior and influencing factors.

At the organizational level of energy-saving behavior, researchers like Aragon-Correa, Sharma, and Moon categorize organizational energy-saving behavior into proactive behavior and responsive behavior (Aragón-Correa & Sharma, 2003; Moon, 2000). Wang Yulu, based on the willingness and degree of organizational involvement in energy-saving, divides organizational energy-saving behavior into proactive, preventive, and defensive behaviors (Wang & Jiang, 2012). Hong Shuai defines energy-saving as the most effective use of energy, categorizing it into direct and indirect energy-saving. Direct energy-saving involves using advanced production tools, technologies, and processes to achieve physical energy savings, while indirect energy-saving involves adjusting economic structures to achieve structural energy savings (Hong & Lv Rongsheng, 2015). Tino Langer et al. suggest that organizations should optimize energy efficiency by introducing advanced production technologies and equipment and adopting the most energy-efficient methods in production at the control, production management, and manufacturing levels to achieve energy-saving goals and enhance sustained competitiveness (Langer et al., 2014).

A review of relevant literature shows that scholars have conducted comprehensive research on the influencing factors of organizational energy-saving behavior. The research perspective has shifted from a static, single perspective to a dynamic, multi-perspective, and the research subjects have moved from macro to micro. The research methods have evolved from theoretical studies to

increasingly rich empirical research. Scholars have mainly studied the factors influencing organizational energy-saving from two aspects: internal and external. External pressures on organizations come from the government, the market, and the public, while internal pressures arise from the organization's economic performance, social responsibility, managerial awareness of energy-saving, among others. Regarding external factors, Zhu Dian et al. argue that as the main body of energy-saving, organizations' formation of energy-saving intentions and the implementation of energy-saving behavior are influenced by government energy-saving policy regulation and market demand (Zhu et al., 2013). Zhang Guoxing studies the game relationship between enterprises and the government in energy-saving from the perspective of government energy-saving subsidy policies. The study suggests that promoting enterprise energy-saving requires establishing comprehensive and multidimensional energy-saving assessment indicators and leveraging market, public, and third-party supervision, and consultation roles (Zhang et al., 2013). Jeffrey Drezner et al. study the energy policies implemented by various countries, finding that economic incentives are more effective than direct government regulation, and they suggest that future energy policy development should focus more on economic incentive measures (Drezner, 1999). Concerning internal factors, domestic and international scholars believe that internal factors within organizations are crucial drivers of organizational energy-saving behavior. Cooremans's research reveals that organizational resources, such as the organization's size, leader commitment, the number and quality of employees related to energy-saving, the soundness of the organizational energy-saving mechanism, and related management, all play a prominent role in promoting organizational energy-saving behavior (Cooremans, 2006). Qu Xiao believes that the traits of organizational managers, the size of the organization, and the level of technological development have a significant impact on the implementation of energy-saving behavior in

organizations. Therefore, enhancing the organization's independent innovation capability is crucial (Cao & Qu, 2014). Yan Jiatong et al. construct a three-party evolutionary game model involving high-energy-consuming enterprises, local governments, and the central government. Through numerical simulation, they explore the strategic choices of the three parties in energy-saving and carbon reduction work, finding that the use cost and carbon reduction efficiency of energy-saving technologies play a crucial role in whether enterprises choose to use energy-saving technologies (Yan et al., 2022).

At the individual level of energy-saving behavior, Greaves et al., focusing on 449 employees in a large media organization in the UK, empirically investigate the influencing factors of employees' willingness to engage in timely computer shutdown, use of video conferencing instead of travel, and recycling of office waste (Greaves et al., 2013). Dixon et al., using the Theory of Planned Behavior and employees' community awareness in the organization, study employees and students in a university in the United States, examining the factors influencing their engagement in energy-saving behaviors such as turning off lights, setting computers to sleep, and double-sided printing (Dixon et al., 2015). Zhang Yixiang et al. establish a theoretical model of employees' energy-saving habits and conduct empirical research on it (Zhang & Wang, 2012). M. J. Handgraaf et al., using employees in a Dutch company as research subjects, reward energy-saving employees with monetary or social rewards, with rewards given privately or publicly. A 13-week experiment shows that publicly awarded social rewards are more effective in stimulating employees' energy-saving behavior (Handgraaf et al., 2013). Zhang et al. (2013) examined electricity-saving habits among 211 office workers in northern China and found significant associations with personal norms, enjoyment, image and perceived harm. Buhl et al. propose that spontaneous environmental innovation behavior by ordinary employees in an organizational

environment can bring about environmental improvement. Research on innovative behavior within these environmentally friendly behaviors may provide a possible precedent for the study of innovative behavior in energy-saving (Bierwirth et al., 2017). Paille et al., using alumni from a university in Mexico as the sample, apply social exchange theory to study the impact of organizational support, psychological contract breach, and work attitudes on employees' environmental behavior in the workplace. The results show that organizational support for environmentally friendly behavior indirectly affects employees' environmentally friendly behavior through employees' organizational commitment (Paillé et al., 2014). By further summarizing the factors that promote and hinder employee energy-saving behavior, it is found that these factors mainly include consequence awareness, responsibility attribution, personal norms, energy-saving attitudes, subjective norms, perceived behavioral control, image, fun, perceived harm, etc. Lo et al. (2014) find that personal norms, energy-saving attitudes, subjective norms, perceived behavioral control, and habits are positively correlated with employees' energy-saving behavior in the workplace.

In conclusion, while these research studies provide insights and recommendations for promoting employee energy-saving behavior, most of the focus has been on habitual energy-saving behavior in office settings, neglecting the innovative energy-saving behavior of frontline employees in organizations (Lo et al., 2014).

1.4.4 Research Review

In summary, the current state of research on influencing factors of energy-saving behavior indicates that there are numerous driving factors, including demographic factors, psychological factors, and external contextual factors. Based on the research of energy-saving behavior models, scholars have constructed theoretical models considering various factors that influence energy-

saving behavior. Research has revealed that the mechanisms through which demographic factors, psychological factors, and external contextual factors influence energy-saving behavior are complex and vary across different research contexts such as daily life, electricity consumption, and waste recycling. However, there is limited research on energy-saving behavior among corporate employees, and studies focusing on social-cognitive mechanisms in such settings are even rarer.

Research on pilots is even more limited. One recent study by Gaitan et al. (2024) examined military cargo pilots' fuel-saving intentions using the Theory of Planned Behavior. The study found that pilots' intentions were related not only to their own attitudes, but also to social and organizational pressure. This finding is useful for the present study because pilots work in a highly regulated and safety-critical environment. In such a setting, energy-saving awareness, intention, and stated behavior are likely to be shaped not only by individual beliefs, but also by procedures, organizational norms, and operational limits.

In the past couple of years, the Chinese government has successively announced its commitment to Carbon Neutrality to the global community and has incorporated it into the 14th Five-Year Plan. This has given tangible significance to the realization of the theories of Carbon Peak and Carbon Neutrality. In light of these developments, numerous scholars have adopted a global perspective to interpret China's future path towards Carbon Neutrality and its implementation strategies. Zhang Yizhi (2020) investigated the impact of rural residents' values on low-carbon energy-saving behavior and found a positive effect. Xi Jiayao (2019) suggested that environmental knowledge significantly contributes to transforming residents' low-carbon energy-saving awareness into concrete environmental actions. Zhao et al. compared China with Europe and the United States, identifying key challenges China faces in the context of Carbon Neutrality:

carbon emissions have not yet reached their peak, the transitional phase from Carbon Peak to Carbon Neutrality is constrained, heavy dependence on low-energy-efficient fossil fuels, and insufficient energy-saving awareness among residents. Although these research contributions offer insights and recommendations for the study of energy-saving behavior, it is vital to investigate energy-saving behavior and its influencing factors within the context of Carbon Neutrality (Liu et al., 2015).

This paper focuses on China's civil aviation industry and explores the factors associated with stated energy-saving behavior among frontline pilots under the Carbon Neutrality agenda. Because frontline pilots directly affect fuel use through operational decisions, they provide an important context in which to examine how energy-saving awareness is related to intention and reported behavior. This study uses a quantitative survey of frontline pilots. By examining the associations among frontline pilots' energy-saving awareness, intention, and stated behavior, and by proposing recommendations to strengthen energy-saving practice, this study seeks to contribute to greener development in civil aviation.

1.5 Research Questions

Before presenting the research questions, this study defines its key terms on the basis of the existing literature and adapts them to the context of energy-saving behavior among frontline pilots in China's civil aviation industry.

Energy-Saving Awareness (ESA). Energy-Saving Awareness (ESA) refers to an individual's cognitive understanding, environmental concern, and attitudinal recognition toward the importance of conserving energy and reducing emissions. It integrates both cognitive and affective dimensions of environmental consciousness (Steg & Vlek, 2009). In the aviation context, ESA denotes pilots' awareness of operational efficiency, ecological responsibility, and the

environmental implications of flight performance. In the conceptual framework developed for this study, ESA comprises three subdimensions – Energy-Saving Knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN) – representing knowledge, value-based, and normative orientations toward energy conservation.

Energy-Saving Intention (ESI). Energy-Saving Intention is defined as an individual's psychological willingness and determination to perform energy-conserving actions. According to Ajzen's Theory of Planned Behavior (TPB) (Ajzen, 1991), behavioral intention represents the immediate antecedent of behavior and mediates the effects of attitudes, norms, and perceived behavioral control. In this research, ESI reflects pilots' readiness to implement energy-efficient operational strategies—such as optimized flight procedures, reduced taxiing, and fuel-efficient climb profiles—demonstrating their motivational readiness for sustainable actions (Liu et al., 2021).

Stated Energy-Saving Behavior (SESB). It refers to the self-reported behavioral practices aimed at reducing energy consumption or improving efficiency (Steg & Vlek, 2009). Within the aviation setting, SESB encompasses pilots' self-reported operational practices that may contribute to lower fuel burn and reduced carbon emissions, such as accurate flight planning, adherence to eco-flying standards, and active participation in energy-saving initiatives. SESB serves as the dependent variable in this study, representing the stated behavioral manifestation of awareness and intention rather than directly observed operational behavior.

In this study, the behavioral data are treated as stated behavior, namely self-reported behavior collected through surveys rather than directly observed operational behavior. There are several limitations to relying on stated behavior: respondents may report behaviors that are seen as socially desirable or environmentally responsible but that do not fully match their actual

operational practice, especially on topics related to energy saving and environmental protection. In addition, stated energy-saving behavior may be constrained by resource limitations, time pressure, or situational factors and may not be fully converted into actual behavior. Due to current safety regulations and data-access limits in civil aviation, this dissertation focuses on stated or self-reported behavior as the most feasible behavioral indicator.

Psychological Factors (PF). Psychological Factors encompass internal cognitive and emotional characteristics, such as self-efficacy, moral responsibility, and personal standards, which shape the strength and persistence of behavioral motivation. Bandura (1997) emphasized that self-efficacy—the belief in one’s capability to organize and execute actions—is central to behavioral performance. In this study, PF moderates the relationship between ESA and ESI, determining whether awareness can effectively translate into behavioral commitment under varying psychological states (Deci & Ryan, 2000).

Situational Factors (SF). Situational Factors refer to external contextual variables, including policy frameworks, organizational culture, and social norms, that facilitate or constrain the realization of energy-saving behaviors. Consistent with Stern (2000) and Guagnano et al. (1995), contextual factors interact with individual intentions to produce behavior. Here, SF comprises Organizational Loyalty (OL), Policy Incentives (PI), and Energy-Saving Subculture (ESS), which collectively moderate the link between ESI and SESB by providing external reinforcement and structural support.

To examine how energy-saving awareness is associated with stated energy-saving behavior among frontline pilots in the context of carbon neutrality, this study formulates six research questions. These questions are grounded in the overall conceptual framework of this dissertation,

which draws mainly on social cognitive theory and is supported by the Theory of Planned Behavior (TPB), the Value-Belief-Norm (VBN) theory, and related behavioral approaches.

1. Is energy-saving awareness (ESA) positively associated with energy-saving intention (ESI) among frontline pilots?
2. Is energy-saving awareness (ESA) positively associated with stated energy-saving behavior (SESB)?
3. Is energy-saving intention (ESI) positively associated with stated energy-saving behavior (SESB)?
4. Does energy-saving intention (ESI) mediate the relationship between energy-saving awareness (ESA) and stated energy-saving behavior (SESB)?
5. Do psychological factors (PF) moderate the relationship between energy-saving awareness (ESA) and energy-saving intention (ESI)?
6. Do situational factors (SF) moderate the relationship between energy-saving intention (ESI) and stated energy-saving behavior (SESB)?

1.6 Scope of the Research

The scope of this research is defined by its focus on examining the psychological and contextual factors associated with stated energy-saving behavior among frontline pilots in China's civil aviation industry. In particular, the study investigates how Energy-Saving Awareness (ESA) relates to energy-saving intention (ESI) and Stated Energy-Saving Behavior (SESB), and how these relationships are further associated with Psychological Factors (PF) and Situational Factors (SF) within the broader context of China's carbon neutrality goals. The research takes an applied behavioral science perspective, combining environmental psychology, organizational behavior,

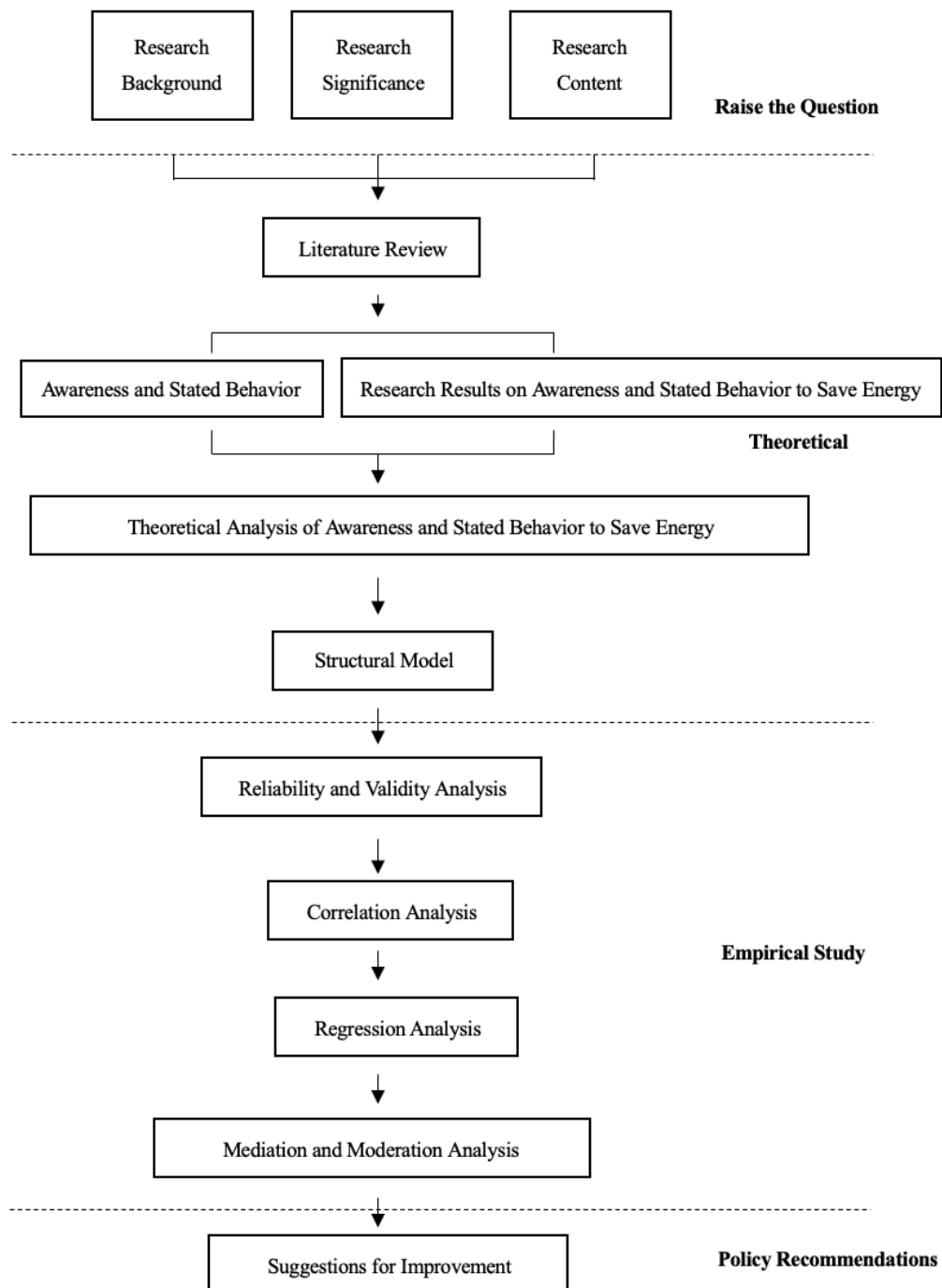
and aviation management to explore pilots' energy-saving decision-making from both individual and organizational dimensions.

The study focuses on commercial airline pilots who are directly responsible for flight operations and fuel consumption management. These individuals represent a critical group whose daily operational decisions have a direct impact on aviation energy efficiency and carbon emissions. Data were collected through structured questionnaires distributed among pilots from multiple Chinese airlines, ensuring representation across age, rank, experience, and educational background. The research employs quantitative methods, including descriptive statistics, reliability and validity testing, correlation analysis, regression modeling, and mediation–moderation analysis, to ensure empirical rigor and statistical robustness.

Geographically, the study is confined to China's civil aviation sector, which operates under strict regulatory and environmental policies aligned with the national carbon neutrality strategy. Temporally, the research focuses on the current operational context (post-2020), reflecting the evolving sustainability requirements of the industry. Conceptually, the study limits its analysis to psychological and situational determinants of energy-saving behavior, rather than technical or engineering-based interventions.

1.7 Framework of the Dissertation Structure

Figure 1 illustrates the overall structure of the dissertation, presenting the logical flow and interconnection among the five chapters. Each chapter builds upon the previous one, forming a coherent framework that moves from theoretical foundations to empirical findings and practical implications.

Figure 1*Framework of the Dissertation Structure*

Chapter 2. Research Objectives and Model Construction

2.1 Theoretical Foundation

Under the context of this study, energy saving is not purely a technical problem; it is fundamentally a behavioral decision problem. Individuals and organizations constantly make choices under constraints—limited information, time pressure, habits, social expectations, and perceived risks. This section therefore takes Social Cognitive Theory as the main theoretical basis of the study, while the Theory of Planned Behavior, the Value-Belief-Norm framework, and related behavioral perspectives are used in a supporting role to explain specific relationships in the model.

2.1.1 Social Cognitive Theory

The earlier form of social cognitive theory was social learning theory, which proposed two types of learning: direct learning, in which stimulus–response links are formed through reward and punishment, and observational learning, in which individuals learn by watching the behavior of role models. Compared with direct learning, Bandura (1978) argued that observational learning is more efficient. It involves four main processes: attention, retention, reproduction, and motivation. Through these processes, individuals adjust and refine their understanding through feedback and gradually turn knowledge into skilled practice. The influence of role models does not reduce creativity. Instead, individuals combine different traits drawn from different role models and, in this way, develop new patterns of behavior.

An important aspect of Social Cognitive Theory is the interaction between the environment, cognition, and behavior (Bandura, 1991). In response to environmental influences, individuals possess self-regulation mechanisms. These mechanisms encompass motivation, cognitive

processes, and emotional states, ultimately affecting self-directed behavior. For personal development, individuals engage in activities influenced by both natural and social environments. Operational environments can be categorized into three forms:

1. **Imposed Environment:** This environment is complex, encompassing opportunities, rewards, obstacles, and punishments. Objective facts in this environment occur regardless of individuals' attitudes.
2. **Selective Environment:** While the objective environment exists, its potential influence depends on specific actions. Individuals' choices activate only a portion of the potential environment, based on their preferences.
3. **Created Environment:** Individuals consciously shape the environment to achieve their goals.

Within these operational environments, individuals may display cognitive-explanatory behavior, choice-activating behavior, and constructive behavior, which reflect different ways of responding to and shaping the operative environment.

Cognitive-explanatory behavior refers to how individuals cognitively interpret operational outcomes and explain why they occur. It involves noticing relevant cues, attributing causes, and forming mental models about what factors drive performance. In the aviation energy-saving context, this may include pilots' explanations for observed fuel outcomes—e.g., attributing lower-than-expected fuel burn to effective speed/altitude management and adherence to fuel-efficient procedures, or attributing higher fuel burn to uncontrollable factors such as weather, ATC constraints, or aircraft loading. These explanations matter because they shape perceived controllability and expectations about whether energy-saving actions are worthwhile.

Choice-activating behavior refers to the decision processes through which individuals translate their interpretations into concrete choices among available options. It is “activating” in the sense that it triggers intention-driven selection of behaviors in real operational settings. For pilots, this includes choosing whether to apply specific fuel-saving practices when conditions permit—such as selecting fuel-efficient taxi techniques, adhering to optimized climb and cruise profiles, requesting more efficient routing/altitudes when feasible, or applying procedures that reduce unnecessary auxiliary power use. Importantly, these choices are shaped by perceived trade-offs (e.g., safety, time pressure, workload), perceived control, and organizational norms.

Constructive behavior refers to proactive actions that go beyond routine compliance by improving practices, learning, and contributing to organizational sustainability capability over time. It includes reflective learning and initiative-taking—such as sharing fuel-efficiency lessons learned with colleagues, proposing procedural refinements, participating in energy-saving training or feedback programs, and supporting an energy-saving subculture within the organization. In this sense, constructive behavior is oriented toward continuous improvement and institutionalization of energy-saving practices rather than one-off decisions. Guided by material and social stimuli, individuals self-evaluate, supervise their actions, and adjust their behavior based on self-evaluation results (Bandura, 2001).

Within ethical environments, moral behavior plays a significant role. Ethical behavior influences self-regulation once individuals establish moral standards. Generally, individuals are inclined to engage in actions that create a sense of achievement and value, while avoiding actions conflicting with their moral principles to prevent negative deviations from their original goals (Bandura, 1991). However, moral behavior also encompasses self-exempting actions. Through mechanisms like rationalization (presenting harmful behavior as beneficial), individuals absolve

themselves of moral responsibility to eliminate self-condemnation and preserve self-esteem. This self-exempting behavior occurs not only at an individual level but also at an organizational level, particularly when organizations prioritize their interests over others' well-being (Bandura, 2000).

As the foundational theory of this study, Social Cognitive Theory provides basic assumptions: individuals can self-regulate and control their behavior; awareness influences the generation and intensity of individual motivation; the environment affects individuals' self-efficacy, which, in turn, impacts behavior; and individuals can engage in observational learning, with role models playing a critical role.

Social Cognitive Theory (SCT) provides the primary theoretical foundation for this study by relating personal cognition to behavior and the environment in which it occurs (Bandura, 1991, 2001). This perspective supports examining pilots' energy-saving awareness alongside psychological factors and perceived organizational influences, rather than assuming that awareness alone explains their responses concerning energy-saving practices.

Household energy-saving research offers useful insights into awareness and motivation, but its application to aviation requires attention to differences in control over action. Household members often have discretion over routine energy use, although resources and shared decisions may constrain their choices. Pilots' actions depend on approved procedures, coordination with other operational personnel and the conditions of each flight. Energy-saving practices are therefore feasible only where they remain consistent with safety and operational requirements.

SCT also provides a basis for considering self-efficacy and environmental influences. Pilots may recognize the importance of energy conservation yet differ in their confidence and perceptions of organizational expectations. These differences motivate the examination of psychological and situational factors in the proposed model. The measured factors represent

selected personal and perceived organizational attributes; they do not cover all the operational conditions that may affect fuel-saving opportunities.

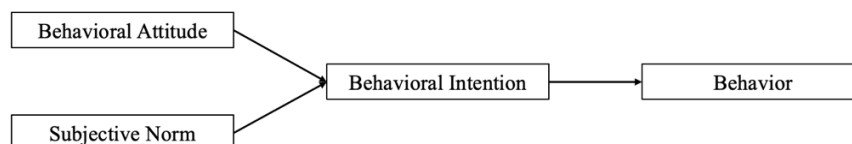
Although SCT describes reciprocal relationships among personal factors, environment and behavior, this study does not test those relationships over time. It uses SCT to guide the selection and interpretation of constructs within a cross-sectional model. TPB complements this framework by providing a specific rationale for the role of intention, as discussed in the following section.

2.1.2 Theory of Planned Behavior

The Theory of Planned Behavior (TPB), introduced by Ajzen, builds upon the Theory of Reasoned Action (TRA) and aims to predict and explain individual behavior (Wang et al., 2022). The TRA, proposed by Fishbein and Ajzen in 1975, analyzes how attitudes consciously influence behavior and predicts individual behavior based on behavioral intentions (Nickerson, 2025). The TRA asserts that an individual's behavior can be inferred from their behavioral intention, which is determined by their attitude toward the behavior and subjective norms, as depicted in Figure 2. Stronger behavioral intention towards a specific action indicates a higher likelihood of performing that action. The primary assumption of TRA is that individuals have complete control over their behavior. However, this assumption's limitations became evident as research progressed, especially when an individual's behavior decision is constrained by their skills, resources, or external circumstances. In such cases, the predictive power of the TRA is reduced.

Figure 2

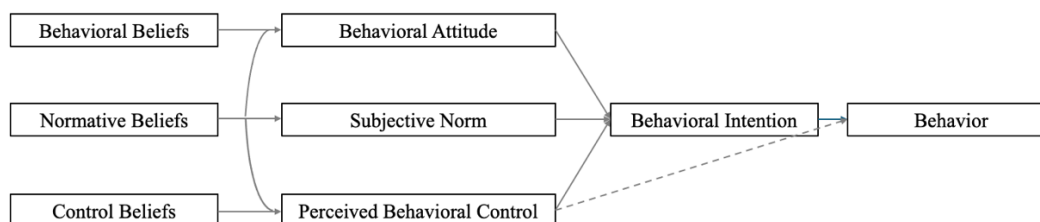
Theory of Reasoned Action Model



In later research, Ajzen further refined the theory to acknowledge that individuals' decision-making is not always purely rational. He introduced the concept of "Perceived Behavioral Control" to account for the influence of internal and external factors on an individual's perceived control over their behavior. Individuals may not always have complete control over their behavior due to the impact of internal and external environments and specific opportunities (Ajzen, 2015). Consequently, human behavior cannot be solely explained by rationality. The "Perceived Behavioral Control" concept complements the TRA by considering an individual's perceived ability to control a behavior and the perceived difficulty of that behavior (Ajzen, 2015; Beck & Ajzen, 1991; Godin & Kok, 1996; Heath & Gifford, 2002; Hsu & Huang, 2012; Paul et al., 2016; Randall & Gibson, 1991). It, along with attitude and subjective norms, forms behavioral intention and directly influences behavior. Behavioral intention serves as both a driving force for behavior and a cognitive reaction preceding behavior. Without a guiding behavioral intention, behavior is less likely to occur. This refinement led to the development of the Theory of Planned Behavior, as shown in Figure 3.

Figure 3

Theory of Planned Behavior Model



The Theory of Planned Behavior has found applications in various domains. In the realm of sustainability, it has been used to study decision-making intentions regarding waste sorting by project managers, highlighting the significant influence of attitude. In agriculture, it has been used to analyze the willingness of farmers to adopt soil conservation techniques, revealing differences in the impact of attitude and perceived behavioral control. The theory has also been applied in fields such as medicine, hotel management, project management, and education. Although TPB includes subjective norms and perceived behavioral control, a pilot's sense of control may differ from the discretion available during a flight. A pilot may intend to save fuel yet be unable to adopt a particular practice because of safety requirements, company procedures or air traffic control instructions. Applying TPB in this setting therefore requires attention to both perceived control and the conditions under which pilots can act.

The value of TPB for this study lies in its account of behavioral intention. Ajzen (1991) identifies intention as an immediate antecedent of behavior. This supports examining ESI as a possible link between ESA and SESB. However, ESA combines knowledge, values and subjective norms and is therefore not equivalent to attitude as defined in TPB. The proposed ESA–ESI–SESB pathway draws on the theory without reproducing its original structure. Nor does it imply that intention is the only possible link between awareness and the measured outcome.

In this study, TPB is used specifically to justify the role of intention within the broader SCT framework. The study does not test all TPB constructs and paths. Because the data were collected at one point in time, the mediation analysis estimates an indirect association but cannot establish that awareness developed before intention or that intention led to later operational behavior.

2.1.3 Attribution Theory

Attribution Theory is discussed here as a supporting perspective within the theoretical framework. Fritz Heider (1958) introduced the concept that the process by which individuals explain events is similar to the process of scientific research. Heider proposed that individuals use a logical and analytical approach to interpret events, with perceptions of causal relationships influencing their behavior (Li, 2011). Kelley (1973) extended this idea by proposing that three elements—the stimulus, the actor, and the context—help explain why the same person may or may not show the same behavior across situations. Here, the stimulus refers to the specific external trigger or target that elicits the behavior (e.g., an energy-saving policy message, a fuel-saving procedure, or a particular operational requirement). The actor refers to the individual who performs the behavior and their relatively stable characteristics (e.g., values, knowledge, habits, self-efficacy, and personal norms). The context refers to the situational conditions under which the behavior occurs (e.g., time pressure, organizational rules, available resources, peer expectations, and operational constraints). Depending on whether behavior varies mainly with the stimulus, the actor, or the context, individuals may respond consistently or differently to similar stimuli. Therefore, these factors influence the attribution process for individual behavior. Carson (2019) indicated that individuals attribute their behavior to external factors when distinctiveness, stability, and consistency are all high.

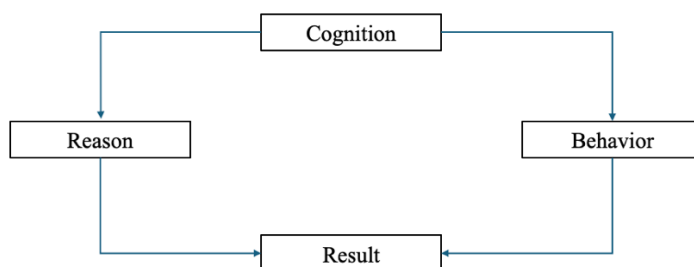
Attribution theory explains how individuals interpret events and assign causes to outcomes. It assumes that people are motivated to understand why things happen, and that these causal explanations influence subsequent attitudes, emotions, and behaviors. The Comprehensive Attribution Model proposed by Hu and Liu (2009) builds on this foundation by integrating both cognitive processes and behavioral feedback, forming a continuous loop that links Outcome →

Reason → Cognition → Behavior → Outcome (see Figure 4). In this loop, people first observe an outcome (e.g., higher or lower fuel consumption), seek reasons for it (e.g., weather, flight technique, or personal skill), update their cognitive understanding, and then adjust their subsequent behavior. This cyclical process illustrates that attribution is not a one-time judgment but an iterative cognitive mechanism that continuously shapes future decisions and actions.

Mapping this model to energy-saving behavior, attribution theory helps explain how pilots and other aviation professionals interpret the causes of energy outcomes and how these interpretations influence their subsequent choices. For instance, pilots who attribute efficient fuel performance to their own skill or effort (an internal, controllable attribution) may feel greater self-efficacy and become more motivated to maintain energy-saving practices. Conversely, those who attribute high fuel use to external, uncontrollable factors (e.g., weather or aircraft type) may perceive limited personal influence and thus show weaker behavioral engagement. Over time, these attribution patterns create feedback loops that reinforce or weaken energy-saving awareness and intention. Therefore, attribution theory offers a cognitive-behavioral explanation for how individuals' causal reasoning and perceived control determine whether energy-saving intentions translate into consistent operational behaviors.

Figure 4

Psychological Attribution Theory Model



2.1.4 Complementary Theories on Energy-Saving Behavior

Following the discussion on Theory of Planned Behavior (TPB) which clarifies how attitudes, subjective norms, and perceived behavioral control are associated with energy-saving intention and self-reported behavior, this section specifically examines the concept of Energy-Saving Behavior, analyzes two complementary theories related to the realm of Energy-Saving Behavior: (1) Value–Belief–Norm (VBN) framework in order to capture the role of underlying values and moral/personal norms in motivating conservation-oriented choices; and (2) Attitude–Behavior–Context (ABC) Theory perspective to account for how contextual and organizational conditions facilitate or constrain the translation of intention into behavior. These theories are selected because they share a common assumption that energy-saving behavior is not purely a technical issue but is shaped by a structured set of cognitive and motivational determinants (e.g., beliefs, norms, and perceived control) interacting with situational conditions. At the same time, they offer complementary explanatory strengths—TPB emphasizing intention formation, VBN emphasizing value-based and moral motivation, and ABC highlighting contextual enablement—making them particularly suitable for analyzing energy-saving behavior in an operational and organizational setting such as civil aviation.

1. Concept of Energy-Saving Behavior. In the 1980s, the World Energy Council defined energy-saving as measures that are technically feasible, economically reasonable, socially acceptable, and enhance energy utilization efficiency. Early energy-saving policies primarily focused on technological advancements to improve energy efficiency, aiming to achieve energy-saving goals. In recent years, scholars have placed greater emphasis on energy-saving management, including research on user behavior during the operational phase of buildings and operational

strategies (Central People's Government of the People's Republic of China, 2007), sparking a trend in energy-saving management.

Generally, energy-saving behavior refers to energy consumption behaviors undertaken to achieve energy conservation. To study energy-saving behavior, understanding energy consumption behavior is crucial. Energy consumption behavior can be classified into several categories. Based on the literature, the most common categories are investment behavior and habitual behavior. Investment behavior involves purchasing equipment with new technologies, while habitual behavior is reflexive and automatic actions undertaken without considering pros and cons. Additionally, Raaij and Verhallen categorized energy consumption behavior into purchasing, using, and maintaining behaviors. Purchasing behavior refers to buying appliances and devices, often involving one-time energy-saving investments. Using behavior involves the daily use of household appliances, and maintaining behavior relates to the maintenance and repair of devices (Van Raaij & Verhallen, 1983). Gardner and Stern categorized energy consumption behavior into efficiency behavior and conservation behavior. Efficiency behavior involves purchasing energy-efficient devices, such as using energy-efficient light bulbs, while conservation behavior involves actively reducing energy use, like lowering air conditioning temperature. Laitner and colleagues classified energy consumption behavior into comparative behavior (lower-cost actions), habitual behavior (habitual use of appliances), and purchase behavior (buying more energy-efficient products or devices) (Steg et al., 2005).

In the literature on energy-saving behavior, researchers often distinguish between different types of actions based on their nature and cost. One common classification divides energy-saving behavior into investment behavior and habitual behavior, covering both one-time decisions that involve financial cost and routine actions that are repeated in daily life (Yue et al., 2013; Perret et

al., 2022). Investment behavior refers to actions that require upfront spending on energy-efficient technologies, such as buying energy-efficient appliances, upgrading equipment, or adopting energy-saving infrastructure. These actions can reduce energy use indirectly by improving efficiency (Yue et al., 2013; Perret et al., 2022). Such decisions usually depend on financial resources, cost–benefit judgment, expected long-term savings, and the availability of relevant technology (Perret et al., 2022).

By contrast, habitual behavior refers to low-cost and repeated actions in daily life that people perform, often almost automatically, in order to reduce energy use. Examples include turning off lights when leaving a room, adjusting thermostat settings, and closing doors while using air conditioning (Yue et al., 2013). Because these behaviors usually do not require substantial financial cost, psychological and motivational factors, such as awareness, habit, and social norms, play a more important role in shaping them (Wang, 2018; Stikvoort et al., 2018). Habitual behaviors are often part of everyday routines and can become stable over time through repeated practice.

Some studies further include reduction behavior as a distinct category, referring to direct decreases in energy consumption through conscious curtailment of usage, such as shortening shower times, reducing vehicle use, or lowering heating in unoccupied spaces (Mi, 2016). These reduction actions emphasize behavioral restraint rather than technological upgrade and are shaped by individuals' perceptions of environmental impact and personal commitment to conservation goals.

Together, these three categories—investment, habitual, and reduction behaviors—provide a comprehensive framework for conceptualizing how individuals engage in energy saving. Investment behavior addresses technological and economic choices, habitual behavior captures

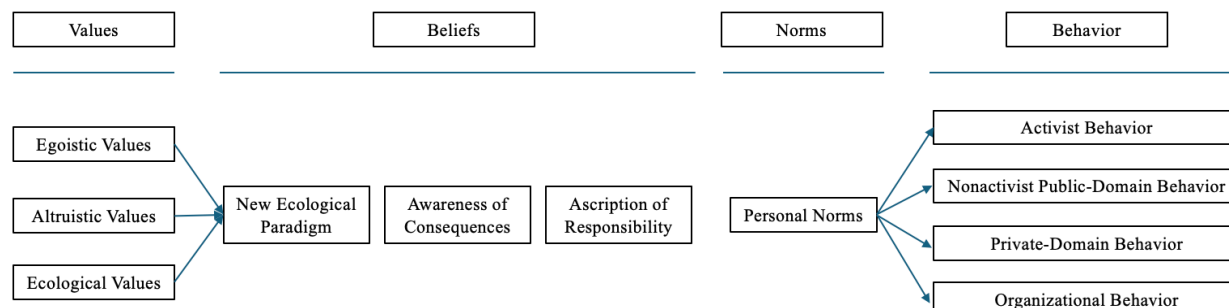
routine, psychologically driven practices, and reduction behavior reflects active choices to limit consumption. Understanding this spectrum is important for designing targeted interventions that address both structural and psychological determinants of energy-saving behavior (Abrahamse & Steg, 2009; Wang, 2018). Reduction behavior entails making choices that holistically minimize energy consumption, sometimes at the expense of personal comfort, such as setting the air conditioning temperature to 26°C in summer rather than keeping it at a cooler setpoint (e.g., 22–24°C) or reducing overall usage time. To explain why these different forms of energy-saving behavior (investment, reduction, and habitual practices) occur and persist, the following sections draw on several complementary theories from environmental and social psychology.

2. Behavioral Science Theory. Behavioral science holds that individual behavior is shaped more by people than by objects. Human beings are not driven by economic concerns alone; they are both rational and emotional (Tan & Bao, 2009). Behavior is also strongly affected by social and psychological factors, including needs, motivation, personality, preferences, and psychological mechanisms (Chen et al., 2014).

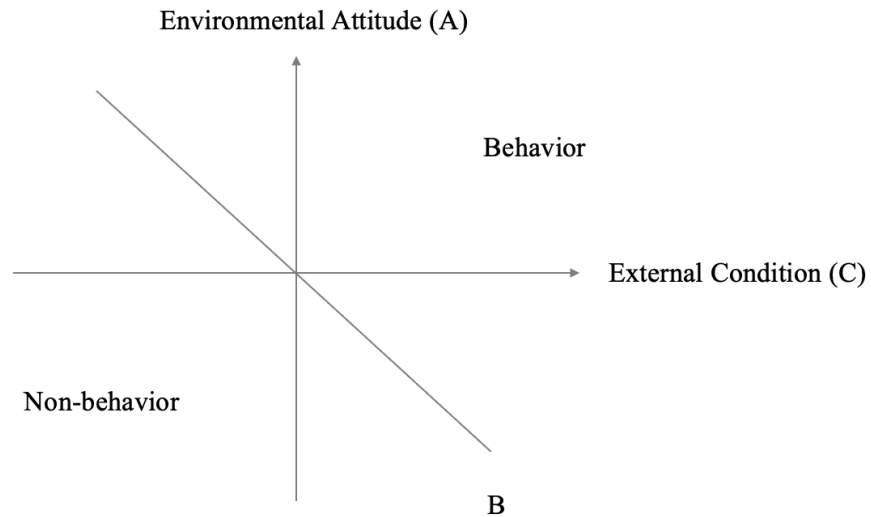
In research on public environmental behavior, Stern and his colleagues found that values influence the new ecological paradigm and affect environmental behavior through beliefs, personal norms, and other psychological variables. On this basis, they developed the Value-Belief-Norm (VBN) theory (Stern, 2000). The New Ecological Paradigm, proposed by Dunlap and Van Liere, describes the relationship between human beings and the natural environment and reflects general concern about the ecological effects of human development (Dunlap & Van Liere, 1978). Through empirical research, VBN theory identified three closely related types of individual values: egoistic, altruistic, and biospheric values. Egoistic values focus on personal benefit and self-interest, such as saving energy mainly to reduce personal cost or improve convenience. Altruistic values reflect

concern for the welfare of other people and society, such as saving energy to protect public health or reduce harm to others. Biospheric values reflect concern for nature and the environment itself, such as saving energy to reduce emissions and protect ecosystems, regardless of direct personal benefit. The theory provides a detailed explanation of how different values affect environmental behavior.

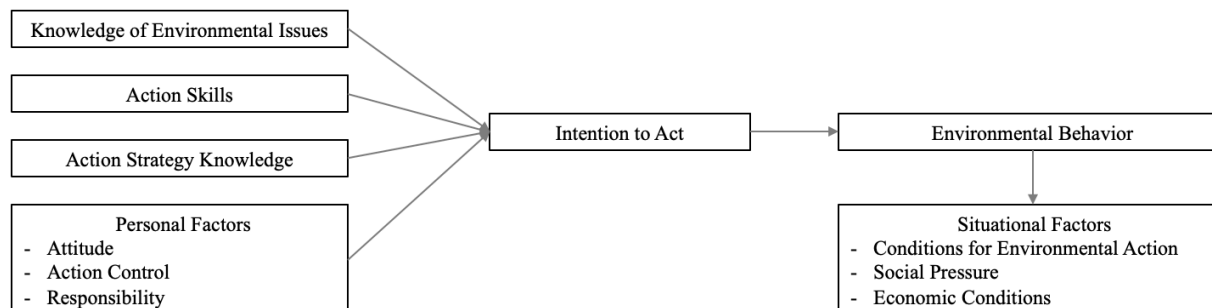
As shown in Figure 5, VBN theory explains environmental behavior through the environmental values, beliefs, and personal norms held by individuals. Egoistic, altruistic, and biospheric values shape the formation of the new ecological paradigm and further strengthen beliefs about environmental issues. These beliefs include awareness of the consequences of one's behavior and a sense of responsibility for environmental outcomes. Together, they help form personal norms and a sense of environmental responsibility, which then lead to proactive environmental behavior. Because individuals differ in their environmental values, and because values, beliefs, and norms continue to work together, environmental behavior also differs across individuals. Stern also pointed out that the paths of influence among these variables are not strictly linear. A variable may affect the next one directly, and it may also influence environmental behavior indirectly through later variables (Stern, 2000). In this way, VBN theory clearly distinguishes different types of environmental values and their roles, and it explains in detail how values, beliefs, and norms shape environmental behavior. It therefore offers a strong theoretical basis for research on environmental behavior.

Figure 5*Value—Belief—Norm Model*

3. Environmental Behavior Theory. Environmental behavior theory examines the reciprocal relationship between human behavior and environmental conditions, integrating perspectives from sociology, psychology, and behavioral science. Within this interdisciplinary field, Guagnano, Stern, and Dietz (1995) proposed the Attitude–Behavior–Context (ABC) theory, which is rooted in environmental sociology rather than experimental behavioral science. As illustrated in Figure 6, in this model, A represents environmental attitudes, B represents environmental behavior, and C represents contextual or situational conditions that can enable or constrain behavioral expression. The theory posits that environmental behavior results from the interaction between internal attitudes and external situational factors: when contextual conditions are favorable and attitudes are positive, pro-environmental behavior is likely to occur. Conversely, when external conditions are unfavorable and environmental attitudes are negative, environmental behavior does not occur. If environmental attitudes tend to be neutral, the occurrence of environmental behavior mainly depends on external conditions, and vice versa. Guagnano tested this model through a waste recycling experiment.

Figure 6*ABC Theory Model*

The Responsible Environmental Behavior (REB) model, as shown in Figure 7, was proposed by Hines in 1987 based on a synthesis and analysis of relevant environmental behavior literature. This model includes four antecedent variables: environmental issue knowledge, action skills, action strategy knowledge, and personality variables. Personality variables encompass attitudes, perceived control, and sense of responsibility. In alignment with the Theory of Planned Behavior, this theory posits that behavioral intention directly impacts actual environmental behavior, while action skills, personality variables, environmental issue knowledge, and action strategies primarily exert an indirect influence on environmental behavior through behavioral intention (Hines et al., 1987).

Figure 7*Responsible Environmental Behavior Model*

Furthermore, the primary factor driving environmental behavior is having a certain level of awareness of environmental issues. Secondary determinants include the individual's skill in implementing the behavior, relevant knowledge, and knowledge of behavior strategies. Alongside understanding environmental issues and possessing relevant behavior-related knowledge, individuals should also possess an intrinsic sense of responsibility, perceived behavior control, and environmental attitudes. When considering external circumstances and internal factors like personal responsibility, individuals will develop more concrete behavioral intentions, positively influencing the transformation from intention to behavior. However, this behavioral determination is not without risks, as various external changes such as economic constraints and social pressures can impact an individual's behavioral choices. This theory fills in some gaps in the Theory of Planned Behavior and confirms that social pressure and situational factors, such as the environment for implementing environmental behavior, are crucial external determinants of environmental behavior.

4. Behavioral Economics. In the 1970s, psychologists Kahneman and Tversky introduced relevant theories and research methods from cognitive psychology into economic research. Their major contributions lie in the proposal of Prospect Theory (Heukelom, 2007). Traditional

economics, with expected utility theory at its core, assumes that economic agents are rational, seeking utility maximization in economic activities. However, prospect theory suggests that under uncertain conditions, people's choices, judgments, and decisions are influenced by cognitive biases and errors, often deviating systematically from traditional economic theories, especially expected utility theory. Thus, prospect theory can be considered an effective correction to traditional economics, particularly in the field of decision-making under risk.

According to Prospect Theory, when individuals face uncertainty, their decision-making involves assessing different expectations or prospects. In prospect theory, choices are modeled through the processes of "editing" and "evaluation" (Heukelom, 2007): individuals edit prospects under the influence of different cognitive heuristics, and they typically evaluate the edited prospects under the influence of cognitive biases. Ultimately, after the processes of editing and evaluation, individuals make decisions. Both the "editing" and "evaluation" processes are influenced by the assumed value function and weighting function in prospect theory, causing deviations in decision-making.

When individuals face uncertainty, they need to balance expected gains and losses rather than certain levels of gains and losses when making decisions. Prospect Theory suggests that under uncertain conditions, individuals' assessments of the probabilities of events may differ from the actual probability distribution. Therefore, Kahneman and Tversky introduced a weighting function that expresses individuals' evaluation of uncertainty. They believed that individuals, when faced with uncertain outcomes, prefer certain results over uncertain ones.

In summary, Prospect Theory has three fundamental theoretical viewpoints: (1) People tend to avoid risks when gaining; (2) People tend to seek risks when facing losses; (3) Under uncertain conditions, what individuals perceive as gains and losses is relative to the reference point.

Prospect Theory laid the theoretical foundation for behavioral economics. Following Kahneman and Tversky, behavioral economists have further expanded the theory of behavioral economics from different perspectives on individual choices and judgments under uncertain conditions, proposing their theories and viewpoints. Major contributions include Rabin's behavioral game theory (Rabin, 1993) and Thaler's Mental Accounting Theory (Thaler, 1985).

In traditional game theory models, Rabin introduced factors such as fairness and reciprocity, which influence participants to base their behaviors on the choices of others. If the other party shows goodwill, the participant is likely to reciprocate with goodwill, demonstrating a cooperative state. If the other party makes a fair choice, the participant is likely to adopt a strategy that does not undermine fairness (Rabin, 1993).

Thaler, in "Mental Accounting and Consumer Choice", first introduced the concept of "mental accounting", revealing the non-substitutability of people's treatment of money and the psychological cognitive processes in investment decisions. Thaler argued that everyone has a mental accounting system that often influences decision-making in unexpected ways, leading individuals to deviate from rational economic principles (Thaler, 1985). Thaler listed four typical phenomena, elucidating how mental accounting departs from the core assumptions of expected utility theory.

In conclusion, behavioral economics focuses on the irrational behaviors of decision-makers and economic anomalies, explaining them effectively. It addresses the shortcomings of traditional economics in explaining the irrationality of human behavior and economic anomalies, modifies the core assumptions of expected utility theory about individuals having stable preferences and pursuing utility maximization, and provides a new perspective for explaining real decision-making behaviors and economic anomalies.

2.1.5 Theoretical integration

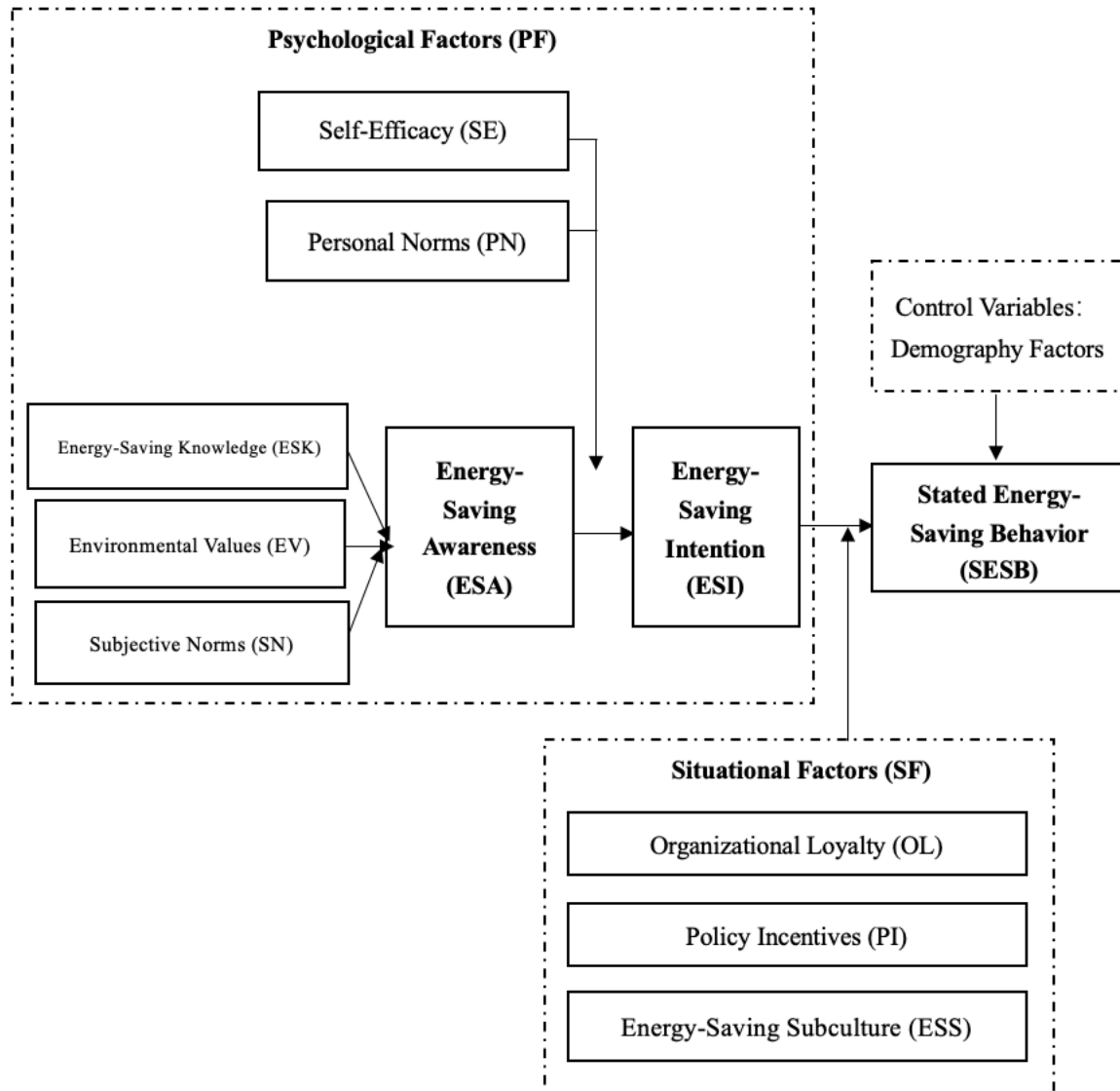
This study develops an integrated theoretical behavioral model to explain the relationships among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB) among frontline pilots in Chinese civil aviation enterprises. The research gap identified in Chapter 1 concerns how energy-saving awareness relates to intention and SESB among frontline pilots, and whether these relationships vary with psychological and organizational factors. Social Cognitive Theory (SCT) provides the overall framework for considering personal and environmental influences together. Theory of Planned Behavior (TPB) gives intention a specific role within this framework, supporting the proposed indirect relationship between ESA and SESB.

The remaining theoretical contributions concern the two moderators. Self-efficacy is drawn from SCT, while personal norms are informed by norm activation theory and the Value–Belief–Norm framework (Schwartz, 1977; Stern, 2000). Together, these concepts inform the hypothesis that the ESA–ESI relationship varies with psychological factors. The Attitude–Behavior–Context (ABC) model provides a basis for examining contextual variation in the ESI–SESB relationship (Guagnano et al., 1995). These moderating relationships are hypotheses developed for this study; they are not treated as established consequences of the source theories.

The model uses selected concepts rather than testing each theory in full. It does not estimate SCT feedback processes, the complete TPB structure or the sequence of beliefs and norms proposed by VBN. Attribution theory and behavioral economics remain background perspectives because causal attributions, reference points and loss aversion were not measured. This scope keeps the theoretical claims aligned with the research questions and the available questionnaire data.

2.2 Research Model

Building on the literature review, this study integrates demographic factors, psychological factors, and external contextual factors. Based on the perspective of Social Cognitive Theory and complemented by Theory of Planned Behavior (TPB), Value-Belief-Norm (VBN) Theory and Attitude–Behavior–Context (ABC) Theory, a model for the awareness - intention - stated behavior to save energy among frontline pilots in China’s civil aviation sector is constructed. As shown in Figure 8, this model takes into consideration situational factors including organizational loyalty, policy incentives, and subculture, all of which moderate the relationship between energy-saving intentions and behavior. Given the unique nature of frontline pilots in China’s civil aviation sector, who operate in high-altitude environments, their primary concern is flight safety. This has led to the emergence of a subculture focused on safe flying practices. In this study, subculture is considered an organizational atmosphere and is treated as a situational factor. Organizational loyalty is included as a component of Situational Factors (SF), alongside policy incentives and energy-saving subculture.

Figure 8*Energy-Saving Behavioral Model*

The innovation of the proposed model lies in its integration of multiple theoretical frameworks to address the unique energy-saving behavior of frontline pilots in China's civil aviation sector. This model departs from traditional energy-conservation approaches by centering social cognitive theory as the main theoretical foundation, while drawing on the Theory of Planned Behavior, the Value-Belief-Norm framework, and sector-specific contextual factors in a

supporting role. In this way, the model provides a more comprehensive understanding of the drivers behind stated energy-saving behavior in this high-stakes, high-risk environment.

One of the key innovations is the incorporation of cognitive, motivational, and situational factors into a single framework, as shown in Figure 8. Traditionally, energy-saving behavior models focus primarily on cognitive factors such as knowledge, attitudes, and intentions or on external situational factors such as policy incentives and social norms. However, the proposed model extends this logic by situating these factors within a social-cognitive framework, which emphasizes the reciprocal interaction among personal factors, environment, and behavior. In the case of pilots, perceptions of safety, professional responsibility, and role expectations are likely to be associated with the links among energy-saving awareness, intention, and stated energy-saving behavior. The model therefore recognizes that, even when pilots are aware of energy-saving practices, the strength of the association between such awareness and stated behavioral commitment may depend on the broader professional and organizational context.

Another innovative aspect is the model's inclusion of situational factors such as organizational loyalty, policy incentives, and subculture within the aviation industry. These contextual elements have often been underexplored in traditional energy-saving behavior models. In the aviation sector, loyalty to the organization and adherence to aviation safety protocols may be positively associated with a pilot's willingness to adopt energy-saving behaviors. The concept of subculture in aviation, which emphasizes safe flying practices, is another novel aspect of this model. In a high-risk environment where safety is paramount, pilots' behaviors may be driven more by adherence to safety standards than by energy conservation, making this contextual factor crucial to understanding energy-saving behavior in this field.

Lastly, the model's empirical validation through a survey among frontline pilots represents another innovation. By applying this integrated theoretical framework to real-world data, the model provides practical insights into how awareness, motivational factors and contextual factors are associated with stated energy-saving behavior. This empirical approach allows for the identification of specific factors that are related to pilots' energy-saving behaviors, offering actionable recommendations for improving energy conservation practices in China's civil aviation sector.

Based on this model (shown in Figure 8), a questionnaire was conducted to understand the current state of energy-saving awareness and behavior among frontline pilots in the Chinese civil aviation sector. The study analyzed the correlation between employees' energy-saving awareness, intention and stated energy-saving behavior, examined the moderating role of situational factors, and provided recommendations for strengthening reported energy-saving practices among frontline pilots.

2.3 Research Hypotheses

This study investigates the current energy-saving awareness and behavior of frontline pilots in China's civil aviation sector. It constructs a social-cognitive model to analyze the associations among energy-saving awareness, intention and stated behavior, and explores the moderating role of situational factors. Based on the model, the following hypotheses are proposed:

Hypothesis 1: There is a positive association between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI) among frontline pilots.

Awareness is generally considered a necessary prerequisite for individual behavior, and Guy & Shove emphasize that obstacles to energy efficiency are often due to a lack of knowledge and information (Guy & Shove, 2014). This assumption is based on the idea that the awareness to

save energy has a positive promoting effect on the energy-saving intention of frontline pilots. Therefore, if frontline pilots have positive awareness regarding energy-saving, meaning knowledge and information about energy efficiency, it may have a positive facilitating effect on their energy-saving intention. This awareness may include knowledge about energy-saving techniques in flight operations, fuel efficiency in aircraft, etc., thereby inspiring pilots to be more willing to adopt energy-saving measures.

Hypothesis 2: There is a positive association between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB) among frontline pilots.

Energy-Saving Awareness (ESA) enables individuals to better understand the importance and limited nature of energy. By recognizing the scarcity of energy resources and their impact on the environment, individuals are more likely to realize the importance of adopting energy-saving behavior (Cao & Qu, 2014; Zhang et al., 2017). Increased knowledge (ESK) contributes to more rational decision-making, making it more likely for individuals to report preference for energy-saving measures in operational settings. This, in turn, fosters a sense of responsibility and morality towards the environment. On the other hand, by gaining perspective in Environmental Values (EV) and understanding the irreversible damage excessive energy use can cause to the Earth, individuals are more willing to consider the bigger picture and engage in energy-saving behavior to mitigate the exacerbation of environmental issues (Sheng & Zhu, 2015). Additionally, when awareness is influenced by social and peer pressure, individuals are more likely to respond to societal expectations. In addition, under the context of Subjective Norms (SN), when the society emphasizes energy-saving consciousness, individuals are more susceptible to social pressure,

prompting them to adopt or report stronger energy-saving behavior to gain social approval (Chen et al., 2023; Yang & Wang, 2023).

Hypothesis 3: There is a positive association between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB) among frontline pilots.

Understanding the psychological mechanism through which awareness translates into sustainable behavior has been a long-standing concern in environmental and behavioral research. While cognitive awareness of environmental issues is a necessary condition for sustainable action, it is rarely sufficient to ensure behavioral change (Kollmuss & Agyeman, 2002). In this regard, the concept of intention—representing an individual’s motivational readiness to act—plays a pivotal role in bridging the gap between awareness and behavior (Ajzen, 1991; Fishbein & Ajzen, 2010). Consequently, this study posits that energy-saving intention serves as a mediating variable linking energy-saving awareness (ESA) to Stated Energy-Saving Behavior (SESB) among frontline pilots in Chinese civil aviation.

According to the Theory of Planned Behavior (TPB) (Ajzen, 1991), behavior is primarily determined by an individual’s behavioral intention, which in turn is shaped by three key antecedents: attitude toward the behavior, subjective norms, and perceived behavioral control. Within this theoretical framework, energy-saving awareness—comprising energy-saving knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN)—reflects an individual’s cognitive and attitudinal readiness to engage in environmentally responsible action. Awareness enhances pilots’ understanding of carbon neutrality, operational efficiency, and the environmental consequences of their professional activities. This heightened cognition strengthens

their attitudinal commitment and perceived responsibility, thereby increasing their intention to engage in energy-saving behavior (Bamberg & Möser, 2007; Stern, 2000).

Empirical studies provide theoretical and empirical support for this proposed pathway. For example, Chen et al. (2017) found that environmental knowledge positively influences pro-environmental intention through strengthened personal norms. In an aviation context, Gaitan et al. (2024) found that subjective norms and perceived behavioral control were positively associated with military pilots' fuel-saving intentions. These findings align with the broader argument advanced by Gifford and Nilsson (2014), who emphasized that intention functions as the proximal predictor of behavior, mediating the effects of distal cognitive and value-based factors. Thus, intention can be understood as a psychological link between awareness and action tendencies, connecting abstract cognition with more specific behavioral goals.

In the aviation context, pilots make operational decisions under strict procedural and institutional constraints. For this reason, awareness alone may not directly lead to stronger stated behavioral tendencies unless pilots also have a clear intention to incorporate energy-saving strategies into their daily professional practice (Kotsopoulos et al., 2023). Intention encourages pilots to turn knowledge into specific operational choices, such as better flight planning, more efficient fuel management, and lower use of auxiliary power, which in turn strengthens stated energy-saving behavior. The mediating role of intention is therefore not only cognitive but also practical, as it links awareness-based motivation with self-reported professional behavior under real operational constraints.

Value–Belief–Norm (VBN) theory links environmental values and beliefs to behavior through personal norms (Stern, 2000). These norms may help explain why energy-saving awareness is associated with motivation. The proposed mediating role of intention draws on TPB.

Applying this framework to civil aviation, energy-saving awareness derived from environmental education and corporate sustainability policies is expected to heighten pilots' pro-environmental beliefs, thereby strengthening their intention to conserve energy during flight operations.

The ABC model emphasizes that contextual conditions shape the relationship between attitudes and behavior (Guagnano, Stern, & Dietz, 1995). In this study, TPB provides the main rationale for examining intention as a mediator. In professional contexts such as aviation, where behavioral opportunities are structured and regulated, intention represents a motivational factor associated with the link between pilots' awareness and stronger stated behavioral tendencies (Steg & Vlek, 2009). Without intention, even high awareness may fail to generate consistent stated behavioral outcomes—a phenomenon often referred to as the “value–action gap” (Blake, 1999).

Therefore, synthesizing the insights from TPB, VBN, and ABC frameworks, this study conceptualizes energy-saving intention (ESI) as the core psychological mediator within the broader social-cognitive process. It captures the motivational transition from understanding energy-conservation principles (awareness) to expressing stronger stated energy-saving behavior. Given the theoretical and empirical evidence, it is hypothesized that pilots who exhibit stronger energy-saving awareness will demonstrate higher energy-saving intention, which in turn will lead to more consistent self-reported energy-saving behavior. Hence, the fourth hypothesis is stated below:

Hypothesis 4: Energy-Saving Intention (ESI) mediates the relationship between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB).

Although in most behavioral models, energy-saving intention (ESI) is expected to mediate the relationship between energy-saving awareness (ESA) and stated energy-saving behavior (SESB), in real-world aviation contexts, this mediating relationship may fail or may be

significantly weakened due to the highly structured, safety-critical, and operationally constrained nature of flight activities. First, operational constraints and situational pressures often override pilots' personal intentions. Civil aviation operations are characterized by strict procedural compliance, complex coordination with air traffic control, and changing meteorological conditions. Even when pilots are aware of energy-saving principles and intend to act accordingly, external factors such as air traffic flow management, route restrictions, or safety-related decisions can force them to deviate from intended fuel-efficient behaviors (Ministry of Transport of the People's Republic of China, 2017; Civil Aviation Administration of China, 2021). For example, a pilot may intend to perform a continuous descent approach to save fuel but must execute a step-down descent due to ATC instructions or terrain limitations. In such cases, intention does not directly translate into behavior because situational control exceeds individual discretion (Gollwitzer, 1999; Stern, 2000). This paper will examine if this hypothesis holds true with quantitative survey data analyzed in later chapter.

Although awareness of environmental issues is widely recognized as a key antecedent of pro-environmental behavior, prior research has consistently shown that cognitive awareness alone does not necessarily lead to behavioral change (Kollmuss & Agyeman, 2002; Gifford & Nilsson, 2014). This gap between knowing and doing—often described as the “value–action gap” (Blake, 1999)—suggests that the translation of energy-saving awareness (ESA) into energy behavioral intention (ESI) depends critically on individual-level psychological characteristics. In the context of civil aviation, pilots' daily operations are subject to strict procedural norms, time pressures, and hierarchical command structures. Under such conditions, even highly aware pilots may fail to form strong energy-saving intentions unless they possess sufficient psychological capacity and

motivation. Therefore, it is necessary to investigate the moderating role of Psychological Factors (PF) in strengthening or weakening the relationship between ESA and ESI.

Psychological Factors (PF) refer to the internal motivational and cognitive resources that influence how individuals perceive, evaluate, and act upon environmental information (Stern, 2000; Steg & Vlek, 2009). In this study, Psychological Factors (PF) primarily include Self-Efficacy (SE) and Personal Norms (PN). Self-Efficacy (SE) refers to the belief in one's ability to perform energy-saving action, and Personal Norms (PN) represent internalized moral obligations to act in environmentally responsible ways (Bandura, 1997; Schwartz, 1977). These factors jointly shape the psychological readiness of pilots to transform awareness into actionable intention.

Individuals with higher Self-Efficacy (SE) are likely to perceive fewer barriers to action and greater control over outcomes, making them more likely to form strong intentions once they are aware of environmental issues (Han, Hsu, & Sheu, 2010). Conversely, individuals with low Self-Efficacy (SE) may recognize the importance of energy conservation yet doubt their personal ability to make a difference, resulting in weaker intentions (Bamberg & Möser, 2007).

Moreover, Personal Norms (PN), a sense of moral responsibility toward the environment, can amplify the cognitive-motivational linkage between awareness and intention. According to the Norm Activation Model (NAM) (Schwartz, 1977), awareness of environmental consequences triggers moral obligations, which in turn strengthen pro-environmental intentions. When individuals perceive saving energy as both a professional duty and a moral imperative, their awareness of carbon neutrality and sustainability goals is more likely to evolve into intentional commitment.

In the aviation domain, these psychological factors play especially significant roles. Pilots operate within structured systems where their individual decisions can have direct implications for

safety and efficiency. High levels of self-efficacy enable pilots to confidently adopt energy-saving procedures, such as optimizing flight paths and reducing idle engine use, even under complex operational conditions. At the same time, strong personal norms rooted in professional ethics and environmental responsibility may lead pilots to internalize corporate sustainability values, thereby enhancing the link between their awareness of energy-saving principles and the formation of corresponding intentions (Kotsopoulos et al., 2023).

Theory of Planned Behavior (TPB) identifies perceived behavioral control as one of the predictors of intention (Ajzen, 1991). The present study extends this reasoning by proposing that PF conditions the relationship between ESA and ESI. When psychological resources are abundant—reflected in high Self-Efficacy (SE) and moral conviction—the cognitive determinants of intention become more powerful. Conversely, when psychological readiness is low, the same awareness may fail to generate actionable intentions. Psychological Factors (PF) are therefore proposed as factors that condition how effectively awareness translates into intention (Hayes, 2018).

Integrating these theoretical and empirical insights, the present study proposes that pilots with stronger psychological resources—higher self-efficacy and stronger personal norms—will show a more pronounced relationship between awareness and intention. In contrast, pilots with lower psychological readiness may exhibit a weaker association, even when their awareness levels are high. Hence, Psychological Factors (PF) are expected to moderate the influence of Energy-Saving Awareness (ESA) on Intention (ESI). Accordingly, the fifth hypothesis of this study is formulated as below:

Hypothesis 5: Psychological Factors (PF) moderate the relationship between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI).

While behavioral intention is widely recognized as the most immediate and robust predictor of behavior in psychological and environmental models (Ajzen, 1991; Fishbein & Ajzen, 2010), numerous studies have demonstrated that the translation from intention to behavior is not always straightforward. This phenomenon, known as the intention–behavior gap, refers to discrepancies between individuals’ expressed intentions and their real-world actions (Sheeran & Webb, 2016). One key reason for this inconsistency lies in the influence of Situational Factors (SF): the external environmental, organizational, and contextual conditions that either facilitate or constrain behavioral execution (Stern, 2000; Steg & Vlek, 2009). Therefore, in this study, Situational Factors (SF) are proposed to moderate the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB) among frontline pilots in Chinese civil aviation.

Situational Factors (SF) encompass a wide array of external conditions that can shape or modify the realization of behavioral intentions. These include organizational loyalty (OL), policy incentives (PI), and energy-saving subculture (ESS) within an organization. According to the Attitude–Behavior–Context (ABC) model developed by Guagnano, Stern, and Dietz (1995), behavioral outcomes depend not only on individual motivation (attitudes and intentions) but also on the enabling or constraining nature of the context. When situational support is strong—such as through clear organizational policies, social norms, and incentives—intentions are more likely to be converted into action. Conversely, when external constraints such as institutional barriers, lack of resources, or cultural indifference are present, even strong intentions may fail to manifest as behavior (Stern, 2000; Gifford & Nilsson, 2014).

In aviation operations, situational influences are particularly salient. Pilots function within highly regulated, hierarchical systems where energy-saving behaviors—such as optimizing flight routes, minimizing idle engine time, or reducing fuel consumption—must align with safety procedures, operational schedules, and organizational directives. Therefore, pilots' ability to act on their energy-saving intention is significantly affected by situational enablers such as company policies, supervisory encouragement, and cultural reinforcement. A strong energy-saving subculture (ESS) within airlines can create collective expectations that reward pro-environmental practices, while policy incentives (PI) can offer tangible motivations for behavioral compliance (Kotsopoulos et al., 2023). Similarly, a sense of organizational loyalty (OL) may strengthen pilots' willingness to align personal intentions with corporate sustainability goals (Boiral, Paillé, & Raineri, 2015). These situational supports effectively bridge the gap between pilots' intentions and their enacted behaviors.

From a theoretical standpoint, this moderating mechanism can also be interpreted through the Theory of Planned Behavior (TPB) (Ajzen, 1991). Within TPB, perceived behavioral control encompasses both internal capacity and external opportunity to perform a behavior. Situational Factors (SF) therefore represent the contextual realization of perceived control—external conditions that either empower or inhibit the behavioral expression of intention. When these external facilitators are present, the predictive power of intention increases; when absent, intention may remain an unfulfilled motivational state (Fishbein & Ajzen, 2010).

Accordingly, the present study conceptualizes Situational Factors (SF) as boundary conditions that determine the extent to which Energy-Saving Intentions (ESI) translate into Stated Energy-Saving Behaviors (SESB). Pilots who perceive stronger situational support—through favorable policy incentives, a cohesive energy-saving culture, and alignment with organizational

values—are more likely to act in accordance with their intentions. Conversely, in less supportive contexts, the same level of intention may not lead to tangible behavioral change due to operational or cultural barriers.

Synthesizing insights from the TPB and ABC models, as well as empirical findings in environmental and organizational behavior research, this study posits that situational factors are associated with the strength of the intention–behavior relationship. Hence, the last hypothesis is proposed:

Hypothesis 6: Situational Factors (SF) moderate the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB).

In summary, all hypotheses are summarized below:

Table 1

Summary of Research Hypotheses

No.	Hypothesis
H1	There is a positive association between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI) among frontline pilots.
H2	There is a positive association between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB) among frontline pilots.
H3	There is a positive association between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB) among frontline pilots.
H4	Energy-Saving Intention (ESI) mediates the relationship between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB).
H5	Psychological Factors (PF) moderate the relationship between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI).
H6	Situational Factors (SF) moderate the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB).

Chapter 3. Methodology

3.1 Research Design

The research design is grounded mainly in Social Cognitive Theory and is complemented by the Theory of Planned Behavior (TPB) (Ajzen, 1991) and the Value-Belief-Norm (VBN) theory (Stern, 2000). Social Cognitive Theory provides the overall logic for examining how cognition, motivation, and environmental conditions interact in a professional setting, while TPB and VBN help explain the pathway linking awareness, intention, and stated behavior. Together, these frameworks support the examination of how Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), Stated Energy-Saving Behavior (SESB), Psychological Factors (PF), and Situational Factors (SF) are associated in the pilot context.

This study adopts a cross-sectional questionnaire survey of 200 frontline pilots in Chinese civil aviation to examine the hypothesized relationship among ESA, ESI, and SESB, including the moderating roles of PF and SF. Items were adapted from prior scales used in environmental psychology and energy-behavior research and were adjusted to fit the aviation context (Steg & Vlek, 2009; Liu et al., 2021). Energy-Saving Awareness (ESA) comprises three subdimensions: Energy-Saving Knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN). Specifically, Energy-Saving Knowledge (ESK) measures pilots' understanding of energy efficiency principles, fuel-saving techniques, and carbon reduction strategies. Environmental Values (EV) and Subjective Norms (SN) represent the comprehensive and social dimensions of Energy-Saving Awareness (ESA), based on Stern's (2000) Value-Belief-Norm (VBN) theory and Ajzen's (1991) Theory of Planned Behavior (TPB). The concept of Energy-Saving Intention (ESI), capturing respondents' willingness and motivation to engage in energy-saving practices, was adapted from behavioral intention measures widely used in environmental psychology (Steg &

Vlek, 2009). Stated Energy-Saving Behavior (SESB) assesses self-reported frequency and consistency of operational behaviors that contribute to fuel efficiency, such as optimal flight path selection and reduced auxiliary power usage (Lo et al., 2014). Psychological Factors (PF) measure internal attributes such as self-efficacy, responsibility, and moral obligation (Bandura, 1997; Deci & Ryan, 2000). Lastly, the concept of Situational Factors (SF), evaluating external influences including organizational loyalty (OL), policy incentives (PI), and energy-saving subculture (ESS), was adapted from Guagnano, Stern, and Dietz (1995).

This part of the research aims to test the hypothesized relationships among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB), as well as the mediating role of ESI and the moderating roles of Psychological Factors (PF) and Situational Factors (SF). The questionnaire combines five-point rating items with multiple-response questions. Statistical analyses—including descriptive statistics, reliability and validity tests, correlation analysis, and multiple regression modeling—are conducted using SPSS and related software to ensure the robustness and reliability of the empirical findings.

3.2 Quantitative Analysis Method

3.2.1 Respondents and Sampling Procedure

The quantitative test of this research was conducted through a structured questionnaire designed to collect empirical data from frontline pilots in China's civil aviation industry. The questionnaire method was selected because it allows standardized data collection from a professionally specific but geographically dispersed group, thereby supporting comparability across respondents while preserving anonymity in a sensitive occupational setting.

The target population for the survey consisted of commercial pilots employed by major Chinese airlines. These individuals were selected because they directly influence operational

energy consumption through routine flight decisions and are among the most important frontline actors for implementing fuel-saving and carbon-reduction practices in daily operations.

Eligible participants were required to hold at least a Commercial Pilot License (CPL) or Airline Transport Pilot License (ATPL) and have active flight status at the time of the survey. The study included pilots of various ranks—captains, first officers, and second officers—to ensure that the data captured differences in operational authority, experience, and responsibility. Additionally, demographic factors such as age, educational background, and years of flying experience were recorded to support later statistical control and subgroup analysis.

In practical terms, the study used stratified outreach combined with voluntary participation. Questionnaire links were circulated through airline intranet platforms and pilot communication groups covering different carriers, ranks, and experience bands. Because the survey invitation was disseminated through internal professional channels rather than through a closed list with a fully traceable denominator, the dissertation can describe the retained sample clearly but does not claim a precisely verifiable population-level response rate.

Since all main variables were measured through the same self-report questionnaire, common method bias was considered during both questionnaire design and data analysis. Following Podsakoff et al. (2003), the questionnaire stressed anonymity and confidentiality, used items adapted from previous studies where possible, and reviewed item wording to make the questions clear and less leading. These steps helped reduce possible same-source bias, but they could not remove this risk completely.

3.2.2 Sample Size

Because this dissertation relies primarily on regression, mediation, and moderation analysis rather than on covariance-based structural equation modeling as its main estimation strategy,

sample adequacy was judged mainly with reference to predictor-to-sample ratios and statistical power logic. As a heuristic benchmark, a design with approximately ten predictors in the most complex regression equation would normally require at least around 100 observations to maintain stable estimation.

On that basis, a retained sample of 200 respondents provides a reasonable margin for the planned regression-based analyses and is generally adequate for detecting moderate associations in social-science research. At the same time, the dissertation does not claim that this sample would necessarily be sensitive to very small effects or to fine-grained subgroup comparisons.

Accordingly, the sample size is treated as sufficient for the dissertation's theory-driven analyses while the interpretation of small effects, rare subgroups, and highly segmented comparisons is kept cautious in the discussion and limitation sections.

In total, 200 completed questionnaires meeting the screening criteria were retained for analysis. In this dissertation, the phrase "response rate" refers to the proportion of returned questionnaires that were complete and usable after screening, rather than to the proportion of all pilots who may have seen the survey invitation through internal circulation channels. This wording is important because the exact number of pilots reached through those channels could not be independently verified.

3.2.3 Research Instruments and Questionnaires

In the process of questionnaire design, this study systematically reviewed previous empirical and theoretical research in the fields of energy-saving behavior, environmental psychology, and sustainable aviation, in order to ensure the scientific rigor and theoretical relevance of the measurement instruments. The development of the survey instrument followed an objective consistency approach, emphasizing conceptual alignment with established theories and

empirical validity across measurement dimensions (DeVellis, 2017). The questionnaire was designed to capture the multidimensional relationships among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB), while incorporating Psychological Factors (PF) and Situational Factors (SF) as moderating constructs.

The questionnaire was administered in Chinese because the respondents were Chinese civil aviation pilots. The English version presented in this dissertation is used for academic reporting. During questionnaire design, the meaning of each item was checked carefully to ensure that the Chinese wording matched the intended construct.

The final version of the questionnaire consisted of two major sections:

The first section served as a screening mechanism to ensure the suitability of respondents for inclusion in the study. It included questions confirming participants' professional identity (commercial airline pilot), possession of a valid pilot license (CPL or ATPL), and current employment status in the civil aviation sector. These items were designed to exclude non-pilot respondents and ensure that all participants were frontline pilots with operational experience. Participants were informed of the purpose, confidentiality, and voluntary nature of the study, in compliance with ethical research standards (Creswell & Creswell, 2018).

The second section formed the core of the instrument, focusing on the measurement of key research variables. This section was divided into several subscales corresponding to the main constructs of the study:

Energy-Saving Awareness (ESA). A higher-order awareness construct referring to pilots' understanding of energy-saving issues, endorsement of environmental values, and recognition of relevant normative expectations. In this dissertation, ESA comprises three subdimensions: Energy-Saving Knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN). The

inclusion of SN within ESA is a context-specific modeling choice intended to capture how pilots cognitively internalize the expectations of regulators, airlines, and peers in a safety-critical professional environment.

Energy-Saving Knowledge (ESK). The extent to which respondents understand fuel-saving practices, carbon-reduction requirements, and the operational significance of efficient energy use in civil aviation.

Environmental Values (EV). The degree to which respondents attach importance to environmental protection, sustainable development, and the broader social significance of low-carbon operations.

Subjective Norms (SN). The perceived expectations from airlines, regulators, colleagues, and the wider professional environment regarding the importance of energy conservation and low-carbon conduct.

Energy-Saving Intention (ESI). Respondents' self-reported willingness, motivation, and readiness to engage in energy-saving practices in their professional work. ESI is conceptually distinct from behavior because it captures planned or intended action rather than reported enactment. Example items included "I hope to do my best to reduce carbon emissions", and "I am willing to bring green behaviors from life to work." The scale was adapted from Steg & Vlek (2009) and Bamberg & Möser (2007), both of which have been validated in environmental behavioral studies.

Stated Energy-Saving Behavior (SESB). Respondents' self-reported energy-saving practices in operational settings. SESB is used in this dissertation as a stated or self-reported behavioral measure based on respondents' reports in the questionnaire, rather than as a direct

observation of actual in-flight operational behavior. It only reflects pilots' reported recognition and selection of energy-saving practices.

Psychological Factors (PF). Measured internal attributes such as self-efficacy, confidence, and moral responsibility. Section F items (e.g., "I have all the technical knowledge and experience required for my job", "I am proud of my work skills") reflected self-efficacy (Bandura, 1997). Section E items (e.g., "If I don't save energy during flight, I will feel guilty") measured moral obligation (Deci & Ryan, 2000; Chen & Zhu, 2019).

Situational Factors (SF). It was operationalized as a combination of organizational and contextual influences listed below:

Organizational Loyalty (OL). Section K items (e.g., "Working in this unit is both my need and my will", "I feel a responsibility to my colleagues and company") reflected emotional commitment to the organization (Allen & Meyer, 1990).

Policy Incentives (PI). Section L items (e.g., "My energy-saving behavior is motivated by company policies or rewards") measured instrumental motivation (Guagnano et al., 1995).

Energy-Saving Subculture (ESS). Section M and O items (e.g., "Pilots frequently exchange energy-saving experiences", "Reward mechanisms enhance enthusiasm for energy conservation") assessed the presence of informal peer influence and cultural support for conservation (Carrus et al., 2021; Stern, 2000). All items in the second section were rated on a five-point Likert scale, ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"), to quantify respondents' attitudes, perceptions, and behavioral tendencies. This standardized format allows for robust statistical analysis and cross-variable comparability.

These construct definitions were specified to reduce overlap among the central variables and to ensure that awareness, intention, stated behavior, and the two moderator constructs are measured as analytically distinct but theoretically related dimensions.

3.2.4 Research Instrument Validity and Internal Consistency Reliability

To ensure the scientific rigor and psychometric soundness of the questionnaire, the study conducted a staged evaluation of measurement quality. Because the primary hypothesis tests in this dissertation are regression-based rather than covariance-based SEM analyses, the measurement assessment focuses on content validity, item clarity, internal consistency, and exploratory factorability. This provides an interpretable foundation for the empirical tests, while not claiming a fully confirmatory validation of the entire measurement model.

Content Validity. Content validity concerns whether the measurement items comprehensively cover the conceptual dimensions of the constructs under investigation. In this study, content validity was ensured through a systematic literature review and expert evaluation to improve alignment between the theoretical definitions and the survey items used in practice. The initial item pool was developed based on prior studies in the domains of environmental psychology, pro-environmental behavior, and energy-saving research (Ajzen, 1991; Stern, 2000; Steg & Vlek, 2009). The items were carefully adapted to the professional aviation context to reflect the behavioral characteristics and operational constraints of frontline pilots. Subsequently, the questionnaire draft was reviewed by three academic experts in behavioral science and two industry practitioners from major airlines. They assessed the conceptual relevance, clarity, and representativeness of each item. This expert review method follows the content validation approach suggested by Lynn (1986), which is widely applied in social and behavioral science instrument development.

Construct Validity (Exploratory Factor Analysis). Construct validity was examined through Exploratory Factor Analysis (EFA). In this study, EFA was used as an initial check of whether the questionnaire items followed the expected factor structure. As Brown (2015) explains, EFA is useful for exploring item patterns, while Confirmatory Factor Analysis (CFA) is more suitable for formally testing a proposed measurement model. Therefore, the EFA results in this study should be understood as preliminary evidence of construct validity, rather than as a full confirmatory test of the measurement model.

The EFA was conducted in SPSS using Principal Component Analysis (PCA) with Varimax rotation. Before factor extraction, the Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s Test of Sphericity were used to check whether the data were suitable for factor analysis. Based on common criteria, KMO values above 0.70 and a significant Bartlett’s test indicate that the data are acceptable for factor extraction (Hair et al., 2019). Items with factor loadings above 0.50 were retained, while items with weak loadings or strong cross-loadings were reviewed. This process helped ensure that the retained items were more closely related to their intended constructs.

The extracted factors were generally consistent with the theoretical framework, and the cumulative variance explained exceeded 65% for all constructs. These results provide initial support for the structure of the questionnaire. However, because this study mainly uses regression-based analysis rather than a full structural equation model, the measurement evidence remains exploratory. Future research could further test the measurement model through CFA, composite reliability, average variance extracted, and HTMT-based discriminant validity assessment.

Internal Consistency Reliability. Reliability refers to the internal stability of the scale, that is, the extent to which multiple items measuring the same concept yield consistent results. To evaluate reliability, this study calculated Cronbach’s α coefficients and Corrected Item–Total

Correlation (CITC) values for each construct. According to the commonly accepted criteria (Nunnally & Bernstein, 1994), α values above 0.70 indicate acceptable reliability, while values exceeding 0.80 represent strong internal consistency. The CITC value for each item should exceed 0.40, demonstrating that each item correlates well with the overall scale score. Additionally, the “ α if item deleted” statistic was examined to confirm that removing any item would not improve the overall reliability of the construct, ensuring that all retained items contributed positively to the scale’s internal consistency. This approach aligns with Tavakol and Dennick’s (2011) recommendation that reliability testing should verify both consistency across items and the conceptual homogeneity of the construct (Table 2).

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum_{i=1}^k \sigma_i^2}{\sigma^2} \right)$$

Table 2

Pilot Test Rules of Thumb about Cronbach’s Alpha Coefficient Size

Alpha Coefficient Range	Strength of Association
$\alpha < 0.5$	Unacceptable
$\alpha < 0.6$	Poor
$0.6 < \alpha < 0.7$	Moderate
$0.7 < \alpha < 0.8$	Good
$0.8 < \alpha < 0.9$	Very good
$\alpha \geq 0.9$	Excellent

3.2.5 Pilot Test

Prior to the formal data collection, a pilot test was conducted to evaluate the clarity, reliability, and internal consistency of the questionnaire items. This preliminary test aimed to

identify potential ambiguities, assess the psychometric soundness of the measurement instrument, and ensure that all constructs were conceptually valid and statistically reliable before distributing the full-scale survey. Conducting a pilot study is a standard and essential step in survey-based behavioral research, particularly when adapting measurement instruments to a new professional or cultural context (DeVellis, 2017; Creswell & Creswell, 2018).

The pilot test sample comprised 50 valid responses collected from frontline civil aviation pilots in China. The respondents were randomly selected from different airlines to ensure representativeness in terms of professional rank, years of flight experience, and educational background. Participants were informed that the purpose of the pilot study was to evaluate the reliability and clarity of the instrument, rather than to test hypotheses. Data were analyzed using SPSS 26.0, focusing on the Cronbach's α coefficient for each primary and secondary construct to assess internal consistency reliability. According to Nunnally and Bernstein (1994), α values above 0.70 indicate acceptable reliability, while values exceeding 0.80 represent strong internal consistency.

The pilot test results are summarized in Table 3, showing Cronbach's α coefficients for all main constructs and their subdimensions. The results demonstrate excellent internal reliability across all variables.

Table 3

Pilot Test

Primary Indicator	Secondary Indicator	Cronbach's α Coefficient	Primary Indicator Cronbach's α Coefficient
Energy-Saving Awareness (ESA)	Energy-Saving Knowledge (ESK)	0.897	0.949
	Environmental Values (EV)	0.865	

Primary Indicator	Secondary Indicator	Cronbach's α Coefficient	Primary Indicator Cronbach's α Coefficient
	Subjective Norms (SN)	0.841	
Energy-saving Intention (ESI)	-	0.896	
Stated Energy-Saving Behavior (SESB)	-	0.899	
Psychological Factors (PF)	Self-Efficacy (SE)	0.892	0.967
	Personal Norms (PN)	0.961	
Situational Factors (SF)	Organizational Loyalty (OL)	0.883	0.969
	Policy Incentives (PI)	0.91	
	Energy-Saving Subculture (ESS)	0.944	

3.2.6 Normality Test

Testing for data normality is a fundamental step in the data screening process of quantitative research, ensuring that the statistical assumptions underlying parametric analyses are met. As the context of this study examines the relationships among ESA, ESI, SESB and the moderating effects of PF and SF, the accuracy and interpretability of inferential results rely heavily on whether the data conform to the assumption of normal distribution. As noted by Hair et al. (2019), most multivariate statistical procedures, including correlation, regression, and mediation–moderation analyses, assume that the variables follow a normal distribution so that parameter estimates, standard errors, and confidence intervals are unbiased and statistically efficient.

Assessing the normality of data distribution is an essential step in quantitative research, particularly in behavioral and social sciences, because many statistical techniques—such as correlation, regression, and mediation analysis—are based on the assumption that the data follow a normal distribution (Hair et al., 2019; Tabachnick & Fidell, 2019). The normality test ensures

that the collected responses conform to this assumption and that subsequent parametric analyses are statistically valid and interpretable. According to Field (2018), the normality assumption is not only a theoretical requirement but also a practical prerequisite for ensuring that estimations of coefficients, variances, and standard errors are unbiased and efficient.

In this study, univariate normality was assessed for each measurement item using both skewness and kurtosis statistics, following the recommendations of Kline (2015) and Byrne (2016). Skewness measures the degree of asymmetry in the distribution, while kurtosis reflects the peakedness or flatness of the curve compared to a normal distribution. For social science research, it is widely accepted that skewness values between -3 and +3 and kurtosis values between -9 and +9 indicate an acceptable approximation of normality (Kline, 2015; Hair et al., 2019). This range accounts for the practical variability of behavioral data, which rarely exhibit perfect normality due to human cognitive and attitudinal diversity (West, Finch, & Curran, 1995).

3.2.7 Correlation Analysis (Pearson's Correlation)

Correlation analysis is a fundamental statistical technique used to examine the strength and direction of linear relationships between continuous variables. In this study, Pearson's Product–Moment Correlation Coefficient (r) was employed to assess the associations among the key constructs—Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB)—as well as the moderating constructs of Psychological Factors (PF) and Situational Factors (SF). The purpose of this analysis was to provide an initial empirical understanding of how these variables are interrelated and to determine whether the observed relationships are consistent with the proposed theoretical model based on the Theory of Planned Behavior (Ajzen, 1991) and the Value–Belief–Norm (VBN) framework (Stern, 2000).

Pearson's correlation was selected because the variables in this study are interval-level composite scores derived from multi-item Likert scales (ranging from 1 = "strongly disagree" to 5 = "strongly agree"). When Likert data are aggregated across multiple items and the sample size is sufficiently large, they can be treated as continuous variables (Norman, 2010). Pearson's correlation is particularly suitable for exploring linear dependencies among such variables, as it provides a precise numerical estimate ranging from -1 to +1, where positive values indicate a direct relationship, negative values indicate an inverse relationship, and values near zero suggest no linear association (Field, 2018).

3.2.8 Linear Regression Analysis

Linear regression analysis is one of the most widely applied statistical techniques in behavioral and social sciences for modeling the relationship between a dependent variable and one or more independent variables. The primary purpose of linear regression is to determine the extent to which independent variables (predictors) can explain variations in a dependent variable (outcome), thereby identifying statistically supported relationships within the theoretical model (Cohen et al., 2003; Hair et al., 2019). In this research, linear regression serves as the fundamental analytical tool to test the proposed hypotheses regarding the effects of Energy-Saving Awareness (ESA) on Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB), as well as the moderating effects of Psychological Factors (PF) and Situational Factors (SF).

For this study, linear regression is theoretically appropriate for several reasons. First, the conceptual framework, grounded in the Theory of Planned Behavior (Ajzen, 1991) and the Value–Belief–Norm (VBN) theory (Stern, 2000), postulates directional and quantitative relationships among psychological and behavioral variables. Specifically, ESA is expected to have a positive association with ESI and SESB, while ESI is hypothesized to mediate the ESA–SESB relationship.

Linear regression provides a robust means to quantify these associations by estimating how a one-unit change in awareness (ESA) may be associated with intention (ESI) and stated behavior (SESB), controlling for demographic and contextual factors.

Second, regression theory allows the simultaneous inclusion of control variable -- such as age, gender, and education -- which account for individual heterogeneity that could otherwise bias the estimated relationships. This property ensures that the observed associations of ESA, ESI, PF, and SF are partial effects, isolated from demographic influences (Field, 2018). By comparing nested models, researchers can also assess incremental explanatory power (ΔR^2), which reveals how much additional variance in SESB is explained after including psychological and situational moderators (Cohen et al., 2003).

Furthermore, the standardized regression coefficients (β) obtained through linear regression provide a dimensionless measure of effect size, allowing direct comparison of the relative importance of predictors. This is particularly useful in this study, where ESA comprises multiple subdimensions -- Energy-Saving Knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN) -- each potentially exerting different degrees of relationships on ESI and SESB. Through regression analysis, the relative predictive strength of these components can be systematically assessed, enhancing theoretical precision (Aiken & West, 1991).

3.2.9 Mediation Test

Mediation analysis is a key statistical technique used to explore how and why an independent variable influences a dependent variable through one or more intervening variables, known as mediators (Baron & Kenny, 1986; Hayes, 2018). In the present study, mediation analysis was employed to examine whether Energy-Saving Intention (ESI) mediates the relationship between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB) among

frontline pilots in Chinese civil aviation. This analytical strategy is consistent with the underlying logic of the Theory of Planned Behavior (TPB) (Ajzen, 1991), which posits that individual awareness and attitudes influence behavior primarily through behavioral intentions.

The mediation model assumes that the effect of an independent variable (X) on a dependent variable (Y) can be decomposed into direct and indirect effects through a mediator (M). The classical method for testing mediation, proposed by Baron and Kenny (1986), is known as the three-step approach or causal steps procedure. It involves the following steps:

Step 1: Test the total effect (path c) — Regress the dependent variable (SESB) on the independent variable (ESA) to verify that ESA significantly predicts SESB. This confirms that there is an overall effect to be mediated.

Step 2: Test the effect of X on M (path a) — Regress the mediator (ESI) on ESA to determine whether awareness significantly predicts intention. A significant path indicates that ESA influences the mediator.

Step 3: Test the mediator and direct effect simultaneously (paths b and c') — Regress SESB on both ESA and ESI. If ESI significantly predicts SESB (path b) while the direct path from ESA to SESB (c') decreases in magnitude compared to Step 1, mediation is suggested. If c' becomes non-significant, the mediation is full; if it remains significant but smaller, the mediation is partial. The Bootstrap method estimates the indirect effect by resampling the dataset thousands of times (typically 5,000 resamples) and calculating the distribution of the indirect effect across those samples (Preacher & Hayes, 2008).

After thousands of repetitions, a bootstrap confidence interval (BootCI) is generated. If the 95% confidence interval does not include zero, the mediation effect is considered statistically significant. The percentile bootstrap approach used in this study is among the most widely

recommended methods for assessing indirect effects due to its accuracy and robustness to violations of normality (Preacher & Hayes, 2004).

In this research, the bootstrap method was implemented using SPSS PROCESS macro (Model 4) developed by Hayes (2018). The independent variable was ESA, the mediator was ESI, and the dependent variable was SESB. Control variables (age, gender, and education) were included to account for demographic influences. The indirect effect and its 95% BootCI were estimated based on 5,000 bootstrap samples. If the confidence interval excluded zero, it would support the mediation hypothesis (H4).

Since all main variables were measured at the same time, the mediation test was used to examine an indirect relationship within the proposed model. It was not used to prove a time-based causal process. This point is important because cross-sectional mediation analysis may give a misleading picture of mediation over time (Maxwell & Cole, 2007).

3.2.10 Moderation Test

Moderation analysis is a statistical approach used to examine whether the strength or direction of the relationship between an independent variable (X) and a dependent variable (Y) changes as a function of a third variable, known as a moderator (Z) (Aiken & West, 1991; Hayes, 2018). In essence, moderation tests the conditional nature of relationships, indicating that the impact of one predictor on an outcome is not uniform but varies depending on contextual or psychological conditions. Within this study, moderation analysis was employed to explore whether Psychological Factors (PF) and Situational Factors (SF) alter the strength of the associations between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI), and between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB), respectively.

Methodologically, moderation was tested through hierarchical multiple regression analysis, following procedures recommended by Aiken and West (1991) and Hayes (2018). In each model, the independent variable and moderator were first mean-centered to reduce multicollinearity, and then their interaction term ($X \times Z$) was created to represent the conditional effect. The significance of this interaction term was assessed while controlling for demographic variables such as age, gender, and educational background.

To aid interpretation, simple slope analysis was conducted by estimating the effect of X on Y at high (+1 SD) and low (−1 SD) levels of the moderator. Visualization of these slopes helps reveal the direction and magnitude of moderation (Cohen, Cohen, West, & Aiken, 2003). For example, a positive interaction between ESA and PF would suggest that higher psychological self-efficacy strengthens the positive relationship with awareness on intention, whereas a significant $ESI \times SF$ interaction would indicate that supportive environments strengthen the association between intention and stated energy-saving behavior.

3.3 Ethical Considerations

An application for ethical approval was submitted to the General University Ethics Panel before data collection. Approval was granted on July 3rd, 2024 (Ethics Reference Number: GUEP 2024 14610 13838). The application covered the survey, including recruitment, informed consent, confidentiality and potential risks to participants.

Participants received information about the study's purpose, procedures and intended use of their responses, and gave informed consent before participating. They were informed that the research was an academic study rather than an employment or performance assessment. Participation was voluntary: participants could decline questions or stop before submitting the questionnaire without penalty.

The questionnaire collected no direct personal identifiers, and survey findings were reported in aggregate. Given the professional sensitivity of pilots' responses, questions avoided confidential operational information and safety incidents. The study addressed energy-saving practices within applicable safety requirements and did not encourage departures from approved procedures.

Electronic survey data and consent documentation were stored in password-protected files accessible only to the researcher and authorized supervisors. Consent documentation was stored separately from research responses. No identifiable research data were made available to employers or other unauthorized parties.

Chapter 4. Empirical Analysis of the Role of Energy-Saving Awareness on Stated Energy-Saving Behavior among Frontline Civil Aviation Pilots in China

This chapter presents the empirical analysis and results of the study based on the data collected from frontline pilots in China's civil aviation industry. The purpose of this chapter is to test the proposed hypotheses and evaluate the relationships among key variables, including Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB), as well as the moderating and mediating effects of Psychological Factors (PF) and Situational Factors (SF). Following the research framework and methodology described in Chapter 3, this chapter applies a series of quantitative analyses, including descriptive statistics, normality tests, reliability and validity assessments, correlation analysis, and multiple regression analyses.

Beginning with a descriptive overview of the demographic characteristics of respondents and the measurement scale statistics, this chapter first provides a preliminary understanding of the sample structure and variable distribution. Next, the normality of the data and the potential for common method bias are examined to ensure the robustness of the statistical analysis. Subsequently, reliability and validity tests are conducted to confirm the internal consistency and construct validity of the measurement model. The later sections present hypothesis testing results through regression and moderation–mediation analyses to examine the proposed associations, indirect relationship, and conditional relationships among the variables. Finally, the empirical findings are summarized and interpreted, laying the foundation for the theoretical discussion and implications in Chapter 5.

In terms of gender, males account for 97.5% of the valid sample (195 respondents) while females account for 2.5% (5 respondents). This marked imbalance reflects the current gender

structure of the Chinese civil aviation pilot workforce. Accordingly, any interpretation of gender-related results in this study should be treated with caution, as the very small female subsample limits representativeness and practical interpretability.

4.1 Descriptive Statistics

4.1.1 Descriptive Statistics of Demographic Characteristics of Respondents

Table 4 demonstrates the Descriptive Statistics of Demographic Characteristics of Respondents. This study collected 200 effective survey samples of frontline pilots in the Chinese civil aviation industry. Basic information included age, gender, education background, rank, years of flying experience, and average annual income.

In terms of age distribution, the 25-49 age group accounted for as much as 94%, the 18-24 age group accounted for 4%, and those over 50 years old accounted 2%. This indicates that the sample group is mainly concentrated in the middle stage of their careers, namely pilots with rich flying experience and in the mature stage of their careers.

In terms of gender, males account for 97.5% while females account for 2.5%. The fact shall be addressed that there were only 5 female samples tested among a total of 200 sample size due to current gender imbalance within Chinese civil aviation industry, thus the statistical significance on female's data and its real-life practicality will be further examined in following sections.

Data on educational background indicates that 96.5% of the respondents hold a bachelor's degree, while 3.5% hold a master's degree or above.

In Ranking distribution, third level (entry-level) pilot and below accounts for 90%, second level (mid-level) pilots comprised 10% of the sample, with no first level (senior level) pilots included. This means the sample is concentrated on operational-level pilots, i.e., frontline operators directly involved in flight missions.

Data on years of flying experience shows that 28.5% of pilots have $0 < n \leq 3$ years of experience, 43% have $3 < n \leq 5$ years, 19% have $5 < n \leq 10$ years, and 9.5% have $n > 10$ years. Pilots with intermediate experience (3-5 years) formed the largest group, accounting for nearly half of the total.

Data on average annual income indicates that income is concentrated between 100,000 and 200,000 CNY. The income distribution is as follows: 50% earn between 100,000 and 200,000 CNY; 31% earn between 200,000 and 500,000 CNY; 11.5% earn less than 100,000 CNY; and 7.5% earn more than 500,000 CNY. This income distribution reflects the middle-to-high income characteristics of civil aviation pilots, showing relatively large salary gap normally caused by different job level, geographical region, airline companies and so on.

Table 4

Descriptive Statistics of Demographic Characteristics of Respondents (n=200)

Name	Options	Frequency	Percentage (%)
Age	18-24	8	4
	25-49	188	94
	Above 50	4	2
Gender	Male	195	97.5
	Female	5	2.5
Education Background	Bachelor's degree	193	96.5
	Master's degree	7	3.5
Pilot rank	Third-class pilot and below	180	90
	Second-class pilot	20	10
Years of flight experience	$0 < n \leq 3$	57	28.5
	$3 < n \leq 5$	86	43
	$5 < n \leq 10$	38	19
	$n > 10$	19	9.5
Average annual income (10K CNY)	$0 < m \leq 10$	23	11.5
	$10 < m \leq 20$	100	50
	$20 < m \leq 50$	62	31
	$50 < m \leq 100$	13	6.5

Name	Options	Frequency	Percentage (%)
	m>100	2	1
Total		200	100

4.1.2 Descriptive Statistics of Measurement Scales

Before conducting descriptive statistical analysis, all constructs were computed from multi-item questionnaire responses using standardized procedures. Each latent variable was represented by the mean value of its corresponding items, following previous environmental behavior studies (Ajzen, 1991; Steg & Vlek, 2009). The items were measured on a five-point Likert scale ranging from 1 (strongly disagree / very little understanding) to 5 (strongly agree / fully understand). Reverse-coded items were adjusted so that higher scores uniformly indicated stronger agreement or higher levels of the construct. Reliability and internal consistency for each construct were verified using Cronbach's α coefficients, all exceeding the accepted threshold of 0.70.

Energy-Saving Awareness (ESA) was computed as the average of three subdimensions: Energy-Saving Knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN). Each subdimension was in turn calculated as the mean of its respective items (Sections B, C, and I). For example, ESK included four items measuring pilots' understanding of energy-saving meaning, policies, differences between flight and general energy-saving, and the relationship between energy-saving and flight safety.

Energy-Saving Intention (ESI) was computed as the mean of five items in Section J capturing willingness and motivation to engage in energy-saving actions (e.g., bringing green behaviors from life to work, reducing carbon emissions).

Stated Energy-Saving Behavior (SESB) was derived from Sections D and G. Each participant selected up to three typical energy-saving behaviors (e.g., minimizing APU use,

optimizing cruise speed, controlling lighting), and the average of these selected scores was used to represent individual behavioral commitment.

Psychological Factors (PF) were operationalized as the average of Self-Efficacy (SE) and Personal Norms (PN), corresponding to Sections F and E, respectively. SE reflected pilots' confidence in their abilities and expertise, while PN reflected internalized moral responsibility for energy-saving conduct.

Situational Factors (SF) were constructed as the average of three subdimensions: Organizational Loyalty (OL) (Section K), Policy Incentives (PI) (Section L), and Energy-Saving Subculture (ESS) (Sections M and O). These represented the institutional, motivational, and cultural contexts influencing pilot behavior.

Table 5 presents the descriptive statistics for each measured variable, including the minimum (Min), maximum (Max), mean (M), and standard deviation (SD). Overall, the means of most variables are at a moderate level (between 2.4 and 3.6), and the standard deviations are moderate (0.5–0.9), indicating that the sample group generally has consistent attitudes toward energy conservation awareness and behavior, but individual differences are still somewhat representative.

Among the comprehensive and attitudinal variables, Energy-Saving Knowledge (ESK) has the highest mean ($M=3.563$, $SD=0.781$), indicating that pilots generally possess a strong reserve of energy-saving knowledge. This is consistent with the energy-saving training and fuel management system long implemented in the civil aviation industry. Environmental Values (EV) has a mean of 3.321 ($SD=0.934$), showing that pilots generally have a moderately high level of environmental values, but there are still significant fluctuations. Subjective Norms (SN) has a

mean of 3.373 (SD=0.841), indicating that organizational culture and group norms play an important role in the formation of energy-saving awareness, but have not yet reached a high level of behavioral drive. At last, Energy-Saving Awareness (ESA) has a mean of 3.419 (SD=0.637), which is at a moderately high level, indicating that most pilots are able to proactively recognize the importance of energy conservation.

On the second section regarding Energy-Saving Intention (ESI), the mean (3.601) is slightly higher (SD=0.792), indicating that although some pilots agree with the concept of energy conservation at the conscious level, the strength of their reported intention is still influenced by incentives and environmental conditions.

The mean of Stated Energy-Saving Behavior (SESB) is 3.635 (SD=0.633), one of the highest among all variables, indicating that the surveyed pilots reported relatively frequent engagement in the SESB items, such as throttle optimization, taxi energy saving, and equipment shutdown procedures. This reflects the significant constraining and guiding effect of systematic energy-saving management in civil aviation on self-reported behavior, although this study measures stated rather than directly observed operational behavior.

Self-Efficacy (SE) is 2.435 (SD=0.731), Personal Norms (PN) is 2.382 (SD=0.956), and Psychological Factor (PF) is 2.404 (SD=0.671). These results indicate that pilots generally have weaker Self-Efficacy (SE) and psychological linkage, possibly due to strict flight operating procedures and lower individual autonomy, which limits their subjective sense of control over Stated Energy-Saving Behavior (SESB).

The mean score for Organizational Loyalty (OL) is 2.651 (SD=0.835), below the scale midpoint of 3. The mean score for Policy Incentives (PI) is 2.872 (SD=0.840), slightly below the midpoint of the five-point scale. The mean score for Energy-Saving Subculture (ESS) is 2.621

(SD=0.663), reflecting that energy-saving culture is still in the cultivation stage; although the concept of energy saving has been accepted, a deep-seated organizational cultural identity has not yet been formed.

The mean of Situational Factors (SF) is 2.716 (SD=0.513), with the smallest standard deviation, indicating that the differences in pilot behavior under Situational Factors (SF) are relatively small, and the association with situational variables is relatively consistent, but the overall strength is limited.

Table 5

Descriptive Statistics of Measurement Scales (n=200)

Name	Min	Max	M	SD
Energy-Saving Knowledge (ESK)	1.512	4.712	3.563	0.781
Environmental Values (EV)	1.012	5.00	3.321	0.934
Subjective Norms (SN)	1.752	5.00	3.373	0.841
Energy-Saving Awareness (ESA)	1.821	4.653	3.419	0.637
Energy-Saving Intention (ESI)	1.251	5.000	3.601	0.792
Stated Energy-Saving Behavior (SESB)	1.751	5.000	3.635	0.633
Self-Efficacy (SE)	1.000	5.000	2.435	0.731
Personal Norm (PN)	1.000	5.000	2.382	0.956
Psychological Factor (PF)	1.124	4.374	2.404	0.671
Organizational Loyalty (OL)	1.000	4.252	2.651	0.835
Policy Incentives (PI)	1.249	4.754	2.872	0.84
Energy-Saving Subculture (ESS)	1.000	4.752	2.621	0.663
Situational Factors (SF)	1.500	3.913	2.716	0.513

4.2 Normality Test

Table 6 presents the normality test results for each measured variable using skewness and Kurtosis statistics. Overall, the skewness values for the observed indicators range from -0.693 to 0.890, and the Kurtosis values range from -0.829 to 1.098. According to the commonly used thresholds proposed by Kline (2015) and Hair et al. (2019), these values fall well within the range

typically regarded as compatible with approximate normality in social science data. Therefore, the observed variables in this study do not show problematic departures from normality and can be treated as meeting the practical statistical preconditions for the subsequent regression analyses.

Table 6

Normality test (n=200)

Name	M	SD	Skewness	kurtosis
ESK1	3.64	0.874	-0.596	-0.142
ESK2	3.615	0.849	-0.365	-0.198
ESK3	3.54	0.945	-0.513	-0.34
ESK4	3.545	0.934	-0.693	-0.239
EV1	3.355	0.997	-0.454	0.121
EV2	3.31	1.058	-0.493	-0.11
EV3	3.38	1.04	-0.57	0.115
EV4	3.335	0.989	-0.431	0.148
SN1	3.39	1.041	-0.108	-0.829
SN2	3.385	1.059	-0.053	-0.69
SN3	3.405	1.018	0.073	-0.759
SN4	3.37	1.034	0.009	-0.656
ESA1	3.395	1.032	-0.103	-0.782
ESA2	3.4	1.047	-0.064	-0.618
ESA3	3.38	1.035	0.092	-0.83
ESA4	3.35	1.05	0.022	-0.744
ESI1	3.6	0.951	-0.326	-0.351
ESI2	3.59	0.968	-0.409	-0.125
ESI3	3.65	0.965	-0.398	-0.21
ESI4	3.56	0.975	-0.466	-0.053
SESB1	3.67	0.839	-0.189	-0.261
SESB2	3.66	0.841	-0.106	-0.331
SESB3	3.64	0.839	-0.167	-0.268
SESB4	3.635	0.914	-0.565	0.543
SESB5	3.66	0.835	-0.022	-0.625
SESB6	3.625	0.859	-0.202	-0.333
SESB7	3.74	0.84	-0.196	-0.299
SE1	2.385	0.878	0.469	0.356
SE2	2.44	0.86	0.786	0.944
SE3	2.5	0.924	0.463	0.364
SE4	2.45	0.944	0.616	0.64

Name	M	SD	Skewness	kurtosis
SE5	2.375	0.882	0.519	0.366
SE6	2.48	0.879	0.733	0.832
SE7	2.485	0.908	0.473	0.536
PN1	2.34	1.109	0.745	0.002
PN2	2.46	1.093	0.453	-0.538
PN3	2.375	1.091	0.735	-0.037
PN4	2.345	1.115	0.693	-0.23
OL1	2.615	1.059	0.053	-0.69
OL2	2.595	1.018	-0.073	-0.759
OL3	2.63	1.034	-0.009	-0.656
OL4	2.74	1.033	-0.068	-0.631
PI1	2.88	1.005	0.004	-0.151
PI2	2.865	1.031	-0.255	-0.373
PI3	2.84	0.974	-0.102	0.11
ESS1	2.65	0.849	0.342	0.035
ESS2	2.68	0.867	0.624	0.464
ESS3	2.505	0.796	0.89	1.098
ESS4	2.66	0.859	0.526	0.479

4.3 Common Method Bias

Since the main variables in this study were measured through the same self-report questionnaire, common method bias needed to be considered. Following Podsakoff et al. (2003), this study tried to reduce this risk in both the questionnaire design and the later data check. In the questionnaire, respondents were told that their answers would be anonymous and confidential. The items were also adapted from previous studies where possible, and the wording was reviewed to make the questions clear and less leading.

Harman's single-factor test was then used as a preliminary check. The eigenvalue of the first principal component before rotation was 11.279, explaining 25.065% of the total variance. This suggests that one single factor did not explain most of the variance in the data. However, more recent work also points out that common method bias is complex, common, and difficult to

fix with a single test after data collection (Podsakoff et al., 2024). Therefore, the Harman test result should only be understood as showing that serious single-factor dominance was unlikely.

4.4 Reliability and Validity Testing

The questionnaire was developed by adapting and refining well-established scales that have been validated and widely used in previous studies, thus forming a measurement system with clear theoretical grounding and empirical support (DeVellis, 2017). Specifically, Energy-Saving Awareness (ESA) was designed as a second-order construct consisting of Energy-Saving Knowledge (ESK), Environmental Values (EV), and Subjective Norms (SN). The ESK items were adapted from recent measures of energy-saving behavior and were further revised in line with relevant fuel-management and operational guidance issued by the Civil Aviation Administration of China (2021), so that the items would adequately cover key areas such as in-flight energy-saving practices, policy awareness, and the link between energy saving and flight safety. The EV items were based on Stern's (2000) Value-Belief-Norm (VBN) framework and established scales of pro-environmental value orientation developed by De Groot and Steg (2008). These items measured value-related dimensions such as awareness of responsibility, moral commitment, and willingness to sacrifice personal interests for environmental goals. The SN items were drawn from the subjective norm tradition within Ajzen's (1991) Theory of Planned Behavior (TPB) and were informed by the item wording used by Han et al. (2010) to capture contextual normative pressure, with emphasis on influences such as supervisors, peer examples, and perceived social expectations.

4.4.1 Reliability Test

At the first-order construct level, the α coefficient for Energy-Saving Awareness (ESA) is 0.832, indicating that it validates the stable structure of respondents' knowledge of energy conservation, value orientation, and social norm consideration, with good internal consistency

among items. The α coefficient for Energy-Saving Intention (ESI) is 0.840, also within the robust range, indicating that respondents' energy-saving intentions have a measurable and consistent structure, with three or more items effectively reflecting the psychological strength of behavioral intentions. The α coefficient for Stated Energy-Saving Behavior (SESB) reaches 0.888, indicating a high degree of consistency among the actually stated energy-saving behaviors, effectively representing latent variables at the behavioral level. Notably, the α coefficient for Psychological Factors (PF) is as high as 0.967, theoretically demonstrating very high internal consistency in its measurement content, reflecting a clear and concise structure of the psychological mechanism jointly constituted by Self-Efficacy (SE) and Personal Norms (PN). The α for Situational Factors (SF) is 0.834, indicating that external environmental factors (such as Organizational Loyalty, Policy Incentives, and Energy-Saving Subculture) also exhibit good stability in the scale design and can be included as reliable situational independent variables or moderating variables in subsequent models.

The reliability test of the secondary indicators further supports the above conclusions. As a multidimensional construct, ESA's sub-constructs, Energy-Saving Knowledge (ESK) ($\alpha = 0.898$), Environmental Values (EV) ($\alpha = 0.920$), and Subjective Norms (SN) ($\alpha = 0.832$), all show significant internal consistency. The high reliability of the ESK indicates strong correlations among the measurement items of energy-saving knowledge, accurately capturing respondents' understanding of energy-saving common sense, technologies, and policies. The α value of EV reaches 0.920, suggesting that environmental values, as a relatively stable individual value orientation, can characterize respondents' value structure from multiple dimensions, including value commitment, environmental responsibility, and ecological ethics. While the α value of SN is slightly lower than the previous two, it is still within the excellent range, indicating that

individuals' awareness regarding social expectations, norms of others, and subjective pressure has a stable structure.

For Psychological Factors (PF), Self-Efficacy (SE) ($\alpha = 0.919$) and Personal Norms (PN) ($\alpha = 0.889$) both showed strong internal consistency. This suggests that the PF items were generally consistent in measuring related psychological factors, including self-efficacy and personal norms. For Situational Factors (SF), Organizational Loyalty (OL) ($\alpha = 0.825$), Policy Incentives (PI) ($\alpha = 0.867$), and Energy-Saving Subculture (ESS) ($\alpha = 0.797$) also showed acceptable internal consistency.

In summary, the reliability test results of the scales in this study show that all primary and secondary indicators have high internal consistency, and no problems such as low reliability, excessive item heterogeneity, or dispersed measurement dimensions were identified. These results provide a dependable measurement foundation for the subsequent regression-based analyses in this dissertation.

Table 7

Reliability Test (n=200)

Primary Indicator	Secondary Indicator	Cronbach's α Coefficient	Primary Indicator Cronbach's α Coefficient
Energy-Saving Awareness (ESA)	Energy-Saving Knowledge (ESK)	0.898	0.832
	Environmental Values (EV)	0.920	
	Subjective Norms (SN)	0.832	
Energy-saving Intention (ESI)	-	0.840	
Stated Energy-Saving Behavior (SESB)	-	0.888	
Psychological Factors (PF)	Self-Efficacy (SE)	0.919	0.967

Primary Indicator	Secondary Indicator	Cronbach's α Coefficient	Primary Indicator Cronbach's α Coefficient
	Personal Norms (PN)	0.889	
Situational Factors (SF)	Organizational Loyalty (OL)	0.825	0.834
	Policy Incentives (PI)	0.867	
	Energy-Saving Subculture (ESS)	0.797	

4.4.2 Validity Test

To ensure the scale's analyzability in terms of construct validity, this study further conducted Kaiser-Meyer-Olkin (KMO) tests on each primary and secondary indicator. The KMO value is primarily used to measure whether the sample data is suitable for factor analysis; its range is 0–1. Generally, a $KMO < 0.6$ indicates poor validity, 0.6–0.7 is average, 0.7–0.8 is good, 0.8–0.9 is very good, and greater than 0.9 indicates excellent validity (Kaiser, 1974; Field, 2013). The KMO coefficients obtained in this study were all above 0.76, and exceeded 0.83 in several constructs, indicating strong correlations among the scale items, a clear structure, and satisfactory validity, consistent with the methodological guidelines proposed in prior measurement literature (Hair et al., 2019).

At the primary indicator level, the overall KMO of Energy-Saving Awareness (ESA) is 0.832, which is considered “very suitable for factor analysis”, indicating a high degree of commonality among the items in ESA. This provides methodological support for subsequent verification of its three-dimensional structure (Energy-Saving Knowledge, Environmental Values, and Subjective Norms). The KMO of Energy-Saving Intention (ESI) is 0.763, falling within the “good” range, showing a reasonable correlation structure among its items and the ability to

effectively extract latent variables at the intention level. The KMO of Stated Energy-Saving Behavior (SESB) is as high as 0.853, indicating a high level of suitability for factor analysis and the ability to stably reflect respondents' SESB patterns. Furthermore, the overall KMO for Psychological Factors (PF) was 0.871, reaching a level "very suitable for factor analysis", indicating a clear internal structure of psychological factors. Respondents' responses to the two psychological traits, Self-Efficacy and Personal Norms, showed a high correlation, supporting a second-order construction of the psychological dimension. For Situational Factors (SF), the KMO value was 0.837, also at a high level, indicating a strong structural correlation between external factors such as organizational context, policy stimuli, and energy-saving subcultures.

Further observation of the secondary indicators revealed that the KMO values for different dimensions all performed well or even excellently. Of the three secondary indicators in ESA, Energy-Saving Knowledge (ESK) has a KMO of 0.844, Environmental Values (EV) has 0.854, and Subjective Norms (SN) has 0.811. All three exceed 0.80, indicating that the three cognitive components of ESA possess good item convergence and factor extraction potential, thus demonstrating the scientific validity of the internal dimensions of ESA. In the psychological factors section, Self-Efficacy (SE) has a KMO of 0.796, and Personal Norms (PN) has 0.839, showing that the psychological variables all possess a good common structure, allowing for the effective extraction of their latent factors. The three secondary indicators of Situational Factors (SF) – Organizational Loyalty (OL) (0.804), Policy Incentives (PI) (0.796), and Energy-Saving Subculture (ESS) (0.796) – all exceeded 0.79, indicating a strong interrelationship among the situational factors and a clear scale structure.

Table 8

Validity Test (n=200)

Primary Indicator	Secondary Indicator	KMO	Primary Indicator KMO
Energy-Saving Awareness (ESA)	Energy-Saving Knowledge (ESK)	0.844	0.832
	Environmental Values (EV)	0.854	
	Subjective Norms (SN)	0.811	
Energy-saving Intention (ESI)	-	0.763	
Stated Energy-Saving Behavior (SESB)	-	0.853	
Psychological Factors (PF)	Self-Efficacy (SE)	0.796	0.871
	Personal Norms (PN)	0.839	
Situational Factors (SF)	Organizational Loyalty (OL)	0.804	0.837
	Policy Incentives (PI)	0.796	
	Energy-Saving Subculture (ESS)	0.796	

4.5 Correlation Analysis

This study further examined the linear correlations among the core latent variables using Pearson correlation analysis to assess the strength and direction of the associations among the constructs of Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), Stated Energy-Saving Behavior (SESB), Psychological Factors (PF), and Situational Factors (SF). Pearson correlation coefficients ranged from -1 to 1, with larger absolute values indicating stronger linear correlations and positive values representing positive correlations. In this study, all variables showed significant positive correlations, with a uniform significance level of $***p < 0.001$, indicating robust statistical correlations among the constructs. This characteristic provides important empirical support for constructing structural models of SESB.

ESA showed high correlations with other variables, particularly with ESI ($r = 0.555^{***}$), SESB ($r = 0.540^{***}$), and SF ($r = 0.556^{***}$), with correlation coefficients exceeding 0.54, indicating a moderately high level. This suggests that respondents' energy-saving awareness is statistically related to energy-saving intentions, stated energy-saving behavior, and the perception of external situational factors. While the correlation between ESA and PF ($r = 0.428^{***}$) was slightly lower than the aforementioned correlations, it remained at a moderate level, indicating that although individual self-efficacy and personal norms are not direct components of ESA, their psychological mechanisms are still significantly related to awareness. This overall result is consistent with the awareness-intention-stated behavior perspective, suggesting that energy-saving awareness is an important variable statistically associated with energy-saving intentions and stated behaviors.

The significant moderate correlation between ESI and SESB ($r = 0.515^{***}$) indicates that stronger energy-saving intentions are associated with higher SESB scores, consistent with the TPB view that intention is a proximal predictor of behavior, while in this study the behavioral outcomes are limited to self-reported behavior. ESI and PF ($r = 0.317^{***}$) and SF ($r = 0.445^{***}$) also showed positive correlations, indicating that psychological and external situational factors are statistically associated with intention. In particular, the correlation between SF and ESI was higher than that between PF, suggesting that organizational culture, policy incentives, and group atmosphere may be more strongly associated with respondents' willingness to engage in energy-saving practices than internalized psychological factors. Their value lies in organizational management, energy-saving policy design, and cultural guidance.

At the stated behavioral level, SESB and ESA ($r = 0.540^{***}$), and ESI ($r = 0.515^{***}$) and SF ($r = 0.511^{***}$) all showed strong correlations, indicating that stated energy-saving behavior is

not only linked to intention but also associated with individual energy-saving awareness and external situational support. The correlation coefficient between SESB and PF is 0.303^{***} , which, although moderately low, is still significant. This indicates that psychological factors such as self-efficacy and personal norms have a certain effect on stated behavior, but their strength is weaker than that of awareness and situational factors. Overall, the high correlation structure of SESB suggests that stated behavioral performance is the result of multiple factors working together, rather than being explained by a single factor.

Looking at PF, the correlations with other constructs are relatively weak. Specifically, the correlation with ESA is $r = 0.428^{***}$, with ESI is $r = 0.317^{***}$, with SESB is $r = 0.303^{***}$, and with SF is $r = 0.241^{***}$. These moderate or weak positive correlations indicate that psychological factors have a limited but present association with energy-saving awareness, intention, and stated behavior. Consistent with numerous behavioral theory studies, psychological factors tend to relate to an individual's intrinsic motivation, sense of responsibility, and self-evaluation of behavior, rather than being the sole predictor of overt behavior. Its low correlation also suggests that PF can function as an independent dimension in the structural model, mediating or moderating its role, rather than being a variable overlapping with ESA, ESI, or SF.

SF generally exhibits high correlations with other variables, particularly with ESA ($r = 0.556^{***}$) and SESB ($r = 0.511^{***}$), both showing moderately high correlations. This indicates a close relationship between external situational factors and awareness structures and stated behavioral performance. The correlation between SF and ESI ($r = 0.445^{***}$) is also high, further validating the significant role of policy incentives, organizational climate, and group culture in shaping energy-saving intentions. The lowest correlation exists between SF and PF ($r = 0.241^{***}$), suggesting a weak interaction between situational and psychological factors. These factors may

independently affect stated energy-saving behavioral pathways and belong to different systems within the structural model.

Table 9

Pearson Correlation Analysis (n=200)

	Energy-Saving Awareness (ESA)	Energy-Saving Intention (ESI)	Stated Energy-Saving Behavior (SESB)	Psychological Factors (PF)	Situational Factors (SF)
Energy-Saving Awareness (ESA)	1				
Energy-Saving Intention (ESI)	0.555***	1			
Stated Energy-Saving Behavior (SESB)	0.540***	0.515***	1		
Psychological Factors (PF)	0.428***	0.317***	0.303***	1	
Situational Factors (SF)	0.556***	0.445***	0.511***	0.241***	1

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

4.6 Hypothesis Testing

4.6.1 Regression Analysis of Energy-Saving Awareness on Energy-Saving Intention

Table 10 examines the association of Energy-Saving Awareness (ESA) with Energy-Saving Intention (ESI) using multiple linear regression analysis. Demographic characteristics such as age, gender, educational background, pilot rank, years of flight experience, and average annual income are included as control variables in the model to ensure that the effect estimation of ESA is not associated with external factors. The overall model statistical results showed an R^2 of 0.354 and an adjusted R^2 of 0.330, indicating that the regression model could explain approximately 33.0%

of the ESI variance, which is considered moderately high in social science research, demonstrating good explanatory power. The F-test result was $F(7,192) = 15.007$, $p < 0.001$, indicating that the model was significant overall, demonstrating that the independent and control variables could significantly predict ESI. Furthermore, the Durbin-Watson value was 1.866, close to the ideal value of 2, indicating that there was no significant autocorrelation in the residuals, satisfying the basic assumptions of linear regression analysis, and the model estimation was reliable.

No statistically significant associations with ESI were detected for age, gender, educational background, pilot rank or average annual income in this sample (all $p > 0.05$). Years of flight experience showed a statistically supported relationship ($B=0.234$, $\beta=0.273$, $t=3.013$, $p=0.003$), with the highest standardized coefficient among the control variables, indicating that the more experienced a pilot is, the more likely they are to develop a stronger desire for energy conservation. This finding has a clear industry logic: experienced pilots are more familiar with fuel cost management, engine performance characteristics, fuel-saving flight techniques (such as single-engine taxiing, optimized climb, and cruise economic speed), and the implementation requirements of airline energy-saving policies. Therefore, they are better able to recognize the importance of energy-saving practices for flight quality, fleet costs, and the company's overall carbon emission reduction performance. This result not only reveals the empowering effect of professional experience but also implies that senior pilots may play a key role in building an energy-saving culture. At the policy level, this could be used to further promote the concept of energy conservation through experience transfer mechanisms, mentorship programs, and exemplary behavior by senior pilots.

The independent variable ESA showed a strong and highly significant positive association in the model ($B=0.548$, $\beta=0.431$, $t=6.099$, $p < 0.001$), indicating that pilots with higher reported

levels of energy-saving awareness also tended to report stronger energy-saving intention in this sample. This result is consistent with the theoretical expectation that awareness and normative recognition are linked to motivational readiness, while still being interpreted as an association rather than as a definitive causal effect.

Regarding multicollinearity, the VIF of each variable did not exceed 2.5, and the Tolerance was greater than 0.40, indicating that the model does not have a multicollinearity problem, and the estimation results are reliable. The VIF of ESA is 1.483, which is within the safe range, further supporting that it has no redundant relationship with other variables, and therefore its impact on ESI is real and independent. This result statistically supports hypothesis H1.

Table 10

Regression Analysis of Energy - Saving Awareness (ESA) on Energy- Saving Intention (ESI)

(n=200)

	Unstandardized Coefficient		Standardized Coefficient	<i>t</i>	<i>p</i>	Collinearity Diagnosis	
	B	Standard Error	Beta			VIF	Tolerance
Constant	0.84	0.698	-	1.204	0.23	-	-
Age	0.078	0.213	0.024	0.368	0.713	1.283	0.779
Gender	0.364	0.307	0.072	1.185	0.237	1.093	0.915
Education Background	0.025	0.254	0.006	0.098	0.922	1.035	0.966
Rank	-0.091	0.192	-0.034	-0.473	0.637	1.574	0.635
Years of Flight Experience	0.234	0.078	0.273	3.013	0.003**	2.432	0.411
Average Annual Income	-0.029	0.077	-0.029	-0.377	0.706	1.813	0.551
Energy-Saving Awareness (ESA)	0.548	0.09	0.431	6.099	0.000***	1.483	0.674
R ²	0.354						
Adjusted R ²	0.33						
F	F (7,192)=15.007,p=0.000						
D-W	1.866						

Note: DV= Energy-Saving Intention (ESI)

* p<0.05 ** p<0.01 *** p<0.001

4.6.2 Regression Analysis of Energy-Saving Awareness on Stated Energy-Saving Behavior

Table 11 presents a multiple linear regression analysis of the relationship between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB). Age, gender, educational background, pilot rank, years of flight experience, and average annual income were further included as control variables to ensure the robustness and reliability of the ESA effect estimate after excluding demographic factors. The model also showed a high level of explained variance, with an R^2 of 0.75 and an adjusted R^2 of 0.74, which suggests that ESA and the control variables were strongly related to SESB in this sample. The F-test results show $F(7,192)=82.122$, $p=0.000$, indicating a highly significant overall model that supports the inference that all independent variables jointly associate with SESB. Meanwhile, the Durbin-Watson value was 1.878, close to the ideal range of 1.5–2.5, indicating that there was no significant autocorrelation problem in the model residuals. Multicollinearity diagnostics also showed that the VIF values of all variables were well below 5, and the Tolerance values were all greater than 0.40, indicating no risk of multicollinearity and that the regression coefficient estimates were stable and reliable.

The core independent variable ESA also had a statistically supported relationship with SESB ($B=0.153$, $\beta=0.145$, $t=3.287$, $p=0.001$), indicating that pilots with higher energy conservation awareness tended to report more frequent energy-saving behaviors in their operational work. The standardized coefficient of ESA was smaller than that of Years of Flight Experience, but ESA was still positively related to SESB. This suggests that energy-saving awareness was one relevant factor associated with pilots' stated energy-saving behavior in this sample. However, the regression result alone does not explain why this relationship exists. Possible reasons may include greater operational familiarity, more exposure to fuel-saving procedures, or stronger work routines. As a cognitive variable, ESA typically includes understanding of the

significance of energy conservation, the consequences of carbon emissions, national carbon neutrality goals, and energy conservation policies and technologies. This statistically supported relationship means that higher levels of pilots' energy conservation knowledge and awareness are significantly associated with higher levels of stated energy-saving behavior. This result is consistent with the awareness–behavior perspective, suggesting that awareness may provide an important basis for stated behavior, and also aligns with the Theory of Planned Behavior (TPB), which emphasizes the role of attitudes and awareness in behavior formation. In other words, pilots are not mechanically reporting energy-saving operations unconsciously, but rather expressing these stated behaviors through understanding, value identification, and a sense of professional responsibility. This result supports hypothesis H2.

Table 11

Regression Analysis of Energy-Saving Awareness (ESA) on Stated Energy-Saving Behavior (SESB)

(n=200)

	Unstandardized Coefficient		Standardized Coefficient	<i>t</i>	<i>p</i>	Collinearity Diagnosis	
	B	Standard error	Beta			VIF	Tolerance
Constant	1.632	0.361	-	4.516	0.000***	-	-
Age	0.025	0.11	0.009	0.226	0.822	1.283	0.779
Gender	0.278	0.159	0.066	1.747	0.082	1.093	0.915
Educational Background	-0.057	0.132	-0.016	-0.43	0.668	1.035	0.966
Pilot Rank	0	0.099	0	-0.004	0.997	1.574	0.635
Years of Flight Experience	0.551	0.04	0.77	13.673	0.000***	2.432	0.411
Average Annual Income	0.031	0.04	0.038	0.789	0.431	1.813	0.551
Energy-Saving Awareness (ESA)	0.153	0.047	0.145	3.287	0.001**	1.483	0.674
R ²	0.75						
Adjusted R ²	0.74						
F	F (7,192)=82.122,p=0.000						
D-W	1.878						

Note: DV= Stated Energy-Saving Behavior (SESB)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

4.6.3 Regression Analysis of Energy-Saving Intention on Stated Energy-Saving Behavior

Table 12 presents the results of a multiple linear regression analysis of Energy-Saving Intention (ESI) on Stated Energy-Saving Behavior (SESB). Demographic variables such as age, gender, educational background, pilot rank, years of flight experience, and average annual income were controlled for to ensure the model estimates accurately reflect the correlation between ESI and SESB after excluding external interference. Overall, the model exhibits a very high goodness of fit, with an R^2 of 0.755 and an adjusted R^2 of 0.746. This means the model can explain approximately 75% of the variance in respondents' stated energy-saving behavior. The high level of explained variance should be interpreted carefully because the study used cross-sectional self-report data and conceptually related constructs. The result should therefore be understood as evidence of a strong association in this sample, rather than as evidence that SESB can be fully predicted by the model. The F-test result is $F(7,192)=84.378$, $p=0.000$, indicating that the overall model is statistically significant, and all independent variables collectively have a substantial association with SESB. Although the model's Durbin-Watson value of 1.941 is slightly below the ideal range, such results are occasionally observed in cross-sectional data. The value is not low enough to fall into the severe autocorrelation risk range, and combined with the residual distribution and collinearity indicators, it can still be considered within an acceptable range. Furthermore, the multicollinearity test shows that the VIF for all variables is below 3, and the tolerance is between 0.464 and 0.969, indicating that the model does not have a significant collinearity problem, and the estimation results can be considered robust and reliable.

The relationship between ESI and SESB is also statistically significant ($B=0.131$, $\beta=0.158$, $t=3.871$, $p<0.001$), indicating that pilots with stronger energy-saving intention report more energy-saving behaviors. This has substantial statistical and theoretical significance, supporting the basic

	Unstandardized Coefficient		Standardized Coefficient	<i>t</i>	<i>p</i>	Collinearity Diagnosis	
	B	Standard error	Beta			VIF	Tolerance
D-W	1.941						

Note: DV=Stated Energy-Saving Behavior (SESB)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

4.6.4 Testing the Mediation Role of Energy-Saving Intention between Energy-Saving Awareness and Stated Energy-Saving Behavior

Table 13 reports the mediation test among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB). The percentile bootstrap method was used to test the indirect effect. Since all main variables were measured at the same time, the mediation result should be understood as an indirect relationship that is consistent with the proposed model.

The total effect of ESA on SESB was 0.571 ($p < 0.001$). This means that higher energy-saving awareness was positively related to higher stated energy-saving behavior. The indirect effect through ESI was 0.183, with a 95% bootstrap confidence interval from 0.103 to 0.246. Since this interval did not include zero, the indirect effect was statistically significant. The direct effect of ESA on SESB remained significant at 0.387 ($p < 0.001$), which suggests a partial mediation pattern. This result shows that energy-saving intention plays a linking role between energy-saving awareness and stated energy-saving behavior. It is also consistent with the awareness–intention–stated behavior pathway and with the TPB view that intention is closely related to behavior. However, because the data are cross-sectional and self-reported, the study cannot prove the exact time order among awareness, intention, and behavior. Therefore, the mediation result should be interpreted as a statistically supported relationship within the proposed model, rather than as proof of a causal chain.

Table 13*Bootstrap Method for Mediation Effect of the Total Dimension of Energy- Saving Intention (ESI)**(n=200)*

ESA → ESI → SESB	Path Coefficients	T Statistics	P Values
Direct Effect	0.387	10.214	0.000
Specific Indirect Effects	0.183	5.083	0.000
Total Effects	0.571	13.909	0.000

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

bootstrap type = percentile bootstrap method

4.6.5 Testing the Moderation Effect of Psychological Factors

The core purpose of Table 14 is to examine whether Psychological Factors (PF) play a significant moderating role in the relationship between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI). From the stratified regression results, Model 1 only includes control variables and ESA, while Model 2 adds the main effect of PF and the ESA×PF interaction term. If the moderating effect is valid, the interaction term should be statistically significant, and the explanatory power (R^2) of the model should be significantly improved in Model 2. First, comparing the goodness of fit of the two models, the R^2 of Model 1 is 0.354, while that of Model 2 increases to 0.387. The adjusted R^2 also increases from 0.330 to 0.358, indicating that the explanatory power of the model does indeed improve after adding PF and the interaction term, and there is no spurious increase, reflecting that the moderating effect has a statistically incremental contribution. Secondly, the key evidence for the moderating effect comes from the interaction term ESA×PF, with a coefficient of 0.319, $t=2.942$, and $p<0.01$, reaching a significant level and indicating a positive effect. This significant interaction term suggests that PF alters the strength of the effect of ESA on ESI: when PF is high, the promoting effect of ESA on ESI is stronger; when

PF is low, this effect is weakened. It is worth noting that the insignificance of PF itself in Model 2 ($p>0.05$) does not affect its validity as a moderating variable, because theoretically, a moderating variable does not need to have a main effect on the dependent variable; its key is whether it can significantly affect the relationship between the independent and dependent variables, and the significant interaction term in this model fully demonstrates this point. At the same time, the VIF of the model is less than 3, and the tolerance is also high, indicating that there is no multicollinearity bias in the results, and the significance of the interaction term is a reliable statistical result, rather than caused by redundancy between variables. In summary, the significant ESA×PF interaction term, the significantly improved explanatory power of Model 2, and the robust multicollinearity test jointly demonstrate that PF does indeed play a significant moderating role in the relationship between ESA and ESI, and that this moderating role is positive. In other words, the higher the level of psychological factors, the stronger the association appears to be between energy-saving awareness and energy-saving intention. The moderation result is statistically supported, has theoretical and empirical relevance, and appears consistent with hypothesis H5.

Table 14

Testing the moderation Effect of Psychological Factors (n=200)

	Model 1	Model 2
Constant	2.723*** (4.430)	2.592*** (4.293)
Age	0.078 (0.368)	0.120 (0.573)
Gender	0.364 (1.185)	0.419 (1.390)
Educational Background	0.025 (0.098)	0.112 (0.447)
Pilot Rank	-0.091 (-0.473)	-0.142 (-0.753)
Years of Flight Experience	0.234** (3.013)	0.234** (3.074)

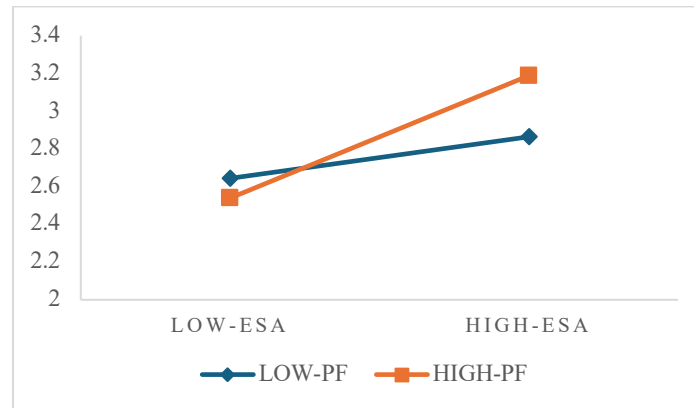
	Model 1	Model 2
Average Annual Income (10k CNY)	-0.029 (-0.377)	-0.022 (-0.295)
Energy-Saving Awareness (ESA)	0.548*** (6.099)	0.434*** (4.508)
Psychological Factor (PF)		0.078 (1.041)
Energy-Saving Awareness (ESA)*Psychological Factors (PF)		0.319** (2.942)
R ²	0.354	0.387
Adjusted R ²	0.33	0.358
F	F (7,192)=15.007, p=0.000	F (9,190)=13.354, p=0.000

Note: DV=Energy-Saving Intention (ESI)

* p < 0.05 ** p < 0.01 *** p < 0.001 (The value in parentheses is the t- value)

Figure 9

Testing the moderation Effect of Psychological Factors



4.6.6 Testing the Moderation Effect of Situational Factors

The main purpose of Table 15 is to examine whether Situational Factors (SF) play a significant moderating role in the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB). To this end, the table uses a hierarchical regression method to construct Model 3 (containing only control variables and ESI) and Model 4 (including SF and the

interaction term $ESI \times SF$). The moderating effect is determined by comparing the changes in explanatory power and the significance of the interaction term between the two models. First, regarding the overall model fit, Model 3 has an R^2 of 0.755 and an adjusted R^2 of 0.746, while Model 4's R^2 increases to 0.770 after adding the moderating variable, and the adjusted R^2 also increases to 0.759, indicating that SF and its interaction term provide additional explanatory power to the model. Although the increase is not extremely large, such incremental explanatory power is theoretically significant in moderating effect research, indicating that situational conditions may help explain differences in the strength of the intention- stated behavior relationship. Secondly, the key evidence for the moderating effect comes from the interaction term. $ESI \times SF$ is significant in Model 4 ($B=0.196$, $t=3.158$, $p<0.01$) and the coefficient is positive, demonstrating that SF is associated with variation in the strength of the ESI–SESB relationship. When SF is high (e.g., organizational culture supports energy conservation, policy incentives are clear, and the energy-saving atmosphere is strong), ESI's ability to convert SESB is enhanced; conversely, when SF is weak (insufficient energy-saving atmosphere, lack of organizational incentives), even if pilots have the intention to save energy, it is difficult to translate this into stated energy-saving behaviors. In other words, the role of ESI is not fixed but varies depending on the context, which is the essential manifestation of the moderating effect. This result statistically supports hypothesis H6.

Table 15

Testing the Moderation Effect of Situational Factors (n=200)

	Model 3	Model 4
Constant	2.293*** (7.258)	2.336*** (7.587)
Age	-0.015 (-0.137)	0.014 (0.136)
Gender	0.216 (1.368)	0.197 (1.283)

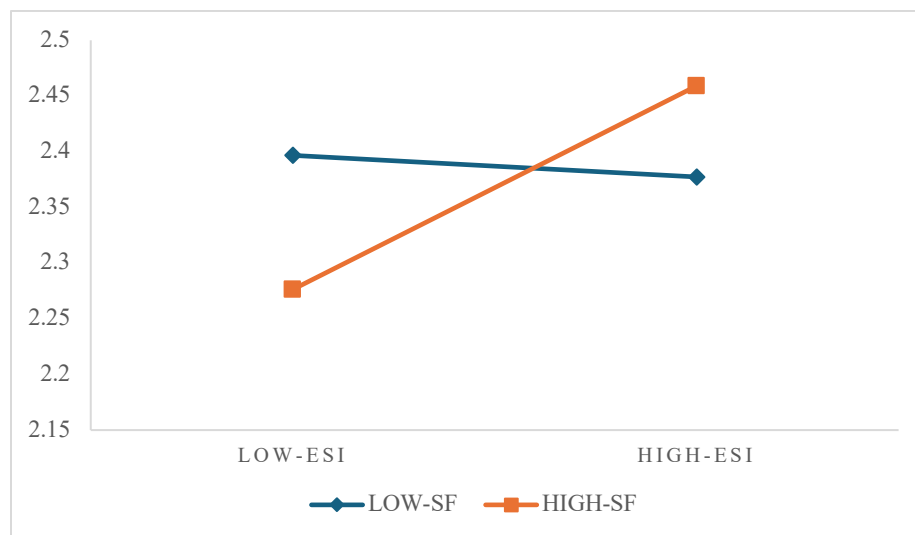
	Model 3	Model 4
Educational Background	-0.045 (-0.346)	-0.055 (-0.436)
Pilot Rank	-0.008 (-0.086)	0.007 (0.076)
Years of Flight Experience	0.558*** (14.855)	0.532*** (13.779)
Average Annual Income	0.027 (0.692)	0.027 (0.712)
Energy-Saving Intention (ESI)	0.131*** (3.871)	0.082* (2.274)
Situational Factors (SF)		-0.117* (-2.120)
Energy-Saving Intention (ESI)*Situational Factors (SF)		0.196** (3.158)
R ²	0.755	0.77
Adjusted R ²	0.746	0.759
F	F (7,192)=84.378, p=0.000	F (9,190)=70.631, p=0.000

Note: DV= Energy-Saving Behavior(SESB)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Figure 10

Testing the moderation Effect of Situational Factors



In conclusion, data analysis has supported Hypotheses 1-6, as summarized below.

Table 16*Hypothesis Testing Results Summary*

No.	Hypothesis	Results
H1	There is a positive association between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI) among frontline pilots.	Supported
H2	There is a positive association between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB) among frontline pilots.	Supported
H3	There is a positive association between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB) among frontline pilots.	Supported
H4	Energy-Saving Intention (ESI) mediates the relationship between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB).	Supported
H5	Psychological Factors (PF) moderate the relationship between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI).	Supported
H6	Situational Factors (SF) moderate the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB).	Supported

Chapter 5. Discussion and Conclusion

This chapter discusses the findings in relation to the research aim, the theories informing the model and previous studies. It considers what the observed relationships among ESA, ESI and SESB suggest about pilots' energy-saving practices and the limits of these interpretations. It then presents the conclusions, contributions and practical recommendations.

5.1 Discussion

5.1.1 Discussion of Research Question 1: The Relationship Between Energy-Saving Awareness and Energy-Saving Intention

The first research question examined whether Energy-Saving Awareness (ESA) was positively associated with Energy-Saving Intention (ESI) among frontline pilots. The result supported this relationship ($\beta = 0.431$, $p < .001$), indicating that pilots who reported stronger awareness of energy conservation also tended to report stronger intention to engage in energy-saving practices. This finding addresses the first research question by identifying a positive association between awareness and intention within the proposed ESA–ESI–SESB model. It is consistent with the Theory of Planned Behavior (TPB), which proposes that behavioral intention is shaped by individuals' evaluations of a behavior, perceived social expectations, and perceived capability to act (Ajzen, 1991). In the present study, pilots who better understand the operational and environmental significance of energy-saving may be more willing to adopt relevant practices at work.

This result is also consistent with Social Cognitive Theory (SCT). SCT links cognition and behavior through individuals' interpretation of environmental demands, expectations about outcomes and self-regulation (Bandura, 2001). For pilots, ESA is not simply abstract environmental knowledge. It may include an understanding that fuel-efficient operations can

contribute to reduced operating costs, lower emissions, organizational sustainability, and the achievement of national Dual Carbon objectives. Pilots may be more motivated to save energy when they see its relevance to their professional responsibilities. The result also aligns with environmental-behavior research showing that knowledge, values, and normative awareness are often related to stronger pro-environmental intentions (Bamberg & Möser, 2007; Stern, 2000). The finding identifies an association between awareness and intention, while their temporal order remains open. Pilots with stronger intentions may also pay greater attention to energy-saving information.

The real-world implication is that airline energy-saving programs should not be limited to issuing general policy documents or numerical carbon-reduction targets. Pilots need to understand how such targets relate to cockpit-level decisions and to safe, routine flight operations. Training could link Dual Carbon objectives to approved fuel-saving practices, including fuel planning, taxiing, climb and descent, and the use of operational information. Senior pilots and flight instructors may also play an important role by linking formal policy messages with practical operational experience.

5.1.2 Discussion of Research Question 2: The Relationship Between Energy-Saving Awareness and Stated Energy-Saving Behavior

The second research question examined whether Energy-Saving Awareness (ESA) was positively associated with Stated Energy-Saving Behavior (SESB). The results supported this relationship ($\beta = 0.145$, $p = .001$), with higher ESA scores associated with higher SESB scores. This finding addresses the second research objective by showing that the association with awareness extends beyond intention to SESB. In practical terms, pilots who understand the importance of fuel conservation, recognize the environmental effects of aviation emissions, and

identify with low-carbon development goals may be more attentive to opportunities for appropriate fuel-efficient operations.

This finding is broadly consistent with the cognitive and normative perspective of the Value-Belief-Norm framework, which proposes that environmental knowledge, values, and personal norms can support pro-environmental action (Stern, 2000). It also reflects SCT, according to which individual cognition can influence behavior through self-regulation, outcome expectations, and professional learning (Bandura, 2001). Pilots who regard energy efficiency as a professional responsibility may attach greater importance to approved fuel-saving practices.

Nevertheless, the positive association does not establish that ESA alone is sufficient for SESB. This is theoretically meaningful because awareness alone is unlikely to determine behavior in a safety-critical and highly standardized profession. In household settings, individuals often have substantial personal control over actions such as switching off appliances or adjusting air-conditioning. In aviation, pilots' discretion is more limited. Flight operations are shaped by safety procedures, dispatch planning, aircraft systems, weather conditions, air traffic control instructions, route restrictions, payload requirements, and time pressure. Therefore, a pilot may have strong awareness of energy conservation but still be unable to adopt a preferred fuel-efficient action in a particular flight situation. This interpretation is consistent with the attitude-behavior-context perspective, which argues that environmental behavior is affected by the interaction between individual dispositions and external conditions (Guagnano et al., 1995).

Awareness programs should be accompanied by clear guidance on when and how approved fuel-saving practices can be used. Airlines should communicate why energy saving matters, but they should also give pilots clear operational guidance on what actions are appropriate, when they are appropriate, and where safety or procedural constraints take priority. For example, training

materials should distinguish between feasible fuel-efficiency practices and actions that cannot be undertaken when safety margins, air traffic control requirements, or standard operating procedures dictate otherwise. Such guidance may help pilots identify fuel-saving opportunities within safety and procedural limits.

5.1.3 Discussion of Research Question 3: The Relationship Between Energy-Saving Intention and Stated Energy-Saving Behavior

The third research question examined whether Energy-Saving Intention (ESI) was positively associated with Stated Energy-Saving Behavior (SESB). The finding supported the proposed relationship ($\beta = 0.158$, $p < .001$). Pilots with higher ESI scores also tended to have higher SESB scores. TPB provides a theoretical basis for this association by identifying intention as an immediate antecedent of behavior (Ajzen, 1991). In this study, ESI represents pilots' reported willingness to engage in energy-saving practices.

The finding addresses the third research question by showing that pilots' motivation is relevant even in a highly regulated workplace. Civil aviation is not a setting in which behavior is determined solely by personal preference. Pilots must comply with safety regulations, standard operating procedures, and real-time operational requirements. Pilots with stronger energy-saving intentions may pay more attention to opportunities to use approved fuel-saving procedures.

However, the relationship also needs to be interpreted through the well-established intention-behavior gap. Research has consistently shown that people may hold strong intentions but fail to act because of competing goals, limited resources, habitual patterns, unforeseen barriers, or insufficient perceived control (Sheeran & Webb, 2016). The gap is especially important in aviation. A pilot may intend to minimize unnecessary fuel use but be required to follow an air traffic control instruction, carry additional fuel because of meteorological uncertainty, follow a

less fuel-efficient descent profile because of traffic sequencing, or prioritize a safety-related decision over fuel efficiency. These constraints do not indicate a lack of commitment; instead, they reflect the fact that safe flight operations take precedence over efficiency objectives.

The association concerns intention and respondents' recognition and selection of energy-saving practices in the questionnaire. Assessing how often these practices are used and whether they are associated with lower fuel use or emissions requires operational data. Responses may also be affected by social desirability, as energy conservation is regarded as responsible professional conduct. Future research could link questionnaire responses to flight records to examine how these reported preferences relate to operational practice.

The practical implication is that airlines should support pilots in putting their intentions into practice. Possible measures include decision-support tools, timely fuel-efficiency feedback, scenario-based training and channels for reporting operational barriers. Their effectiveness could be assessed through changes in the use of approved fuel-saving procedures and fuel consumption under comparable operating conditions. Such evaluation should account for aircraft type, route, weather and air traffic restrictions, with safety remaining the overriding priority.

5.1.4 Discussion of Research Question 4: The Mediating Role of Energy-Saving Intention

The fourth research question examined whether Energy-Saving Intention (ESI) mediated the relationship between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB). The mediation analysis supported a partial mediation pattern. ESA had a significant total association with SESB (effect = 0.571, $p < .001$), and the indirect association through ESI was significant (effect = 0.183, 95% CI [0.103, 0.246]). The direct association between ESA and SESB remained significant after ESI was included (effect = 0.387, $p < .001$). These findings indicate a

significant indirect association between ESA and SESB through ESI, alongside a remaining direct association after ESI is included in the model.

This result is theoretically consistent with TPB, in which intention functions as the immediate motivational link between cognitive evaluations and behavior (Ajzen, 1991). It is also compatible with SCT, which emphasizes that cognition may influence behavior through self-regulation, outcome expectations, learning, and interactions with the environment (Bandura, 2001). In this study, greater awareness was associated with stronger intention, which was in turn associated with higher SESB scores. One possible explanation for the remaining association is that pilots with greater awareness may more readily recognize fuel-saving opportunities and regard energy efficiency as a professional responsibility.

The partial mediation result indicated that ESI does not fully account for the association between ESA and SESB in the fitted model. A pilot may engage in an approved energy-saving procedure because it has become part of established professional routine, because company procedures require it, or because digital decision-support systems make the action more visible and easier to perform. Such behavior may occur even when intention is not the sole immediate driver.

The indirect association through ESI is consistent with the proposed ESA–ESI–SESB model. Because the measures were collected at one point in time, this finding describes a statistical pattern rather than a demonstrated sequence of change (Maxwell & Cole, 2007). Longitudinal research could examine whether changes in awareness precede changes in intention and subsequent practice.

5.1.5 Discussion of Research Question 5: The Moderating Role of Psychological Factors

The fifth research question examined whether Psychological Factors (PF) moderated the relationship between Energy-Saving Awareness (ESA) and Energy-Saving Intention (ESI). The results supported this moderating relationship. The interaction term $ESA \times PF$ was positive and significant ($B = 0.319$, $t = 2.942$, $p < .01$), and the explanatory power of the model increased after the interaction was added (R^2 increased from 0.354 to 0.387). This finding indicates that the association between ESA and ESI was stronger at higher PF scores.

This result is consistent with SCT's emphasis on self-efficacy. Bandura (1997, 2001) argues that self-efficacy shapes whether individuals believe that they can organize and perform the actions required to achieve a desired outcome. In the aviation context, pilots may understand the importance of energy saving but differ in their confidence to identify appropriate opportunities, apply approved procedures, communicate operational needs, and make decisions under complex conditions. Pilots who feel capable of applying approved fuel-saving procedures may be more willing to act on their awareness.

Personal norms offer one possible interpretation of the overall PF finding. From a Value-Belief-Norm perspective, a sense of moral obligation can motivate pro-environmental action (Stern, 2000). For pilots, this obligation may take the form of professional responsibility, with energy saving regarded as part of responsible practice rather than simply a company requirement. Such responsibility may help explain why the association between awareness and intention was stronger at higher PF scores.

Airline managers should consider differences in pilots' confidence and sense of professional responsibility when designing awareness training. Some pilots may understand energy-saving information but lack confidence in applying it under operational pressure. Others

may view fuel efficiency primarily as a management requirement rather than as a personally meaningful professional responsibility. Scenario-based training and guidance from experienced pilots could help build confidence in using approved fuel-saving procedures.

The data collected in this study were self-reported and cross-sectional, and the analysis does not establish that increasing PF would strengthen the relationship between ESA and ESI.

5.1.6 Discussion of Research Question 6: The Moderating Role of Situational Factors

The sixth research question examined whether Situational Factors (SF) moderated the relationship between Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB). The results supported this relationship. The $ESI \times SF$ interaction was positive and statistically significant ($B = 0.196$, $t = 3.158$, $p < .01$), and model explanatory power increased from $R^2 = 0.755$ to $R^2 = 0.770$ after SF and the interaction term were included. The association between ESI and SESB was stronger at higher SF scores, reflecting the combined measure of organizational loyalty, policy incentives and energy-saving subculture.

This result is consistent with the Attitude–Behavior–Context (ABC) model, which considers how individual dispositions and external conditions jointly shape environmental behavior (Guagnano et al., 1995). It also accords with SCT’s emphasis on the role of the social environment (Bandura, 2001). In aviation, organizational expectations, incentives and shared working practices may help explain why the relationship between intention and SESB varies across pilots.

The finding adds an organizational perspective to the ESI–SESB relationship. One possible explanation is that pilots find it easier to act on their intentions when energy-saving practices are recognized and supported within their airline. Clear guidance and access to operational information may also help pilots identify when approved fuel-saving procedures are feasible. These examples

illustrate how organizational support could operate in practice. The result therefore supports considering organizational conditions alongside individual motivation when interpreting SESB. It directs attention to the workplace context in which pilots make energy-saving decisions.

Airlines could support energy-saving practice through clear procedures, timely operational information and feedback from pilots about barriers to implementation. Recognition of fuel-saving efforts should remain consistent with safety requirements and avoid pressure to compromise operational judgement. Pilots' feedback could help identify where changes to planning, training or dispatch coordination are needed. These recommendations are consistent with the emphasis on low-carbon development and operational efficiency in the CAAC's green-development plan (Civil Aviation Administration of China, 2021).

5.2 Conclusion

This study examined the relationships among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB) under the framework of carbon neutrality, using a sample of 200 frontline pilots in Chinese civil aviation.

The empirical results provide support for all six proposed hypotheses, indicating that the conceptual model is broadly consistent with the observed data.

The hypothesis-testing results suggest a coherent pattern of associations among awareness, intention, psychological factors, situational factors, and stated energy-saving behavior. First, support for H1 and H2 indicates that Energy-Saving Awareness (ESA) is positively associated with both Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB), underscoring the importance of cognitive factors in energy-saving psychology and reported practice. Support for H3 further indicates that ESI is positively associated with SESB, which is consistent with the classic intention–behavior pathway. Support for H4 suggests that ESI plays a

partial mediating role in the association between ESA and SESB, meaning that awareness is related to stated behavior partly through intention. The significance of H5 indicates that Psychological Factors (PF) condition the awareness–intention relationship, while H6 indicates that Situational Factors (SF) condition the intention–stated behavior relationship. These results should be interpreted as statistically supported associations within a cross-sectional self-report design rather than as definitive causal effects.

The mediation findings should be understood in the same way. They show that the data are consistent with the proposed link from energy-saving awareness to energy-saving intention and then to stated energy-saving behavior. However, because the data were collected at one point in time, this study cannot prove that awareness first leads to intention and then leads to behavior. This point is important because Maxwell and Cole (2007) warned that cross-sectional mediation analysis may give a misleading picture of mediation over time. Therefore, the value of the findings lies in showing a clear and theoretically supported relationship among ESA, ESI, SESB, PF, and SF in the aviation context, rather than in proving a fixed causal order.

Given the cross-sectional and self-reported nature of the data, these findings should be interpreted as statistically supported associations within the proposed model, not as evidence of a temporal or causal sequence.

5.3 Research Contributions

Under the policy context of the Dual Carbon Goal, the practical significance of this study lies in moving the discussion of pilots' stated energy-saving behavior beyond a purely technical or compliance-based frame and toward a more integrated managerial understanding of how such stated behavior relates to motivational and organizational conditions in a professional setting. The quantitative findings in Chapter 4 indicate that Energy-Saving Awareness (ESA) is positively

associated with both Energy-Saving Intention (ESI) and Stated Energy-Saving Behavior (SESB). In practical terms, this suggests that pilots' awareness should not be treated as an attitudinal variable, but as an important cognitive foundation through which organizational Dual Carbon objectives are interpreted and connected to daily operations. Accordingly, the practical value of ESA is that it helps pilots understand why energy-saving practices are operationally meaningful and how such practices can be reconciled with professional priorities, especially safety and procedural discipline.

The mediating role of ESI further refines the practical implications of the model. Quantitative test results showed that ESI is positively associated with SESB and partially mediates the relationship between ESA and SESB. This means that awareness alone does not fully account for reported energy-saving practice in this sample. Rather, stronger awareness is statistically associated with stronger intention, and intention is in turn associated with reported energy-saving practice within the proposed model. For management, this is a critical point. It suggests that enterprises should not assume that once pilots understand low-carbon goals, corresponding behavior will automatically follow. Instead, management interventions should pay attention to the motivational conditions under which awareness is more likely to be accompanied by readiness, willingness, and commitment to report energy-saving practices in concrete operational contexts. These findings suggest that practical recommendations should consider pilots' motivation alongside the organizational conditions in which ESI may be put into practice.

The moderating effects of Psychological Factors (PF) and Situational Factors (SF) make the practical significance of the findings more specific and more policy-relevant. The results suggest that PF strengthens the relationship between ESA and ESI, whereas SF strengthens the relationship between ESI and SESB. This indicates that the pathway from awareness to stated

behavior is contingent. When pilots report stronger self-efficacy, stronger personal norms, and a clearer sense of professional responsibility, the association between awareness and intention appears stronger. On the other hand, when the organizational environment provides clearer procedures, stronger policy support, more consistent guidance, and better operational infrastructure, the association between intention and stated behavior appears stronger.

Taken together, this study aims to provide an empirical basis for designing multi-level intervention strategies in civil aviation enterprises. At the awareness level, managers should strengthen pilots' understanding of fuel-saving knowledge, energy-saving objectives, and the operational logic linking environmental performance with airline efficiency, so as to enhance ESA. At the motivational level, enterprises should cultivate self-efficacy, internalized responsibility, and professional identification with green development, thereby strengthening the conditions under which ESA is associated with ESI. At the organizational level, enterprises should further improve flight operation guidelines, fuel-saving procedures, decision-support tools, and performance feedback mechanisms, so that pilots can implement energy-saving intentions under conditions that remain fully compatible with safety requirements. This practical point is also consistent with recent international discussions on sustainable aviation. The ICAO Environmental Report 2025 treats operational improvements and flight operations as part of aviation's response to climate change, together with cleaner energy and new technologies (International Civil Aviation Organization, 2025). Therefore, this study does not argue that pilots alone can reduce aviation emissions. Instead, it shows that pilots' energy-saving awareness and intention are one part of the wider effort to improve operational efficiency. For airlines, these findings suggest that awareness and intention should be considered alongside the conditions that make approved fuel-saving practices feasible. Training and operational support could be evaluated using both questionnaire responses and

records of procedure use. Fuel outcomes would then need to be assessed under comparable operating conditions, accounting for aircraft type, route, weather and air traffic restrictions. This would allow airlines to distinguish improvements in awareness or willingness from changes in practice and measurable fuel savings, while keeping safety as the overriding requirement.

5.4 Research Innovation

1. This study is conducted within the context of China and examines the associations among energy-saving awareness, energy-saving intention, and stated energy-saving behavior among frontline civil aviation pilots. It analyzes the patterns and characteristics of pilots' stated energy-saving behavior and examines how psychological and situational factors are related to the proposed model. Within the context of the Dual Carbon in China, this study constructs a Stated Energy-Saving Behavioral Structural Model and applies standardized empirical research methods. Through interdisciplinary analysis, the study examines the associations and moderating effects among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), Stated Energy-Saving Behavior (SESB), Psychological Factors (PF), and Situational Factors (SF), thereby providing a theoretical basis and practical reference for governments and enterprises to guide pilots' reported energy-saving practices and support the green transformation of civil aviation under the Dual Carbon context.

2. This paper adopts a multidisciplinary approach, combining research content from social science, social psychology, behavioral science, and management science. This comprehensive approach aids in fully understanding and explaining the correlation between Energy-Saving Awareness (ESA) and Stated Energy-Saving Behavior (SESB) among frontline pilots. The multidisciplinary approach is particularly helpful in delving into the complexity and interrelatedness of relevant factors. Starting from the perspective of Social Cognitive Theory, the

study explores the associations and moderation effects between Energy-Saving Awareness (ESA) to Energy-Saving Intention (ESI) and ultimately to Stated Energy-Saving Behavior (SESB) among frontline pilots in Chinese civil aviation. This theoretical perspective facilitates a deeper understanding of the decision-making process of pilots, offering theoretical guidance for formulating behavioral intervention strategies. Through questionnaires on 200 Chinese frontline pilots, the study provides highly specific data support. This not only quantifies the awareness and stated behavior of the study subjects but also allows for a thorough exploration of the underlying reasons and motivations, enhancing the depth and comprehensiveness of the research. The obtained data can help validate research hypotheses within the established theoretical framework and provide certain empirical support.

3. A further theoretical innovation of this study lies in extending and contextualizing traditional cognitive- and social-behavioral perspectives, including TPB- and VBN-related insights, into a high-risk and highly regulated professional environment. Unlike general consumer populations whose energy-saving behaviors are relatively autonomous, frontline pilots operate under strict Standard Operating Procedures in which aviation safety takes priority over discretionary action. The dissertation therefore shows that the awareness–intention–stated behavior pathway needs to be interpreted together with psychological reinforcement and situational enablement. In this sense, the study suggests that environmental awareness in safety-critical industries cannot be understood adequately without considering organizational subcultures, policy incentives, and procedural boundaries

5.5 Limitations of the Study and Future Research Directions

This study examined the relationships among Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), and Stated Energy-Saving Behavior (SESB) among frontline pilots in

Chinese civil aviation. The findings provide useful evidence for understanding energy-saving behavior in a safety-critical and highly regulated professional setting. However, several limitations should be noted.

1. Limitations of Research Content. This study focuses on frontline pilots in China's civil aviation industry. This group is important because pilots are directly involved in flight operations and fuel-use decisions. However, energy-saving in civil aviation also involves other groups, such as dispatchers, maintenance staff, ground staff, cabin crew, managers, and regulators. The findings of this study therefore should not be extended to the whole aviation workforce without further evidence. Future research could include more occupational groups and compare whether energy-saving awareness and stated behavior differ across job roles.

2. Limitations of Sampling and Response. The study used 200 valid questionnaires. This sample is useful for the regression-based analysis in this dissertation, but it is still limited in size. The sample was also unbalanced in terms of gender. Male pilots accounted for 97.5% of the valid responses, while female pilots accounted for only 2.5%. This partly reflects the current gender structure of the civil aviation pilot group in China, but findings related to gender should still be interpreted with caution.

The sampling process also has limits. The questionnaire was shared through airline internal platforms and pilot communication groups. As a result, the study could not confirm the total number of eligible pilots who received the survey invitation. Following AAPOR's Standard Definitions, this study reports the number of valid questionnaires used in the analysis, rather than a formal population response rate (AAPOR, 2023). Future research should use a clearer sampling frame where possible and record the number of invitations, returned questionnaires, excluded cases, and valid responses.

3. Limitations of Self-Reported and Stated Behavior. This study measured SESB as stated energy-saving behavior. In other words, the data reflect pilots' own reports of energy-saving practices, rather than directly observed flight behavior. Stated behavior may differ from actual operational behavior. This is especially important in aviation, where safety rules, weather, air traffic control, company procedures, and aircraft status may limit what pilots can do in practice. Future research could use field observation, simulator-based tasks, behavioral experiments, or flight operation data, if such data can be collected under proper safety, privacy, and regulatory conditions.

The Future Research Directions are as follows:

1. Expand and Balance the Research Sample. Achieving carbon emission control in an enterprise requires collective efforts from various personnel, ranging from management to ground staff, far beyond just frontline employees. Although this study concentrates on frontline pilots in the Chinese aviation industry, it is also crucial to understand and address all employees' energy-saving awareness and the extent to which such awareness is associated with their stated behaviors. Therefore, future research can explore the impact of energy-saving awareness on stated behavior among other groups of aviation employees.

The study provides limited evidence on gender differences due to the fact that only 5 of the 200 participants were women, reflecting the current gender imbalance within China's civil aviation sector. Future research could conduct observational field studies with more balanced and expanded gender samples. Such studies could help validate the present conclusions and assess the feasibility of implementing gender-specific energy conservation training in professional settings. Such programs could then be tailored to address distinct behavioral patterns or motivational factors

among male and female pilots, ultimately helping organizations design more targeted and impactful sustainability initiatives.

2. Cross-Cultural Comparative Studies. As globalization continues to progress, there is a growing emphasis on international exchanges in various fields. Sustainable development strategies, as a significant initiative proposed by the United Nations, have a substantial global impact. Some scholars have conducted research on cross-cultural backgrounds related to energy development. For example, Harold Wilhite and others conducted surveys on energy usage behavior among residents in Fukuoka, Japan, and Oslo, Norway. The study showed significant differences in the ways and choices of energy use between the two cultural backgrounds. By discussing this phenomenon, the study aimed to explore the connection between culture and economic development factors. The findings indicated that individual behavioral choices vary under different cultural contexts, and there is a correlation with national policies (Wilhite et al., 1996). Similar types of research have explored the differences in energy-saving behavior between Japan and New Zealand, highlighting that the political policies adopted by countries under different social and cultural backgrounds can be a key factor in changing consumer behavior and energy-saving intentions (Murphy, 2016).

Concurrently, conducting research in cross-cultural contexts is also beneficial for promoting social equity. Some scholars, starting from the perspective of social equity, argue that individual actions can contribute to fostering social fairness. Currently, there is relatively little research on individual behavior in cross-cultural contexts. The cultural context may influence the decision-making and behavioral tendencies of employees from different backgrounds (Bolino & Turnley, 2008). Similarly, self-awareness can vary significantly due to differences in national and cultural backgrounds, including differences in behavior adopted by individuals of different genders

in different settings. By studying pilot populations with different socio-economic attributes across cultures, more innovative and internationally applicable research directions can be proposed for the development of international civil aviation enterprises. This research can shed light on the energy-saving awareness and stated behavioral characteristics of frontline pilots in various countries, considering the international nature of the aviation industry. Because the aviation industry is highly internationalized, different cultural backgrounds may significantly affect the acceptance and reported enactment of energy-saving concepts. Through this research direction, a deeper understanding of the commonalities and differences in stated energy-saving behavior among civil aviation personnel from different countries or regions can be achieved. This can provide more specific guidance and strategies for enterprises to promote low-carbon concepts globally. Simultaneously, in cross-cultural comparative research, considering differences in cultural background, a more in-depth study of variation in energy-saving awareness among civil aviation personnel in different cultures can be conducted. For example, certain cultures may prioritize collective interests, while others may focus more on individual rights. By comparing energy-saving awareness in these different cultural backgrounds, better strategies for civil aviation enterprises to address different cultural groups can be formulated. Moreover, a more in-depth investigation into whether different cultural backgrounds effectively link to stated energy-saving behavior can be carried out. For instance, some cultures may emphasize a sense of social responsibility, while others may be more concerned with the economic benefits of energy saving. By understanding these cultural differences, civil aviation enterprises worldwide can develop more targeted incentive measures to encourage employees from different cultural backgrounds to participate actively in energy-saving practices. Additionally, political policies in different countries are closely related to the country's culture. The study of government policies on energy

conservation in different cultural backgrounds can help better understand the potential association between cultural backgrounds and energy-saving behavior. It can also assist aviation enterprises in adapting to different cultural backgrounds and political policies, effectively enhancing the practical effects of low-carbon development concepts globally. This approach can ultimately provide green development strategies tailored to the cultural characteristics of each country for global civil aviation enterprises.

3. Strengthen Measurement and Behavioral Validation. Future research should also combine questionnaire data with more objective operational indicators wherever regulatory compliance allows. For example, simulator tasks, training records, or appropriately governed flight-data proxies could help assess the extent to which stated energy-saving behavior is aligned with actual operational practice. Such work would allow researchers to move beyond stated behavior, revisit the measurement model with stronger confirmatory procedures, and examine more directly how policy guidance and organizational conditions affect actual operational behavior.

5.6 Strategies and Recommendations

5.6.1 Enhancing the Popularization of Energy Conservation Behavior

1. National Level. In the present global context, the continuous increase in global energy consumption and the escalating environmental issues, leading to climate change, have garnered widespread attention. A series of energy-saving actions is required to reduce energy consumption and lower carbon emissions, thus achieving sustainable development.

(1) Policy Guidance and Implementation. The survey addressed several aspects of policy implementation. Section B examined familiarity with aviation energy-saving policies, while Section L covered motivation from company policies, financial rewards and energy-saving

requirements in promotion regulations. These questions provide a basis for considering how policy objectives are communicated to pilots and reflected in organizational arrangements.

In the reported model, policy incentives formed part of SF, together with organizational loyalty and energy-saving subculture. The positive $ESI \times SF$ interaction ($B = 0.196$, $p < .01$; Table 15) indicated that the ESI–SESB association was stronger at higher SF scores. This finding supports examining policy arrangements within the wider organizational setting, including the expectations and working practices through which pilots encounter them.

At national and industry levels, aviation authorities and industry bodies could provide guidance to help airlines translate energy-saving objectives into operating procedures and staff training. This guidance should explain when approved energy-saving practices are applicable, how safety requirements take precedence and what information pilots need when considering these practices. Examples drawn from different operating conditions could help airlines explain how broad policy objectives apply to daily work.

(2) *Active Promotion of Awareness.* Public information and education are crucial for disseminating knowledge about energy conservation and environmental protection. The government can conduct activities such as green and low-carbon knowledge promotion events and establish green and low-carbon demonstration areas. These efforts aim to enhance the energy-saving awareness and education of the general public. The focus is on making people realize the importance of energy conservation for environmental protection and sustainable development, guiding them to develop good energy-saving habits in their daily lives and work. This requires collaboration between the government, media, schools, and other entities to jointly create a green and low-carbon culture. The goal is to deeply embed the concepts of green and low-carbon

practices in people's minds, influencing their understanding and behavior towards energy conservation.

(3) *Establishment of Incentive Mechanisms.* Establishing sound incentive mechanisms is another effective way for the national level to promote energy conservation. By providing rewards for innovation and practices related to energy conservation by enterprises and individuals, more people can be encouraged to participate in energy-saving efforts, promoting the application and dissemination of energy-saving technologies. Simultaneously, the government needs to offer policy support, encouraging enterprises to adopt energy-saving equipment, optimize production processes, and support the development and utilization of green energy. These measures can help companies save costs, enhance competitiveness, and contribute to environmental and resource protection, achieving a mutually beneficial situation for economic and social benefits.

(4) *International Exchange.* Strengthening cooperation and communication with other countries is a crucial avenue for promoting knowledge about energy conservation. Drawing lessons from and absorbing international advanced energy-saving concepts and technologies can promote continuous improvement and enhancement of domestic energy-saving efforts. This contributes to accelerating the pace of energy conservation in China and forming a collaborative force to address global energy and environmental challenges. International exchanged could support the sharing of fuel-saving practices and operational experiences.

2. Corporate Level. At the corporate level, companies, as the main entities of economic activities, play a crucial role in the context of Dual Carbon. Airlines need to comprehensively consider their own situations, formulate specific and feasible strategies based on their actual conditions, and actively promote green and low-carbon development. As the quantitative test results suggest, when corporate contextual factors such as energy-saving subculture, policy

incentives, and organizational loyalty are high, the association between energy-saving intention and stated behavior is stronger. Therefore, enterprises can focus on the following aspects to enhance actions on energy conservation:

(1) Establish a Comprehensive Management System. As a collective entity, an enterprise should establish a robust energy-saving management system and formulate corresponding energy-saving goals and plans. Clear responsibilities and reporting arrangements could help coordinate energy-saving initiatives across departments. The establishment of such an internal system effectively integrates enterprise resources, forms a collective force to drive energy-saving initiatives, ensures the orderly progress of energy-saving work, and achieves substantial results.

(2) Provide Energy-Saving Training. Enterprises can regularly organize employees to participate in energy-saving knowledge training and skill enhancement courses to raise their awareness and skill levels. Through these training programs, employees can gain a deeper understanding of the importance of energy conservation and learn how to save energy in their daily work. This integration of energy-saving concepts into daily work potentially helps form long-term behavioral habits.

(3) Introduce Energy-Saving Equipment. During the normal operation of an airline, reducing corresponding energy consumption and improving energy utilization efficiency through the use of new technologies are strategies that companies need to consider for transformation. Airlines can invest in research and development of energy-saving equipment, simultaneously optimizing and adjusting the entire process to minimize energy consumption and implement the lowest carbon emissions. This technological transformation not only enhances the competitiveness of the enterprise but also contributes to environmental protection and resource conservation.

(4) Conduct Energy-Saving Inspections. Establishing an energy-saving monitoring system is indispensable for energy-saving work in enterprises. Through real-time monitoring and analysis of energy consumption, enterprises can identify problems promptly and take measures for adjustments, ensuring the continuous and stable effectiveness of energy-saving initiatives. This data-driven monitoring method helps enterprises have a more comprehensive understanding and management of energy consumption, enabling targeted improvements and adjustments to energy-saving measures.

(5) Facilitate Mutual Communication. Encouraging mutual exchange of energy-saving experiences and technologies among enterprises and establishing a database of energy-saving cases are crucial. Promoting successful energy-saving practices inspires more enterprises to unlock their energy-saving potential. Sharing successful experiences and cases fosters learning and collaboration among enterprises, leading to collective progress and advancement in the field of energy conservation. Interactive collaboration among enterprises not only expedites the progress of energy-saving work but also creates a chain reaction in the subculture of sustainability, encouraging more enterprises to join the ranks of energy conservation, contributing collectively to environmental protection and sustainable development.

3. Employee Level. In the process of airline operations, employees, as the most fundamental and crucial group, play a pivotal role in the implementation of low-carbon development. The behavior and awareness of frontline employees are of paramount importance to the effective control of a company's energy consumption, subsequently reducing operational costs and enhancing economic benefits. Therefore, companies should take a series of measures at the employee level to elevate their energy-saving knowledge and stimulate their proactiveness and practical actions in energy conservation.

(1) *Participation in Knowledge Lectures.* Firstly, companies can inspire employee awareness of energy conservation by organizing lectures and workshops on energy-saving knowledge. Employees should actively participate in these activities to recognize the importance of energy-saving to both the environment and the company. These activities aim to strengthen employees' understanding of energy-saving and their sense of professional responsibility.

(2) *Adherence to Company Energy-Saving Norms.* As employees, adherence to the company's energy-saving norms is essential. Companies can consider incentives to encourage compliance with energy-saving requirements. By rewarding employees who excel in energy conservation, companies can set examples and inspire the proactiveness and engagement of other employees. Where employees do not follow energy-saving requirements, airlines should review the operational circumstances and provide appropriate feedback.

(3) *Mutual Learning.* Establishing exemplary energy-saving positions is crucial for mutual learning among employees. Companies can designate outstanding employees in energy conservation as examples and leaders for other employees. Through demonstration and leadership, the entire team's awareness of and behavior in energy conservation are likely to be positively influenced. This approach may support mutual learning and the exchange of practical energy-saving experience among employees.

(4) *Regular Review and Feedback.* Regular reflection and summation are necessary for individual employees. Periodically organizing energy-saving knowledge tests and evaluations of energy-saving practices helps companies identify problems and deficiencies in employees' energy-saving efforts. The findings can inform targeted training and guidance. Additionally, establishing employee energy-saving suggestion boxes and complaint channels encourages employees to provide suggestions and opinions on energy-saving improvements, offering an effective means

and platform for employees to participate in energy-saving initiatives. This contributes to the elevation of employee engagement and the establishment of an effective feedback mechanism.

Through the collective efforts of the national, corporate, and employee levels, the enhancement of energy-saving knowledge dissemination becomes feasible. This collaborative approach could support progress towards achieving goals of resource conservation, environmental protection, and sustainable development.

5.6.2 Understanding of Employee Self-Assessment in the Dual Carbon Context

In previous chapters, quantitative test results have indicated that the association between ESA and ESI was stronger at higher PF scores. Therefore, by gaining a thorough understanding of employees' self-assessment under the Dual Carbon Goal, better guidance and motivation can be provided for their active participation in energy-saving and emission reduction actions, ultimately facilitating the achievement of Carbon Neutrality targets.

1. Employee Energy-Saving Satisfaction Survey. Firstly, within the organization, regular surveys and questionnaires can be conducted to assess employees' satisfaction with energy-saving initiatives. Employees can be asked questions related to their understanding of the company's energy-saving and emission reduction policies, their efforts to save energy in daily work and life, and their awareness and support for Carbon Neutrality goals. This approach provides a comprehensive understanding of employees' awareness and self-assessment under the Dual Carbon context, serving as a reference for subsequent management and motivation measures.

By utilizing the results of both survey questionnaires and employee satisfaction surveys, companies can gain a better understanding of employees' self-assessment under the Dual Carbon context. This insight guides subsequent management measures and incentive plans. Through these survey methods, a feedback mechanism can be established, promoting employees' understanding

and support for Carbon Neutrality goals. This, in turn, facilitates the smooth implementation of overall energy-saving and emission reduction efforts.

2. Themed Discussion Sessions. Organizing themed discussion sessions or seminars for employees provides another avenue for understanding their experiences and perspectives on energy-saving and emission reduction. Such interactive platforms facilitate communication and sharing among employees, allowing a deeper understanding of their practical actions and attitudes under the Dual Carbon context. Through the exchange of experiences, viewpoints, and ideas, employees can inspire and learn from each other, enabling management to gain clearer insights into employees' practical situations regarding energy-saving and emission reduction.

During these themed discussion sessions or seminars, employees can share the energy-saving measures they have adopted in their work and daily lives, discuss challenges and difficulties in energy-saving and emission reduction, and propose improvement suggestions and feasible solutions. Through collective discussions, issues can be identified, solutions sought, and employees' enthusiasm and innovative spirit can be stimulated. This open communication platform contributes to enhancing employees' understanding and endorsement of the company's energy-saving and emission reduction policies, thus elevating their self-assessment awareness and proactive engagement.

3. Digital Monitoring Tool.

(1) Real-time Data Monitoring. Within the allowance of safety regulation in the industry, where suitable flight records are available, airlines could use them to examine fuel use and the application of approved energy-saving procedures. Comparisons should account for aircraft type, route, weather, air traffic restrictions and crew responsibilities. The analysis could inform training and procedural review.

(2) Data Collection and Analysis. The digital monitoring platform can collect data on fuel usage and recorded operational practices to conduct in-depth analysis. This helps identify practices and operating conditions that warrant further review, enabling the formulation of practical improvement measures based on operational evidence rather than self-report alone.

(3) Personalized Recommendations and Improvement Plans. Based on the results of data analysis, operational records could support feedback tailored to pilots' duties and operating conditions. This means that employees can receive targeted guidance and support based on their actual situations and performances, enhancing their understanding of their own state in energy-saving and enabling more effective measures. Personalized recommendations and improvement plans can inspire employees' initiative, helping them become active participants in energy-saving and emission reduction.

(4) Enhanced Self-Assessment Accuracy. Through the digital monitoring platform, employees can access real-time information about their energy-saving and emission reduction efforts, gaining insights into their performance under the Dual Carbon context. This provides employees with additional evidence for self-assessment, helping them more accurately evaluate their energy-saving practices. With real-time data feedback and analysis, employees gradually recognize the effects of their energy-saving efforts, motivating greater improvement and ongoing progress.

(5) Employee Engagement and Incentives. The establishment of the digital monitoring platform can motivate employees to participate in energy-saving and emission reduction actions, enhancing their sense of responsibility and mission. Through real-time monitoring and personalized recommendations provided by the platform, employees perceive the importance of their role in energy-saving and are more actively involved in related activities. Feedback could

focus on learning and the appropriate use of approved procedures. Any comparison of performance should account for operational conditions and the responsibilities of the crew involved.

In summary, the establishment of real-time data monitoring and corresponding feedback mechanism signifies a crucial step for companies transitioning towards comprehensive digital management and monitoring under the Dual Carbon context. A limited trial could assess whether this feedback is useful to pilots and whether it leads to changes in operational practice. Its value should be judged through those outcomes before the approach is adopted more widely.

5.6.3 Employee Training Needs and Household Energy Conservation

1. Employee Training and Communication Needs. Airlines could use employee feedback to identify training needs and select appropriate ways to communicate energy-saving practices. Educational activities could help employees understand the practical relevance and long-term benefits of energy conservation. For example, organizing specialized lectures or seminars and inviting relevant experts to explain the importance of energy conservation and environmental protection to the environment and society can be effective. Additionally, encouraging employees to participate in community environmental activities can provide them with firsthand experience of the impact of environmental actions, thereby fostering their enthusiasm.

Digital platforms could provide an additional way to share energy-saving information and encourage employee participation. Online activities, such as webinars and short video competitions on platforms like TikTok, can guide employees to share their energy-saving experiences and ideas. Internal communication platforms can be used to share information related to energy conservation and environmental protection, and regular energy-saving challenges or activities can motivate employees to actively participate and propose innovative energy-saving suggestions.

Establishing awards for outstanding energy-saving employees can recognize those making exceptional contributions to energy conservation and environmental protection, motivating them to become advocates and role models. Regular assessments of employees' awareness levels, reported practice changes, and, where objective data are available, operational behavior changes in energy conservation can further refine and optimize training plans, ensuring a continuous and effective enhancement of employees' awareness of energy conservation and environmental protection. By combining practical considerations and characteristics and leveraging digital technology and social media platforms, it is possible to better guide and inspire employee participation in energy conservation and environmental protection actions, thereby promoting sustainable development and corporate social responsibility.

2. Household Energy-Saving Awareness. As a supplementary awareness activity, airlines could offer voluntary sessions on household energy conservation, using practical examples to explain potential costs and savings. Such examples could make the household costs and benefits of energy-saving measures easier to understand.

Firstly, employees can be guided to focus on the economic benefits of energy-saving measures. Detailed explanations can be provided on how these measures help them save energy costs, thereby reducing their overall living expenses. For example, by replacing traditional incandescent bulbs with energy-efficient LED lighting, employees can significantly lower their home electricity expenses. Additionally, promoting smart home systems can enhance energy utilization efficiency, leading to reduced water and electricity bills. These tangible economic benefits can directly stimulate employees to actively engage in energy-saving actions, realizing that energy conservation not only contributes to environmental protection but also benefits their own financial well-being.

Secondly, by offering examples and tips for energy-efficient household living, employees can extend energy-saving concepts to their homes and develop good habits. Activities like organizing “Family Energy Saving Day” can involve experts sharing practical tips and tricks for energy-efficient living, such as the proper use of home appliances and regular checks of water pipes. This allows employees to easily incorporate energy-saving practices into their daily lives. Encouraging employees to share their own experiences and achievements in energy-efficient living fosters a collaborative learning atmosphere, encouraging more employees to actively participate in energy-saving efforts.

These activities concern household energy use. Any influence on workplace intentions or operational practices would require separate evaluation.

3. Increasing Employee Inclination Toward Energy-Saving Actions. In civil aviation enterprises, increasing employees’ inclination toward energy-saving actions is an important and complex task. To stimulate employees’ enthusiasm and creativity in participating in energy-saving activities, a variety of strategies and measures must be comprehensively employed to establish a comprehensive energy-saving culture and value system.

Airlines could launch rewards schemes or competitions to invite practical energy-saving proposals from employees. Establishing an energy-saving reward fund or awards encourages employees to submit various energy-saving ideas and proposals. These rewards can include physical prizes, bonuses, as well as certificates of recognition or special benefits. Through rewards, employees can feel that their contributions are acknowledged, motivating them to think innovatively and participate more actively.

For example, conducting an “Energy Saving Challenge” competition could involve employees submitting outstanding energy-saving cases or creative proposals individually or as a

team. Proposals judged as the most innovative and implementable could be rewarded with prizes such as holiday gifts, cash rewards, or special privileges. Such competition activities not only stimulate employees' initiative but also bring more energy-saving inspiration and results to the entire team.

Establishing a long-term mechanism for energy-saving awareness education is also crucial. Regularly hosting energy-saving knowledge training, lectures, and discussions allow employees to stay informed about the latest energy policies, regulations, technological applications, and practical experiences. Additionally, implementing an "Energy-Saving Mentor" system, where employees specializing in energy-saving and environmental protection guide others in learning and practicing energy-saving techniques, can be effective.

For instance, launching a "Green Academy" project could involve periodically inviting experts in the field of energy-saving and environmental protection to conduct online or offline knowledge sharing and interactive exchanges. Simultaneously, creating a "Green Zone" platform enables employees to share their practical experiences and insights in energy-saving and environmental protection, promoting communication and interaction among employees and fostering a positive learning atmosphere and spreading effects.

Airlines could assess participation, the feasibility of submitted proposals and any changes in operational practice before extending these activities. The findings could then guide revisions to the programs.

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Appendix

Note on the questionnaire

Appendix presents the full questionnaire used in this study. The questionnaire was used to measure Energy-Saving Awareness (ESA), Energy-Saving Intention (ESI), Stated Energy-Saving Behavior (SESB), Psychological Factors (PF), and Situational Factors (SF). The items are listed in the same order as they appeared to respondents. The Appendix presents the English version of the questionnaire administered in Chinese. Where items were modified for the civil aviation context, the wording was adjusted to fit pilots' work and flight operations.

Survey on Energy-Saving Awareness and Behavior of Frontline Pilots in Chinese Civil Aviation

Dear Sir/Madam,

Thank you for participating in our survey. The purpose of this questionnaire is to understand the actual situation of energy-saving awareness and behavior among frontline pilots in Chinese civil aviation. All results from this questionnaire will be used for academic research only and will not be used for any other purposes. Please read the questions carefully and provide responses based on your actual circumstances. Your answers are of great significance to our research.

Sociodemographic Factors

A. Basic Information

- A1. Your age:

- A. 18 years old or below

- B. 18-25 years old
 - C. 25-50 years old
 - D. 50 years old or above
-
- A2. Your gender:
 - A. Male
 - B. Female
-
- A3. Your education:
 - A. Below undergraduate
 - B. Bachelor's degree
 - C. Postgraduate or above
-
- A4. Your rank:
 - A. First Level (senior level)
 - B. Second Level (medium level)
 - C. Third Level (junior level)
-
- A5. Your years of flying experience:
-
-
- A6. Your average annual income:
 - A. Below 10,000 RMB
 - B. 10,000-50,000 RMB
 - C. 50,000-100,000 RMB

- D. 100,000-200,000 RMB
- E. 200,000-500,000 RMB
- F. 500,000-1,000,000 RMB
- G. Above 1,000,000 RMB

Objective Questions

Please mark "√" on the most appropriate option based on your actual situation.

A7. Your political outlook:

- [1] The masses; [2] A member of the Communist Youth League;
- [3] Communist Party members (including probationary members);
- [4] Other parties; [5] Independent Party

B. To what extent do you understand the following aspects in terms of energy conservation awareness:

	Fully understand	Relatively understand	Generally understand	Less understand	Very little understand
1. Understand the meaning of energy-saving and emission reduction in flight					
2. Understand the flight energy-saving policies implemented by the aviation industry, and understand the energy-saving issues in daily life and flight					
3. Understand the difference between flight energy-saving behavior and general energy-saving behavior					
4. Understand the relationship between flight energy conservation and flight safety					

C. To what extent does the following situation align with your own situation:

	Fully compliant	relatively compliant	generally compliant	less compliant	completely non compliant
1. I am willing to sacrifice some personal interests for energy-saving and emission reduction actions					
2. When implementing energy-saving behaviors, I feel a sense of satisfaction and achievement					
3. I believe that energy conservation is beneficial for sustainable development					
4. Protecting the environment, energy conservation and emission reduction are not only the responsibility of the government and the company, but also my responsibility					

D. Which of the following behaviors are important energy-saving behaviors in flight control (multiple answers can be selected, but up to 3 options can be selected)

1. Minimize APU usage time as much as possible
2. Shorten taxi time and execute single engine green taxi
3. Try to improve the utilization rate of bridge load power supply as much as possible
4. Choose a more energy-efficient flight altitude while ensuring safety
5. Cruise using economic speed
6. Frequent use of reduced thrust takeoff
7. Overcome difficulties and apply for direct flight or altitude
8. Temporary route optimization can save a lot of fuel consumption

E. To what extent does the following situation align with your own situation:

	Fully compliant	relatively compliant	generally compliant	less compliant	completely non-compliant
1. No matter what others do, I have an obligation to save energy					
2. If I don't save energy during flight, I will feel guilty					
3. Not saving energy during flight violates my principles					
4. Based on my values, I should save energy during flight					

F. To what extent does the following situation align with your own situation:

	Fully compliant	relatively compliant	generally compliant	less compliant	completely non-compliant
1. The current job is completely within my ability range					
2. I have all the technical knowledge and practical experience required for my current job					
3. I believe my abilities are not inferior to those of other colleagues					
4. My past experience and achievements have made me very confident					
5. I am an expert in my field of work					
6. I have done more challenging work before than now					
7. I am very proud of my work skills and abilities					

G. Which of the following behaviors are important energy-saving behaviors that save electricity (multiple answers can be selected, but up to 3 options can be selected)

1. Reduce APU usage time

2. Improve bridge load usage
3. Maximize the use of bridge mounted power sources without relying on APUs
4. Lower the air conditioning temperature
5. Reasonably control the lighting inside and outside the aircraft
6. Optimal use of airborne equipment
7. Ensure that the aircraft's power system is regularly inspected and maintained
8. Manage the use of generators based on electricity demand

H. On the issue of work efficiency and work pressure, your specific opinion is:

	Strongly agree	more agree	generally agree	less agree	very disagree
1. Correct understanding of energy conservation helps pilots develop more effective flight plans and improve work efficiency					
2. Energy saving training can help improve work efficiency					
3. Incorrect fuel management may cause additional work pressure on pilots					
4. The company's policies and goals may increase the workload of pilots					

I. To what extent does the following situation align with your own situation:

	Fully compliant	relatively compliant	generally compliant	less compliant	completely non compliant
1. When making energy-saving decisions, I consider the type of role I play in the company					
2. I am influenced by superiors when making energy-saving decisions					
3. I am influenced by the behavior of pilots I like or admire when making energy-saving decisions					

4. When making energy-saving decisions, I will refer to the behavior of my friend pilots					
--	--	--	--	--	--

J. To what extent does the following situation align with your own situation:

	Fully compliant	relatively compliant	generally compliant	less compliant	completely non compliant
1. I will prioritize my own needs and desires, regardless of whether it is energy-saving or not					
2. I hope to do my best to reduce carbon emissions and reduce negative impacts on the environment					
3. I think having energy-saving awareness can improve one's professional competitiveness among colleagues					
4. My enthusiasm and initiative for the utility of energy conservation					
5. I am willing to bring green behaviors from life to work					

K. Do you agree with the following viewpoints

	Strongly agree	more agree	generally agree	less agree	very disagree
1. My current job is of great significance to me					
2. I often consider the affairs of my unit as my own, and working in this unit is both my need and my will					
3. If I decide to leave the company now, my meaning in life will be greatly affected					
4. I will not leave the unit immediately because I feel that I have a responsibility and obligation to both the unit and colleagues, and the unit is worthy of my loyalty					

L. To what extent does the following situation align with your own situation:

	Fully compliant	relatively compliant	generally compliant	less compliant	completely non compliant
1. My energy-saving behavior is motivated by the company's energy-saving and emission reduction policies					
2. I am very concerned about the company's economic rewards for energy-saving behavior					
3. I am very concerned about the requirements for energy conservation and emission reduction in the company's promotion regulations					

M. For some analytical viewpoints, your specific judgment is:

	Strongly agree	more agree	generally agree	less agree	very disagree
1. Have pilots with energy-saving awareness formed a unique social group					
2. Do pilots frequently communicate and exchange energy-saving experiences and practices among this social group					
3. The informal work opinions formed by the familiar group of pilots have a positive impact on energy-saving awareness and behavior in flight work					
4. The company leadership should pay attention to absorbing beneficial opinions from the pilot feedback group					

N. Your opinion on the following points is:

	Strongly agree	more agree	generally agree	less agree	very disagree
1. The company should actively encourage pilots to adopt energy-saving behaviors to reduce carbon emissions					

2. Pilots need more auxiliary information and energy-saving education knowledge to develop relevant habits					
3. The main responsibility of pilots is to ensure flight safety, not energy conservation					

O. Your opinion on the following suggestions is:

	Strongly agree	more agree	generally agree	less agree	very disagree
1. Establishing a reward mechanism for pilots who excel in energy conservation can enhance their enthusiasm for energy conservation					
2. Energy conservation can reduce environmental pollution, save company costs, and fulfill social responsibilities. The sense of satisfaction generated by individuals is the internal driving force behind pilots to actively implement energy-saving behaviors					
3. Pilots can share their energy-saving practices and experiences with each other, demonstrating and encouraging other pilots to adopt similar behaviors					
4. The more pilots understand the importance of the environment for sustainable development, the more likely they are to adopt energy-saving behaviors					