



Value-Driven Engagement: How Perceptions Influence Chinese Students' Intentions in the Forest-Based Bioeconomy

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Abstract. Using questionnaire survey data from a randomly sampled cohort of Chinese university students (N=1105), this study investigates their intentions and behaviours regarding participation in the Forest-based Bioeconomy. Findings indicate that students' understanding of the foundational theories of the Forest-based Bioeconomy remains relatively vague, with the Value-Belief-Norm (VBN) theory serving as a relevant theoretical framework for examining student engagement interest. Concurrently, ecological worldviews correlate with students' perceived enabling conditions for advancing the Forest-based Bioeconomy, jointly influencing their participation interest. These findings illuminate intrinsic motivations driving Chinese university students' engagement in Forest-based Bioeconomy activities, charting pathways for identifying policies that foster student participation and thereby comprehensively advancing the Forest-based Bioeconomy's development in China.

Keywords: Forest-based Bioeconomy, College Students, Values-beliefs-norms (VBN) Theory

1 Introduction

The Forest-based Bioeconomy represents a novel economic model that enhances socio-economic well-being while safeguarding natural resources. As the world's largest oil importer and second-largest energy consumer, China urgently requires transitioning from a petrochemical energy economy towards a greener, more circular, and lower-carbon-intensive economic paradigm to achieve a carbon-neutral economy. China aims for non-fossil energy to account for 20% of primary energy consumption by the 2030s, with renewable energy exceeding 60% by mid-century. However, despite its potential as a new engine for economic growth, the market penetration of Forest-based Bioeconomy in China remains significantly less favourable compared to international counterparts ^[1].

Enhancing awareness and education levels can increase university students' understanding of the Forest-based Bioeconomy and their acceptance of its products, thereby promoting its long-term development in China. Ioannidis et al., in examining Greek

public perceptions of renewable energy and the circular economy, found a positive correlation between educational attainment and willingness to pay for renewable energy [2].

Nevertheless, existing theoretical research has not sufficiently explored the driving mechanisms influencing university students' support for the Forest-based Bioeconomy transition and their interest in practical implementation. In recent years, despite the state's sustained promotion of Forest-based Bioeconomy implementation through diverse pathways, controversy persists regarding the precise nature of this transition and the resulting economic models. Taking forest biomass energy as an example, some consumers, harbouring doubts about the safety and environmental credentials of biofuels, remain inclined towards traditional fossil fuels. This reluctance hinders the effective stimulation of market demand [1]. Consequently, the theoretical vision of the Forest-based Bioeconomy may diverge significantly from its actual implementation [3]. Such uncertainties in potential organisational procedures cause university students to maintain a wait-and-see attitude towards the Forest-based Bioeconomy. Only when individuals possess sufficient information regarding the potential costs and benefits of innovative sustainable practices can they form preliminary attitudes about participating in Forest-based Bioeconomy activities. Moreover, the motivation to gather such information is driven by relatively stable pro-environmental values, beliefs, and norms [4]. Consequently, this study employs the environmentalist value-belief-norm (VBN) theory [5] to predict the driving forces determining university students' participation interest. Additionally, their motivation may be influenced by contextual factors such as market demand for biomass, government subsidies, or infrastructure availability [6].

2 Research Hypothesis

Altruism emphasises an individual's concern for and dedication to the welfare of others and society. Existing research indicates that individuals with higher altruistic values are more inclined to focus on social and environmental issues and actively participate in related sustainable development activities, whereas the opposite tendency hinders people's interest in and actions towards environmental protection. [7] Openness to change reflects an individual's capacity to accept and adapt to novel concepts and experiences. Mortreux (2017), in examining adaptive capacities across diverse regions and groups in response to climate change, found that populations exhibiting greater openness to change demonstrated significantly superior adaptive capabilities. Traditionalist values emphasise respect for and adherence to established beliefs, customs, and authority. University students influenced by such values may exhibit slower acceptance of emerging fields like the Forest-based Bioeconomy, thereby creating barriers to their interest in this domain [8]. Based on the preceding discussion, this study proposes the following hypotheses:

H1a: University students' altruistic values exert an indirect positive influence on their interest in learning about the Forest-based Bioeconomy.

H1b: University students' self-interest values exert an indirect negative influence on their interest in learning about the Forest-based Bioeconomy.

H2a: University students' openness-to-change values exert an indirect positive influence on their interest in learning about the Forest-based Bioeconomy.

H2b: University students' traditionalism values exert an indirect negative influence on their interest in learning about the Forest-based Bioeconomy.

The ecological worldview centres on the wholeness and complexity of ecosystems, emphasising the unity and harmony between humanity and nature. It regards humans and nature as an interdependent, organically integrated whole that co-evolves. This perspective helps individuals recognise their intrinsic connection to the natural world, thereby enhancing environmental awareness and participation enthusiasm (Wardropper et al., 2020). Furthermore, university students' perceptions of environmental threats correlate positively with their motivations for environmental behaviour. Specifically, awareness of environmental threats further prompts students to adopt personal norms, ultimately stimulating their interest in engaging with bioeconomy-related practices^[9]. Based on the preceding discussion, this study proposes the following hypotheses:

H3: University students' ecological worldview exerts an indirect positive influence on their interest in understanding the Forest-based Bioeconomy.

H4: University students' awareness of the consequences of environmental threats has an indirect positive effect on their interest in learning about the Forest-based Bioeconomy.

H5: University students' personal norm has a direct positive effect on their interest in learning about the Forest-based Bioeconomy.

Moreover, multiple empirical studies indicate that perceptions of profitability within the Forest-based Bioeconomy, levels of technological development, and the existence of policy measures such as subsidies exert a positive influence on university students' participation in decision-making processes^[6]. According to the contextual factors identified by Horbach (2008) as primarily influencing the diffusion of environmental innovations, university students who perceive market demand, environmental policy measures, and technological development as conducive to the advancement of the Forest-based Bioeconomy are deemed to exhibit greater interest in engaging in related practical activities^[10]. Based on the foregoing discussion, this study proposes the following hypotheses:

H6: University students' perception of pro-environmental effectiveness of the Forest-based Bioeconomy exert a direct positive influence on their interest in learning about it.

H7a: University students' beliefs about the future market demand of the Forest-based Bioeconomy has a direct positive effect on their interest in learning about the Forest-based Bioeconomy.

H7b: University students' beliefs about future environmental policies of the Forest-based Bioeconomy has a direct positive effect on their interest in learning about the Forest-based Bioeconomy.

H7c: University students' beliefs about future technology developments of the Forest-based Bioeconomy has a direct positive effect on their interest in learning about the Forest-based Bioeconomy.

Due to the influence of personal values and beliefs, university students may perceive and evaluate external conditions differently, such as future market demand for Forest-based Bioeconomy products or the environmental benefits derived from their multi-sectoral applications. The ecological worldview plays a central role in individuals' ecosystem values, enabling resource managers or advocacy organisations to construct information frameworks more effectively to promote or protect specific ecosystem services. ^[11] This process may also be explained by the concept of selective perception, wherein information carries inherent biases stemming from subjective interpretation and differing evaluations grounded in existing value systems. Based on the foregoing discussion, this study proposes the following hypotheses:

H8: An ecological worldview exerts a positive influence on university students' perceived pro-environmental effectiveness of the Forest-based Bioeconomy.

H9a: An ecological worldview exerts a positive influence on university students' beliefs about future market demands in favour of the Forest-based Bioeconomy.

H9b: An ecological worldview exerts a positive influence on university students' beliefs about future environmental policies in favour of the Forest-based Bioeconomy.

H9c: An ecological worldview exerts a positive influence on university students' beliefs about future technology development in favour of the Forest-based Bioeconomy.

3 Method and Procedures

To assess university students' interest in participating in the Forest-based Bioeconomy, we drew upon Stern et al.'s theoretical framework. Extracting variables from the Value-Based Norms (VBN) theory, we adopted and adapted validated scales from the literature. These were measured using a five-point Likert scale, with questionnaire surveys collecting data on Chinese students' cognitive-behavioural perceptions of the Forest-based Bioeconomy and factors influencing participation intentions. Data collection occurred between January and March 2025 through a combined quota and random sampling approach. The nation was divided into seven regions based on administrative divisions, with each region serving as a stratum. Stratum weights were calculated according to each region's resident population size, and the number of questionnaires distributed per region was determined via sample allocation. Finally, random sampling was employed to distribute questionnaires to university students across these seven regions via the Questionnaire Star platform. Ultimately, the study was implemented strictly according to the pre-determined sample allocation plan, yielding 1,600 responses. Of these, 1,105 valid questionnaires were obtained, largely meeting the anticipated objectives. Finally, this research employed descriptive statistical analysis and structural equation modelling for data analysis.

4 Results

4.1 Chinese University Students' Knowledge of Basic Forestry Bio-Economic Theories

When examining the Forest-based Bioeconomy and its associated concepts, we observe that respondents' familiarity with terms such as 'sustainable development,' 'circular economy,' 'bioeconomy,' and 'Forest-based Bioeconomy' diminishes progressively. Concurrently, respondents rated traditional Forest-based Bioeconomy products significantly higher than innovative Forest-based Bioeconomy products and forest recreation and other service-oriented products. Interestingly, the data indicates that the individual recognition scores for traditional products such as timber construction, forest biomass energy, and forest processing products, as well as innovative products like wood-based textiles and wood-based plastics, were significantly higher than the overall recognition score for Forest-based Bioeconomy products, suggesting potential conceptual biases among respondents who may not explicitly associate these sub-sectors with the broader Forest-based Bioeconomy product category. Although university students demonstrated relatively low awareness of the 'Forest-based Bioeconomy' concept, they had already engaged in Forest-based Bioeconomy-related actions in daily life. For instance, they practised zero-waste behaviours such as bringing reusable water bottles, lunch boxes, and bags to avoid purchasing single-use plastic items. However, they remained unaware of the connection between these actions and the Forest-based Bioeconomy.

4.2 Matching Values-Beliefs-Norms (VBN) Theory with Chinese College Students' Participation Interests

The VBN theory was originally proposed within a Western cultural context, exhibiting differences from the values, beliefs, and norms held by Chinese university students. Self-interest ($\beta=0.208$, $p\leq 0.00$) was also found to promote ecological worldviews, while the hypothesized path for traditionalism ($p>0.05$) did not hold within the Chinese cultural context. This may stem from the fact that, with the expansion of education and the increasing prominence of environmental issues, Chinese university students have begun to recognise that the health of ecosystems is closely linked to their own long-term interests. Consequently, the 'self' of Chinese university students is no longer a narrowly defined individual self, but rather a 'greater self' integrated with nature ^[12]. Consequently, this paper revises the model by amending Hypothesis H1b to reflect a 'positive influence' and removing Hypothesis H2b. This modification adheres to the principle of aligning with objective evidence, ensuring the model is grounded in authentic data and theoretical interpretation.

4.3 Analysis of Influencing Factors of Chinese College Students' Interest in Participation within the Framework of Value-Belief-Norm (VBN) Expansion Theory

As can be seen from the following table, the P-values are less than 0.05, and the paths obtained are statistically significant, which means that there is a significant effect of the measurable variables on the latent variables, indicating that the corresponding variables have a significant effect and that each latent variable can be measured better. The specific path coefficients are shown in Table 1.

Table 1. Results of empirical tests.

			standardised	non-standardised	S.E.	C.R.	P
ecological world view	←	altruism	.431	.319	.028	11.347	***
ecological world view	←	self-interest	.186	.189	.040	4.757	***
ecological world view	←	openness-to-change	.362	.223	.025	9.035	***
awareness of consequences	←	ecological world view	.689	1.032	.069	14.983	***
personal norm	←	awareness of consequences	.610	.555	.034	16.373	***
market demand	←	ecological world view	.809	1.531	.105	14.521	***
environmental policy	←	ecological world view	.749	1.254	.090	13.882	***
technology development	←	ecological world view	.627	.819	.062	13.119	***
environmental effect	←	ecological world view	.660	.788	.057	13.899	***
interest	←	personal norm	.154	.178	.047	3.767	***
interest	←	Market demand	.198	.165	.042	3.964	***
interest	←	environmental policy	.139	.131	.049	2.643	.008
interest	←	technology development	-.082	-.099	.050	-1.967	.049
interest	←	perceived pro-environmental effectiveness	.240	.316	.052	6.040	***

The results indicate that altruism ($\beta=0.431$), self-Interest ($\beta=0.186$), and openness-to-change ($\beta=0.362$) all exert a significant positive influence on ecological worldview. This coherence enabled university students to significantly enhance their cognitive awareness of environmental threat consequences ($\beta=0.610$) within the construction of ecological worldview ($\beta=0.689$), thereby jointly reinforcing the interest in participating in Forest-based Bioeconomy intentions and behaviours through personal norm ($\beta=0.154$). Overall, the findings align with Stern et al.'s (1999) theoretical predictions that relatively stable values, beliefs, and norms exert an indirect influence on university students' participation interest.

Concurrently, perceived environmental effectiveness ($\beta=0.240$), market demand ($\beta=0.198$), and environmental policy ($\beta=0.139$) exerted positive and significant influences on their participation interest. This indicates that university students who believe in the developmental potential of the Forest-based Bioeconomy sector are more inclined to proactively engage in related practical activities. In contrast, a weak negative correlation exists between perceived future technology development ($\beta = -0.082$) and student interest.

Moreover, university students' perception of market demand exhibits a significant positive correlation with the strength of their ecological worldview ($\beta=0.809$, $p=0.00$). Simultaneously, their environmental policy ($\beta=0.749$, $p=0.00$) and future technology development ($\beta=0.627$, $p=0.00$) also demonstrate a significant positive correlation with the intensity of their ecological worldview. Furthermore, belief in the perceived pro-environmental effectiveness ($\beta=0.660$, $p=0.00$) also correlates positively with their ecological worldview. These significant relationships indicate that university students' ecological worldview determines how they perceive and evaluate external matters [13], while exerting a strong indirect influence on their overall interest in dedicating time to participating in such practices. As shown in Figure 1.

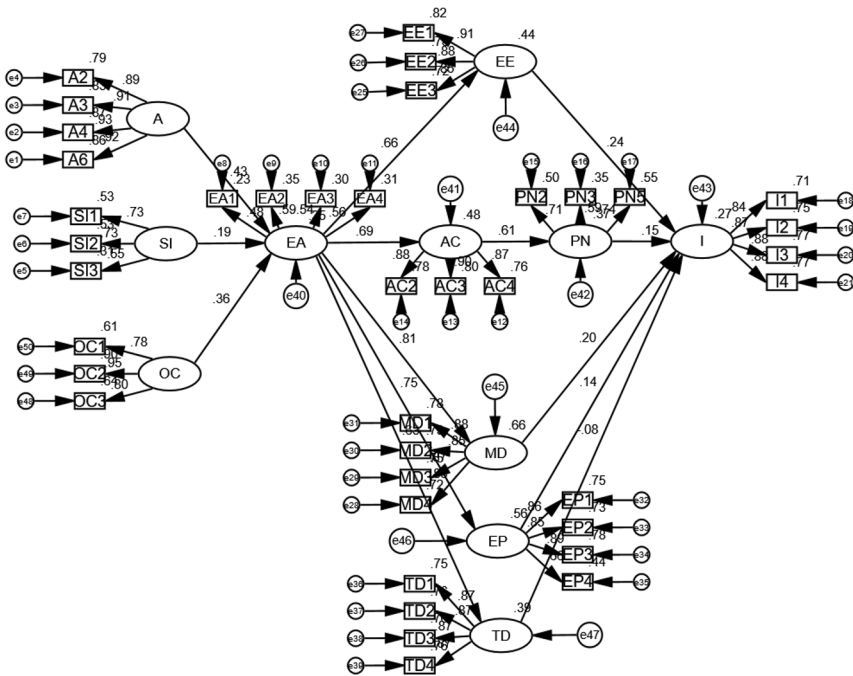


Fig. 1. Results of structural equation modelling runs (Source: Created by the author.)

5 Conclusion

We aimed to explore university students' knowledge of the Forest-based Bioeconomy and the potential realization measures that influence their interest in participating in the behaviour.

Firstly, according to survey findings, the majority of university students possess a relatively low level of understanding regarding the fundamental concepts of the Forest-based Bioeconomy, indicating that its market penetration indeed has considerable room for improvement. Particularly when compared to terms such as 'sustainable development' and 'circular economy,' Chinese university students generally demonstrate lower awareness of the concept of the 'Forest-based Bioeconomy,' consistent with research findings from the Mekong region. On one hand, Chinese university students are aware of related products but fail to clearly categorise specific sub-sectors within the product spectrum. On the other hand, despite their relatively low conceptual understanding of the 'Forest-based Bioeconomy,' they demonstrate commendable practices in zero-waste behaviour and climate action. This discrepancy between cognitive internalisation and between cognition and action will intensify students' cognitive uncertainty regarding related technologies, becoming a significant barrier to their open-mindedness towards the Forest-based Bioeconomy^[2]. It further underscores the evident shortfall in establishing foundational concepts of the Forest-based Bioeconomy among China's university student population.

Secondly, the findings indicate that university students' behaviour aligns fundamentally with the VBN theory, with all variables exhibiting significant correlations with the subsequent variable in the causal chain^[5]. Contrary to our expectations, although egoism exerted a lesser influence than altruism, it still exerted a significant positive effect. This further indicates that, nurtured by China's internal value systems, Chinese university students have begun to recognise the close connection between ecosystem health and their own long-term interests^[12].

Finally, we discovered that contrary to the conventional understanding that the driving force behind the transition to a Forest-based Bioeconomy stems from perceptions of economic benefits and associated policy support^[14], the factor most closely associated with Chinese university students' interest in participating in Forest-based Bioeconomy activities is actually their perception of environmental benefits. Moreover, university students' ecological worldviews serve as crucial mechanisms shaping their perception and evaluation of external phenomena^[13]. When public awareness of environmental crises heightens, heightened ecological worldview consciousness among students not only drives policy refinement and technological advancement but also stimulates market demand for eco-friendly technologies and sustainable products, collectively forming a bidirectional drive between internal and environmental factors.

Based on the empirical findings outlined above, this paper proposes the following policy recommendations: Firstly, higher education institutions must enhance students' understanding of the fundamental theories underpinning the Forest-based Bioeconomy. This requires not only disseminating foundational concepts through general education curricula, supplementary practical activities, and cutting-edge seminars to

convey ‘what the Forest-based Bioeconomy entails’. Secondly, a specialised archival system for the Forest-based Bioeconomy should be established for this cohort, grounded in students' values, beliefs, and norms. Research indicates that students exhibiting greater altruism, openness to change, heightened awareness of environmental threats, and stronger ecological worldviews are more likely to demonstrate heightened interest in the Forest-based Bioeconomy, subsequently translating this interest into tangible action. Therefore, cultivating their role as opinion leaders within the student body can further stimulate interest in the Forest-based Bioeconomy among their peers. Thirdly, policymakers may also strengthen advocacy for environmental outcomes, enhancing university students' awareness of market demand and policy support. This optimises students' background perception mechanisms to bolster their engagement interest.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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