IJEM
International Journal of Economics and Management
Journal homepage: http://www.ijem.upm.edu.my

Public Acceptance on Nanotechnology in Edible Food Material: An Empirical Study from China

ZHENWEI LIAO[a,b], MOHD HELMI ALI[c*], DAN TU[d], SHANMEI XIONG[e] AND NORHIDAYAH SULEIMAN[f]

[a]*Faculty of Economic and Management, Universiti Kebangsaan Malaysia, Malaysia*
[b]*Faculty of Science, The Hong Kong Polytechnic University, China*
[c]*UKM-Graduate School of Business, Universiti Kebangsaan Malaysia, Malaysia*
[d]*Naval Architecture and Shipping College, Guangdong Ocean University, China*
[e]*School of Economics and Management, Nanchang Institute of Science and Technology, China*
[f]*Faculty of Food Science and Technology, Universiti Putra Malaysia, Malaysia*

ABSTRACT

Nanotechnology in Edible Food Materials (NEFM) raises health concerns and public skepticism, necessitating enhanced regulatory scrutiny and public acceptance strategies. This study delves into the key factors influencing public acceptance of NEFM in China, offering vital insights for strategic policy development to promote NEFM integration. Utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM), the study analyzed 275 validated responses from Chinese citizens. It reveals that epistemic trust, social trust, and self-efficacy play crucial roles in shaping public attitudes towards NEFM, each through distinct mechanisms. A notable finding is the inverse relationship between epistemic trust and NEFM acceptance, mediated by perceived risks and benefits. This highlights the intricate balance required to address potential negative consequences and uncertainties of NEFM. Public trust in governmental bodies emerges as a significant determinant of NEFM approval, affecting both risk and benefit perceptions, in contrast to the negligible impact of trust in commercial entities. This study also underscores the positive correlation between perceived benefits and NEFM acceptance, suggesting the importance of highlighting tangible NEFM benefits in consumer education and public outreach programs. The study contributes to the theoretical framework by integrating insights from the Social Cognitive Theory and the Theory of Planned Behavior. It provides a comprehensive understanding of factors fostering public acceptance of NEFM, vital for policymakers and stakeholders in developing strategies that enhance public perception and acceptance, thereby fostering the growth and advancement of NEFM in China and beyond.

JEL Classification: I31

Keywords: Nanotechnology; Edible food materials; Public acceptance; Epistemic trust; Social trust; Self-efficacy; Perceived risks

* Corresponding author: Email: mohdhelmiali@ukm.edu.my
DOI: http://doi.org/10.47836/ijeam.19.1.05

Article history:
Received: 16 June 2024
Accepted: 23 December 2024

INTRODUCTION

Nanotechnology's rapid evolution brings transformative advancements across sectors, predominantly impacting the global food industry (Magnabosco et al., 2023; Chaudhary, 2023;). Its diverse applications, from enhancing food quality, refining taste to prolonging shelf life, underscore its revolutionary potential in food production and consumption (Chaudhary, 2023; Sahani and Sharma, 2021). However, these advancements have potential risks and uncertainties, warranting careful regulatory scrutiny and fostering public concerns. These factors often induce skepticism and reluctance towards such innovations, posing challenges for policymaking (Kamarulzaman et al., 2020; Talebian, 2021).

Previous research has repeatedly underscored the importance of formulating scientifically sound food policies (Parsons et al., 2021; Monticone et al., 2023; Tian et al., 2024). Historical public opposition to nascent technologies, such as genetic modification food technology and new energy technology, accentuate that public perceptions of benefits and risks are pivotal in influencing public acceptance and driving policy directives (Talebian, 2021). Therefore, understanding the antecedent factors influencing the public's acceptance of Nanotechnology in Edible Food Materials (NEFM), a novel food technology, becomes particularly crucial. It is also imperative to comprehend the relationship between these antecedent factors and the perceptions of benefits and risks associated with NEFM. This understanding becomes more critical globally, where supporting regulatory frameworks and policy reforms would bolster the adoption of cutting-edge technologies, driving economic growth, and shaping food policies accordingly (Bastus and Puntes, 2018). This detailed understanding can significantly contribute to the legislating process, enabling policymakers to devise effective, balanced, and integrative policy measures (Kuang et al., 2020). In addition, it can inform public outreach strategies, risk communication, and regulatory oversight, shaping a conducive environment for the broader acceptance of NEFM (Kamarulzaman et al., 2020). In short, the advent of NEFM heralds a transformative era in the food industry (Bastus and Puntes, 2018).

The successful integration of NEFM into consumer markets largely hinges on acceptance shaped by epistemic trust, social trust, and self-efficacy. Public trust in scientific expertise (Hu et al., 2020; Connor and Siegrist, 2010) and confidence in regulatory institutions (Zhu et al., 2020; Liu et al., 2019) are key in shaping perceptions and attitudes towards NEFM. Self-efficacy, or the belief in one's understanding of NEFM (Bandura, 1986; Jani, 2011), further influences this. This paper examines how these elements collectively impact NEFM's public perception, underlining the importance of policy strategies to encourage acceptance. Understanding the role of epistemic and social trust and self-efficacy is critical for informed public decision-making (Kamarulzaman et al., 2020; Kuang et al., 2020). Policies enhancing the dissemination of clear scientific information, boosting institutional trust, and empowering the public through knowledge are essential for the ethical management and wider acceptance of NEFM (Mah et al., 2021; Bastus and Puntes, 2018; Kuttschreuter and Hilverda, 2019). This underscores the need for policy initiatives that empower citizens with knowledge and resources to equip them in the face of rapidly advancing technologies (Kamarulzaman et al., 2020; Talebian, 2021). Policymakers and regulators can leverage these insights to foster trust and public self-efficacy, promoting responsible nanotechnology use.

The extant scholarship on Nano-food public acceptance is notably sparse. Nonetheless, extrapolations from broader literature on public acceptance offer valuable interdisciplinary insights into a spectrum of influential factors. Rana and Dwivedi (2015) highlighted variables like emotions and self-efficacy in e-government adoption, pointing to the importance of considering cultural differences in acceptance, such as between India and China. Hu et al. (2020) delved into trust factors affecting public acceptance, yet some variables were overlooked. Extending models to include more variables could enrich future policy strategies. Sharon et al. (2020) focused on the role of self-identification in trust assessments, but their sampling method could bias results, underscoring the need for more representative samples in policy research. Wang et al. (2021) explored subjective attitudes, but a deeper analysis of trust’s influence on behavior is necessary for effective policymaking. Gao et al. (2022) showed political trust's impact on policy acceptance but didn't consider self-efficacy's role. Also, a broader classification of social trust, including industry and public

organizations, could offer nuanced insights. In synthesis, existing empirical inquiries underscore a pronounced research gap in NEFM public acceptance. The formulation and execution of productive policy frameworks in this arena demand an intricate comprehension of the myriad factors that sway public acceptance. This entails a nuanced consideration of distinct regional socio-cultural milieus and an emphasis on addressing overlooked research dimensions, such as the dimension of current study.

To address these gaps, this study developed an approach involving seven key variables, including epistemic trust (ET) and Self-Efficacy (SE), to investigate the antecedents and pathways of NEFM recognition in China. This study combined the social cognitive theory (SCT) and theory of planned behaviour (TPB), and based on the previously research (Sahani and Sharma, 2021; Hu et al., 2020; Wang et al., 2021), established A new model for the new field of NEFM. In the model, we added the variable SE as a new discussion in this field. And we use the newly upgraded Smart-PLS 4.0 as an analysis tool. Through not only these innovations mentioned above, but current study also expects to provide relevant promotion guidance in the field of NEFM public acceptance in China and expects it to be beneficial to the promotion and development of NEFM technology & Policy in China. From a policy perspective, understanding these acceptance pathways is crucial, as they provide insight into public sentiment that can directly influence policy development. Effective policies incorporating these factors can drive NEFM technology adoption and steer its evolution towards public needs, exhibiting a reservoir of untapped potential for policymakers at all hierarchical levels. It is hoped that the policy suggestions from this study will prompt Chinese authorities to create well-informed, tailored policies on NEFM, ultimately boosting its adoption and development.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Theoretical Foundation

This study builds upon existing research to analyze trust, self-perception, and risk assessment within the context of NEFM public acceptance (see Fig. 1). Integrating the SCT and the TPB, it posits individual acceptance of NEFM as deeply rooted in personal beliefs, societal structures, and perceived control over outcomes (Bandura, 1986; Ajzen, 1991; Rana and Dwivedi, 2015). TPB is particularly appropriate here as it helps explain behavior influenced by attitudes, subjective norms, and perceived control, which aligns well with the factors being explored in this study. The public acceptance of NEFM refers to the willingness of the public to purchase and use NEFM products (Bearth and Siegrist, 2016;). As technological barriers are removed, the success of NEFM deployment is largely dependent on whether people are eager to purchase and perceived control over outcomes from this innovation (Kuang et al., 2020). How do the key concepts mentioned above interact? In this study, the following aspects are discussed.

Public Acceptance in the Form of Epistemic Trust, Trust in Organization, and Self-Efficacy

ET governs the relationship between public perceptions of scientific knowledge and acceptance of technological advancements. It pertains to the faith the public invests in the wisdom and proficiency of scientific authorities (Hu et al., 2020). ET is critical in shaping the individual's openness to accepting and adopting (Campbell et al., 2021; Hu et al., 2020). The intricate relationship between complex scientific information and public understanding forms a significant portion of this investigation. Higher levels of epistemic trust correlate with an increased propensity to embrace new technology, bridging the gap between scientific complexity and layman apprehension (Hu et al., 2020). Trust in organizations encompasses the public's confidence in institutions' abilities, both public and private, to safely navigate the risks and ethically manage the integration of nanotechnology into the food industry (Connor et al., 2010). The focus here is to decode how this trust—or lack thereof—modulates public acceptance. This study details the components of organizational assurance necessary to foster public compliance and consent, examining how these entities' governance and regulatory posture inform public sentiment and approval (Kamarulzaman et al., 2020; Bastus and Puntes, 2018). SE reflects the belief in one's capacity to execute behaviors necessary to produce specific performance attainments. This self-assurance can significantly influence one's attitude towards NEFM (Bieberstein et al., 2012). Individuals with high SE will likely engage more constructively with pertinent information, leading to a stronger inclination to accept NEFM (Gupta et al., 2016).

Perceived Risks or Benefits and Public Acceptance

The dual concepts of perceived risks and benefits serve as pivotal touchstones for public acceptance (Del-Real and Díaz-Fernández, 2021; Hu et al., 2021). These perceptions encompass the individual's assessment of the potential dangers and advantages that NEFM poses to society and personal well-being (He and Hwang, 2016). The research will evaluate how the balance between perceived risks and benefits can impede or promote the acceptance of NEFM. Previous research conducted by Liu et al. (2019) indicated that trust in societal organisations affects the risks and benefits associated with a project. Public acceptance is directly influenced by perceived benefits or risks and trust in industrial organizations, as highlighted by previous studies in technology acceptance (Del-Real and Díaz-Fernández, 2021; Hu et al., 2020). Therefore, it can be inferred that the mediating role of perceived benefits or risks are crucial in linking self-efficacy to public acceptance, suggesting that the positive influence of self-efficacy on public acceptance is channeled through the perceived benefits or risks associated with the technology.

The evaluation aims to articulate the complex interplay between these perceptions and the overall disposition towards embracing NEFM, highlighting their critical influence on decision-making processes (Chaudhary, 2023). Through a granular multi-disciplinary analysis, this study aspires to augment the theoretical tapestry of public acceptance mechanisms by examining how each of these constructs—epistemic trust, organizational trust, self-efficacy, and perceived risks and benefits—interact and converge to shape attitudes toward the adoption of NEFM in China (Fig.1).

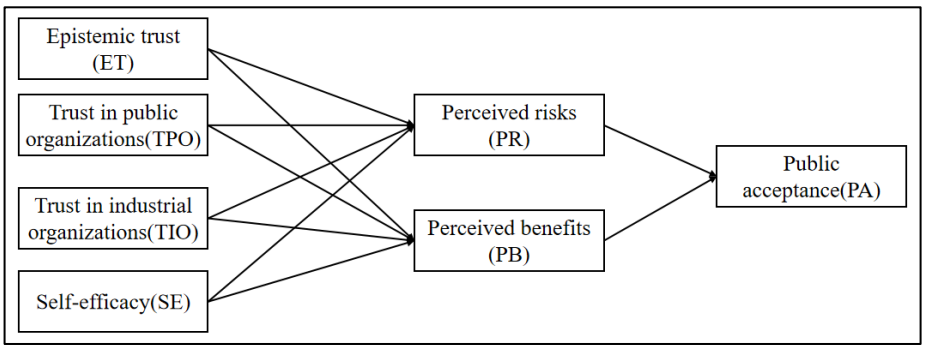

Figure1 Theoretical Model

Hypothesis Development

The assumptions mentioned in current study are all established within the context of the public acceptance of NEFM.

Epistemic Trust and Public Acceptance

ET refers to the public's confidence in the scientific understanding and expertise underpinning a specific technology, with a focus on using nanotechnology in edible food materials. (Kuang et al., 2020; Hu et al., 2020; Sjöberg, 2005; Sjöberg, 2008). The notion of ET is intrinsically linked to public acceptance of novel phenomena such as in context of NEFM. Public acceptance of such technologies is contingent not only on their potential benefits but also on the extent to which the public trusts the sources providing information about these benefits and the broader implications of the technology's use (Hu et al., 2020). The existing literature provides a strong foundation for the hypothesis that ET positively influences public acceptance (Sharon et al., 2020). The relationship between ET and public acceptance is also argued to be mediated by perceived benefits (Hu et al., 2020). Therefore, the following hypothesis is proposed:

H1: Epistemic trust positively influences public acceptance of NEFM

Trust in Public Organizations and Public Acceptance

Trust in public organizations refers to the degree of reliance individuals place on national and local public agencies responsible for regulating, researching, and ensuring the safety of food products (Hu et al., 2020; Connor et al., 2010; Sjöberg, 2005). Research conducted by Gao et al. (2022) demonstrated that public trust in regulatory entities significantly impacts perceived risk, benefit, and technology acceptability. Additionally, Hu

et al. (2020) found that trust in public organizations positively impacts perceived benefits and has a significant indirect role in the public acceptance of new technologies, such as genetically modified food. These findings indicate a substantial influence of trust in public organizations on shaping public perception and acceptance of novel technologies. Thus:

H2: Trust in public organizations positively influences public acceptance of NEFM.

Trust in Industrial Organizations and Public Acceptance

Trust in Industrial Organizations (TIO) refers to the faith individuals place in the food, agriculture, pharmaceutical, and biotechnology companies producing NEFM (Connor et al., 2010). This trust is essential for shaping public perceptions and acceptance of nano food technology, as highlighted by previous research (Kuang et al., 2020). Furthermore, through empirical analysis, Liu et al. (2019) demonstrated that the public acceptance of genetically modified foods was affected by TIO. Additionally, according to Social Cognitive Theory (Bandura, 1986), the public's observations of these organizations' actions and outcomes could reinforce trust, further influencing NEFM acceptance. Above previous research provides a deeper understanding of the dynamics between TIO and public acceptance, supporting the following hypothesis:

H3: Trust in industrial organizations positively influences public acceptance of NEFM.

Self-Efficacy and Public Acceptance

In this study, Self-Efficacy refers to an individual's belief in their ability to understand, interact with, and effectively manage the aspects and implications of nanotechnology in edible food materials (Wang et al., 2021; Jani, 2011). Previous research by Huang et al. (2016) indicates that self-efficacy significantly influences perceived benefits, and Jani (2011) found that individuals with higher self-efficacy may underestimate the risks associated with projects, suggesting a bias in self-efficacy. This suggests that individuals' belief in their ability to perform a particular behavior can directly impact their perception of the benefits of a technology, thereby affecting their overall acceptance of it. Research has demonstrated that self-efficacy affects autonomous vehicles' perceived usefulness and functional value, indicating its potential influence on public acceptance (Zhu et al., 2017). Thus:

H4: Self-efficacy positively influences public acceptance of NEFM.

Perceived Risks and Benefits and Public Acceptance and Their Mediating Role

Del-Real and Díaz-Fernández (2021) discovered that perceived benefits and risks significantly influence the public's willingness to use rescue drones. Similarly, Hu et al. (2020) found that perceived benefits and risks have a direct and statistically significant impact on the public acceptance of genetically modified food. From this light, both PB and PR are equally important in determining the public acceptance. Therefore, it can be inferred that the mediating role of perceived benefits or risks are crucial in linking trust in public organizations to public acceptance, indicating that the positive influence of public organizations' trust on public acceptance is channeled through the perceived benefits or perceived risks associated with the technology.

Perceived risks are the impressions or interpretations of uncertainty and potential negative consequences of a threatening product (Zhang et al., 2019). Perceived risks in the context of the study can be defined as the subjective interpretation or apprehension of potential adverse outcomes and uncertainties associated with the utilization of NEFM (Wang et al., 2019). Similarly, Hu et al. (2020) found that perceived risks significantly affect the public's acceptance of genetically modified food. Zhang et al. (2019) indicated that perceived risks significantly influence public acceptance in the context of nuclear power technology, providing evidence for the association between perceived risks and public acceptance in the technology field. Hu et al. (2020) highlighted the indirect role of ET in influencing PA of genetically modified food by shaping PR, providing a basis for the mediation of perceived risks in the relationship between epistemic trust and public acceptance. This is attributed to the notion that individuals are more likely to embrace new technologies when they can perceive the benefits or risks of the new technology based on their epistemic trust (Hu et al., 2020).

Trust in public organizations plays a pivotal role in shaping the perception of risks associated with new food technology (Hu et al., 2020), where effective communication and regulation by these organizations can lead to increased public acceptance (Gao et al., 2022; Zhu et al., 2020). These dynamic highlights the mediating effect of perceived risks on the relationship between trust in public organizations and acceptance of new food technology (Hu et al., 2020; Connor et al., 2010). Trust in industrial organizations like food and biotech companies affects public acceptance of Nanotechnology in Edible Food Materials (NEFM) by altering perceived risks, where higher trust can reduce risk perception and enhance acceptance (Connor et al., 2010; Liu et al., 2019; Kuang et al., 2020). This illustrates perceived risks as a key mediator between industrial trust and NEFM acceptance. Self-efficacy significantly influences how individuals perceive and assess the risks associated with new technology (Zhu et al., 2020), thereby impacting their acceptance (Wang et al., 2021). This effect presages the mediating role of perceived risks in the relationship between an individual's confidence in understanding NEFM (self-efficacy) and their acceptance of this technology (Jani, 2011).

H5: Perceived risks of NEFM significantly associate with the public acceptance.

H5a: Perceived risks mediates the relationship between Epistemic trust and s public acceptance NEFM.

H5b: Perceived risks mediates the relationship between trust in public organizations (TPO) and public acceptance of NEFM.

H5c: Perceived risks mediates the relationship between Trust in industrial organizations (TIO) public acceptance of NEFM.

H5d: Perceived risks mediates the relationship between Self-efficacy (SE) and public acceptance of NEFM.

PB refers to the individual's belief that a particular action or product will produce positive consequences and play a significant role in accepting new technologies as individuals assess the positive outcomes associated with a particular action or product (Ghoochani et al., 2016). Hu et al. (2020) found that PB have a direct and statistically significant impact on public acceptance of genetically modified food, therefore the similar effect is expected in NEFM. The PB associated with NEFM significantly influence public acceptance, as demonstrated by Del-Real and Díaz-Fernández (2021) and Hu et al. (2020) in their studies on similar technologies. Public Acceptance (PA) of NEFM is crucial for its successful adoption and utilization by the public, as it reflects the trust of individuals to purchase and use NEFM products (Bearth and Siegrist, 2016; Kuang et al., 2020).

When public organizations are trusted, the public is more inclined to perceive new food technologies as bringing beneficial outcomes like safer and more nutritious food, directly influencing their acceptance (Hu et al., 2020). This trust enhances the perception of the benefits of these new food technologies, acting as a mediating factor that increases public willingness to adopt them (Connor et al., 2010). Public trust in industrial organizations is linked to the belief that they will use new food technology to produce superior food products, enhancing public acceptance (Kuang et al., 2020). This belief in their potential to innovate and benefit food technology through these new methods is a mediating factor, boosting public willingness to accept the technology (Liu et al., 2019). Individuals with higher self-efficacy tend to perceive new food technology as beneficial, associating it with improvements like longer shelf life and better food quality, which drives their acceptance (Jani, 2011). This positive perception, stemming from their confidence in understanding the technology, mediates and increases public acceptance (Wang et al., 2021). Therefore, the following hypotheses are proposed on PB for the NEFM area:

H6: Perceived Benefits of NEFM significantly associates with the public's acceptance.

H6a: Perceived Benefits mediates the relationship between Epistemic trust and public acceptance NEFM.

H6b: Perceived Benefits mediates the relationship between trust in public organizations and public acceptance of NEFM.

H6c: Perceived Benefits mediates the relationship between Trust in industrial organizations and public acceptance of NEFM.

H6d: Perceived Benefits mediates the relationship between Self-efficacy and public acceptance of NEFM.

RESEARCH METHODOLOGY

Survey Design and Reliability

To measure the constructs of the study, a structured questionnaire was utilized. The items of the constructs were adapted from previous studies, ensuring content validity as shown in Table 1. Respondents were required to use a five-point Likert scale that ranged from "strongly disagree" to "strongly agree". To ensure the reliability and repeatability of the 5-point Likert scale used in this study, we engaged experts in item development based on a comprehensive literature review, ensuring conceptual relevance. We conducted a pilot study to refine items, with feedback indicating clarity and coherence. Test-retest reliability was assessed over a 3–4-week interval revealing correlations above the acceptable benchmark of 0.70, indicating satisfactory stability of responses over time.

Internal consistency was measured using Cronbach's alpha coefficient, which exceeded the accepted threshold of 0.70, along with Composite reliability (CR) figures surpassing 0.70, confirming high data quality. Item scoring involved summing or averaging, with reversed items duly recoded to maintain scale orientation. Analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM) validated the measurement model by ensuring factor loadings above 0.7 and construct reliability and Average Variance Extracted (AVE) values above 0.7 and 0.5, respectively. This rigorous adherence to methodological standards establishes the constructs' validity, allowing for precise data interpretation and subsequent analysis. The survey's design and reliability measures meticulously follow stringent methodological standards, guaranteeing robust and valid tools for later analytical phases, thereby fitting seamlessly into this study without redundancy.

Data Collection and Analysis

This study employed a snowball sampling technique to recruit respondents. A sampling frame was established to target individuals with varying demographic characteristics that are crucial to understanding NEFM public acceptance. Specifically, the study aimed to include respondents with different educational backgrounds, professional experiences, income levels, and geographical diversity, ensuring representation across urban and rural areas, as well as various tiers of cities. Initial participants were selected based on these criteria, ensuring a diverse sample that could provide well-informed perspectives. Participants were required to have at least basic familiarity or interest in NEFM, which was assessed through preliminary screening questions. After selecting initial participants, they were asked to refer others who also met the outlined criteria, thereby expanding the sample size iteratively. Before administering the survey, this study obtained their informed consent for participation. The questionnaire was kept short to ensure that respondents completed it, and most responses were obtained one to one online in person to minimize the likelihood of missing data. 574 questionnaires were successfully gathered from May 1, 2023, to August 15, 2023 via the online platform at http://www.wjx.cn/. This study adopted precautionary measures (respondents' IP addresses, and response times) to avoid multiple responses from the same respondents. The data treatment is conducted as follows: (1) the questionnaires not aligned with the logic of PA1-PA3 anti-questions were also eliminated, i.e., if PA1 and PA3 are inverse of each other, only samples that comply with the following logic are retained. When the answer of PA1 is 1 or 2, the samples of PA3 whose answer is 4 or 5 are retained; when the answer of PA1 is 4 or 5, the samples of PA3 whose answer is 1 or 2 are retained. When the PA1 option is 3, the sample with the answer PA3 being 3 is retained, (2) any others that were visibly invalid - those displaying highly repetitive single option answers - were discarded from the sample. Thus, only 275 questionnaires were validated and retained from the initial collection for further analysis.

The Partial Least Squares (PLS) method was utilized by implementing SmartPLS 4.0 software to examine the research hypotheses in this investigation. PLS was selected due to its suitability for exploratory research and ability to evaluate reflective constructs, as suggested by Hair et al. (2019). The analysis followed a two-step process, comprising a measurement model assessment and hypothesis testing via a non-parametric bootstrap technique (Iranmanesh et al., 2017).

RESULTS

The demographic characteristics of respondents is provided in Table 1. With 53.5% holding at least a bachelor's degree, the respondents are well-educated, influencing their perception of NEFM. Professionally, the majority come from liberal arts (38.9%) and engineering (25.8%), providing varied insights into technological acceptance. Most are young or middle-aged (92.4% between 18 to 45 years), and predominantly urban dwellers (68.4%), with a significant number from first-tier cities (31.6%). This demographic spread, including a high female representation (65.1%), and diverse income levels, with most earning below 10,000 Yuan monthly, offers a comprehensive view of the impact of epistemic trust, social trust, and self-efficacy on NEFM acceptance in China.

Table 1 Demographic characteristics

Classification	No. of respondents	%
Gender		
Male	96	34.9
Female	179	65.1
Total	275	100
Age group		
Below18	6	2.2
18-45	254	92.4
46-69	15	5.5
Above69	0	0
Total	275	100
Type of residents		
Rural residents	87	31.6
Urban residents	188	68.4
City Location		
First-tier cities	87	31.6
Second-tier cities	66	24
Third-tier cities	59	21.5
Fourth-tier cities	29	10.5
Fifth-tier cities	34	12.4
Total	275	100
Educational background		
High school/junior high school and below equivalent education	24	8.7
College or equivalent education	40	14.5
Bachelor's degree or equivalent education	147	53.5
Master's degree or equivalent education	56	20.4
Doctoral degree or equivalent education	8	2.9
Total	275	100
Professional Background		
Science	58	21.1
Engineering	71	25.8
Liberal Arts	107	38.9
Compound (this is selected when you have two or more professional backgrounds in this question option at the same time)	11	4
Other,	28	13.2
Total	275	100
Occupation		
State organs, party organizations, enterprises and institutions in charge	38	13.8
Professional and technical personnel	41	14.9
Clerical and related personnel	22	8
Commercial, service industry personnel	47	17.1
Agriculture, forestry, animal husbandry, fishery, water conservancy industry production personnel	7	2.5
Production, transport equipment operators and related personnel	10	3.6
Military personnel	1	0.4
Other employees who are not conveniently classified	109	39.6
Total	275	100
Income level (unit: RMB/month)		
Below3000	78	28.4
3001-5000	50	18.2
5001-10000	88	32.0
10001-20000	45	16.4
20001-30000	5	1.8
30001-50000	3	1.1
50001-80000	1	0.4
80001-100000	1	0.4
Above100000	4	1.5
Total	275	100.0

Assessment of the Measurement Model

Table 2 shows convergent validity for the reflective constructs by evaluating each item's loading, which should surpass 0.7, and inspecting the composite reliability and average variance extracted values for each construct, which should exceed 0.7 and 0.5, respectively (Hair et al., 2019). As per Table 1, both items and constructs adhered to the recommended criteria, signifying that convergent validity was successfully established.

Table 2 Reliability and validity & measurement model evaluation

Items	Loadings	CR	AVE	R^2	Cronbach's alpha	CRa
Public acceptance (PA) (Hu et al., 2020)		0.921	0.797	0.669	0.870	0.887
PA1 I am willing to buy nano ingredients (i.e., using nanotechnology in the ingredients)	0.946	–	–	–		
PA2 I am willing to buy this food if the packaging of the food shows that the product contains ingredients related to nano ingredients.	0.935					
PA3 Whenever possible, I would avoid buying nano ingredients. (The reversed question is not discussed repeatedly)						
PA4 I would choose to buy these products because of the longer shelf life of nano ingredients compared to ordinary ingredients.	0.788	-	-	-		
Epistemic trust (ET) (Hu et al., 2020; Sjöberg, 2008)		0.835	0.628	-	0.729	0.788
ET1 With the current scientific knowledge, nano ingredients may have unknown negative effects.	0.805	-	-	-		
ET2 The scientific knowledge about nano ingredients may still be incomplete.	0.726	-	-	-		
ET3 The researchers who applied nanotechnology to the ingredients were hardly aware of all the consequences of their creation.	0.841	-	-	-		
Perceived benefits (PB) (Hu et al., 2020)		0.938	0.791	0.380	0.912	0.914
PB1 Overall, I think the application of nanotechnology in ingredients is useful for society.	0.917	-	-	-		
PB2 I think nano ingredients create a higher quality of life and it is a great technological advancement.	0.918	-	-	-		
PB3 I think the application of nanotechnology in ingredients can provide more food selectivity.	0.860	-	-	-		
PB4 I think nano ingredients will eventually be accepted by most people.	0.862	-	-	-		
Perceived risks (PR) (Hu et al., 2020; Chen, 2008; Zhang et al., 2019)	-	0.932	0.734	0.45	0.909	0.916
PR1 In general, I think nano ingredients may be dangerous to people.	0.881	-	-	-		
PR2 I believe that eating nano ingredients may cause fetal malformations in women during pregnancy.	0.880	-	-	-		
PR3 I think the nano ingredients may contain toxicity.	0.892	-	-	-		
PR4 I think that eating nano ingredients may change our genes or those of future generations.	0.859	-	-	-		
PR5 I think that the application of nanotechnology in ingredients may have a negative impact on the environment.	0.763	-	-	-		
Trust in industrial organizations (TIO) (Hu et al., 2020; Connor et al., 2010)	-	0.912	0.723	0.382	0.871	0.871
TIO1 Regarding nano ingredients, I think I am willing to trust food companies.	0.862	-	-	-		
TIO2 Regarding nano ingredients, I think I am willing to trust agricultural companies.	0.785	-	-	-		
TIO3 Regarding nano ingredients, I think I'm willing to trust pharmaceutical companies.	0.891	-	-	-		
TIO4 Regarding nano ingredients, I think I am willing to trust biotech companies.	0.860	-	-	-		
Self-efficacy (SE) (Wang et al., 2021; Jani, 2011)	-	0.912	0.636	-	0.89	0.952
SE1 I think I understand some basic knowledge about nano ingredients.	0.704	-	-	-		
SE2 I think I can discern some information about nano ingredients.	0.661	-	-	-		
SE3 I think I was able to avoid some of the risks that nano ingredients can pose.	0.746	-	-	-		
SE4 I think I was able to get some of the benefits that nano ingredients might bring.	0.838	-	-	-		
SE5 I think I was able to seize the opportunities that came with the application of nanotechnology in ingredients.	0.897	-	-	-		
SE6 I think I can handle the challenges that come with applying nanotechnology to ingredients.	0.905	-	-	-		
Trust in public organizations (TPO) (Hu et al., 2020; Connor et al., 2010)	-	0.926	0.716	--	0.901	0.909
TPO1 Regarding nano ingredients, I think I am willing to trust the State Food and Drug Administration.	0.856	-	-	-		
TPO2 Regarding nano ingredients, I think I would like to trust the public research institutes in the field of nano food.	0.773	-	-	-		
TPO3 Regarding nano ingredients, I think I'm willing to trust the National Institute of Public Health.	0.878	-	-	-		
TPO4 Regarding nano ingredients, I think I'm willing to trust the National Administration of Market Surveillance.	0.894	-	-	-		
TPO5 Regarding nano ingredients, I think I'd like to trust other relevant food safety oversight authorities.	0.827	-	-	-		

Notes: AVE = Average variance extracted; CR = Composite reliability(rho_c); VIF = Variance inflation; CRa= Composite reliability (rho _a).

Reliability and Validity

The evaluation of the measurement model in this study reveals high levels of internal consistency and convergent validity for the constructs involved. Specifically, the construct reliability measures, captured through Cronbach's alpha, composite reliability, indicate commendable internal coherence within the model. The lowest Cronbach's alpha noted is 0.729 for Epistemic Trust (ET), above the accepted threshold of 0.7, suggesting adequate internal consistency (Hair et al., 2014). Additionally, all constructs present Dijkstra-Henseler's rho values exceeding the often-cited benchmark of 0.7, with the lowest observing a satisfactory value of 0.788 for ET (Hair et al., 2019) (refer to Table 2). Consistently, Composite Reliability (rho_c) values range above the standard value of 0.7, with Public Acceptance (PA) boasting the highest CR value of 0.921, further validating the robustness of the constructs (Hair et al., 2014).

Convergent validity is also systematically substantiated; as in Table 2, the Average Variance Extracted (AVE) for each construct exceeds the 0.5 standard, pointing to a sufficient one-dimensionality of the constructs. The perceived Benefits (PB) construct shows the highest AVE of 0.791, while the lowest AVE corresponds to ET, at 0.628. These metrics convincingly suggest that the constructs have acceptable convergent validity (Hair et al., 2019).

Assessments of discriminant validity display confirmatory results. According to the Variance Inflation Factor (VIF) scores provided in Table 4, no construct encounters collinearity issues, all falling well below the problematic threshold of 3.3. Such an observation underlines that multicollinearity does not concern this study's constructs (Hair et al., 2014). Discriminant validity is further corroborated by the criteria established by Fornell and Larcker (1981), as visualized in Table 2 & 3. The square roots of AVE for each construct were systematically higher than their corresponding inter-construct correlations, fulfilling the Fornell-Larcker criterion and indicating satisfactory discriminant validity (Hair et al., 2019). The cross-loadings in Appendix 2 validate the study's factor structure by exhibiting strong discriminant validity. Primary loadings on intended constructs (for example, items PA1, PA2, and PA4 on Achievement (PA) with values of 0.946, 0.935, and 0.788) are consistently higher than any cross-loadings with non-target constructs. This trend is consistent across all measured constructs, demonstrating each construct's individuality and confirming the discriminant validity per stringent research standards (Appendix 2). The Heterotrait-Monotrait Ratio (HTMT) presented in table 3 reinforces these findings, with all values residing below the conservative cutoff of 0.85, reinforcing adequate discriminant validity across the constructs (Hair et al., 2019).

Table 2 Discriminant Validity – Cross Loadings

	PA	ET	PB	PR	TIO	SE	TPO
PA1	0.946	-0.290	0.744	-0.591	0.479	0.417	0.442
PA2	0.935	-0.233	0.753	-0.547	0.485	0.404	0.463
PA4	0.788	-0.260	0.594	-0.503	0.448	0.363	0.374
ET1	-0.203	0.805	-0.155	0.297	-0.085	-0.149	0.174
ET2	-0.135	0.726	-0.040	0.193	-0.093	-0.140	0.202
ET3	-0.299	0.841	-0.229	0.402	-0.129	-0.015	-0.042
PB1	0.737	-0.184	0.917	-0.470	0.428	0.389	0.448
PB2	0.735	-0.239	0.918	-0.503	0.430	0.357	0.432
PB3	0.635	-0.086	0.860	-0.402	0.410	0.351	0.491
PB4	0.678	-0.220	0.862	-0.510	0.447	0.431	0.425
PR1	-0.619	0.382	-0.517	0.881	-0.394	-0.302	-0.403
PR2	-0.536	0.261	-0.479	0.880	-0.359	-0.367	-0.449
PR3	-0.534	0.316	-0.497	0.892	-0.358	-0.353	-0.398
PR4	-0.482	0.389	-0.424	0.859	-0.370	-0.315	-0.317
PR5	-0.436	0.396	-0.336	0.763	-0.296	-0.218	-0.227
TIO1	0.397	-0.126	0.379	-0.381	0.862	0.411	0.507
TIO2	0.437	-0.135	0.399	-0.381	0.785	0.263	0.508
TIO3	0.466	-0.088	0.399	-0.326	0.891	0.389	0.531
TIO4	0.486	-0.104	0.458	-0.331	0.860	0.407	0.552
SE1	0.220	-0.056	0.214	-0.178	0.241	0.704	0.176
SE2	0.194	-0.028	0.171	-0.144	0.191	0.661	0.109
SE3	0.197	0.045	0.202	-0.102	0.262	0.746	0.268
SE4	0.430	-0.101	0.422	-0.424	0.424	0.838	0.410
SE5	0.441	-0.142	0.416	-0.328	0.421	0.897	0.382
SE6	0.433	-0.108	0.429	-0.352	0.390	0.905	0.310
TPO1	0.388	0.136	0.407	-0.322	0.495	0.217	0.856
TPO2	0.512	-0.036	0.502	-0.462	0.609	0.323	0.773
TPO3	0.371	0.141	0.418	-0.336	0.456	0.342	0.878
TPO4	0.392	0.133	0.412	-0.331	0.521	0.335	0.894
TPO5	0.320	0.065	0.353	-0.306	0.493	0.379	0.827

Table 3 Hetrotrait-monotrait ratio test

	PA	ET	PB	PR	TIO	SE	TPO
PA	-	-	-	-	-	-	-
ET	0.335	-	-	-	-	-	-
PB	0.877	0.234	-	-	-	-	-
PR	0.686	0.458	0.577	-	-	-	-
TIO	0.606	0.160	0.540	0.467	-	-	-
SE	0.451	0.218	0.427	0.351	0.454	-	-
TPO	0.529	0.229	0.548	0.453	0.686	0.386	-

Notes: ET - Epistemic trust; TIO – Trust industrial organizations; TPO – Trust public organizations; SE – Self-efficacy; PR – Perceived risks; PB – Perceived benefits; PA– Public acceptance.

Examining loadings and cross-loadings with these assessments further corroborates reliability and validity. The factorial loadings of all items on their respective constructs are substantial and exceed the cross-loadings with other constructs, as detailed in Table 2 and 3. This evidence advocates for a clear and distinct measurement of the concepts intended and supports the presence of adequate convergent validity within the reflective models.

Assessment of the Structural Model

The structural model was evaluated for its predictive accuracy using the explained variance portion. The R2 values were presented in Table 2. To test the hypotheses, non-parametric bootstrapping with 2,000 replications was employed (Minh et al., 2019; Zainuddin et al., 2017). The results showed that all other paths except for item (SE2) were significant. Moreover, most hypotheses were supported, while hypotheses H6, H5c, and H6c were not supported (Figure 2 and Table 5). The findings suggest that the model can effectively predict the outcome variables. Therefore, the structural model can be deemed a reliable and valid for assessing the relationships among the observed variables (Kline, 2015).

Multicollinearity Assessment

Table 4 presents the Construct Variance Inflation Factor (VIF) values for various constructs in the study. The Variance Inflation Factor is a statistical measure used to assess the degree of multicollinearity in a multivariate regression analysis. It quantifies how much the variance of an estimated regression coefficient is increased due to multicollinearity. Higher VIF values indicate a higher degree of multicollinearity, which can lead to unreliable and unstable estimates of the regression coefficients.

The table illustrates the VIF values for each construct in relation to the other constructs. The VIF value of 1.084 between ET and PB indicates a low level of multicollinearity, which means that the two constructs are not highly correlated and can be reliably used in the model. However, some VIF values are notably higher, such as 1.836 between PB and 1.836 between TIO and PR. These values suggest that there may be a higher degree of multicollinearity between these constructs, potentially affecting the stability and reliability of the regression coefficients in the model. In summary, Table 4 provides an overview of the Variance Inflation Factor (VIF) values for each construct in relation to the others, helping to assess the degree of multicollinearity in the analysis. Some constructs exhibit low VIF values, indicating low multicollinearity levels and ensuring the reliability and stability of the estimates. Meanwhile, higher VIF values for certain constructs may warrant further investigation to reduce potential issues with multicollinearity.

Table 4 Construct variance inflation value

	PA	ET	PB	PR	TIO	SE	TPO
PA					-	-	-
ET			1.084	1.084	-	-	-
PB	1.392				-	-	-
PR	1.392				-	-	-
TIO			1.836	1.836	-	-	-
SE			1.272	1.272	-	-	-
TPO			1.763	1.763		-	-

Notes: ET - Epistemic trust; TIO – Trust industrial organizations; TPO – Trust public organizations; SE – Self-efficacy; PR – Perceived risks; PB – Perceived benefits; PA– Public acceptance.

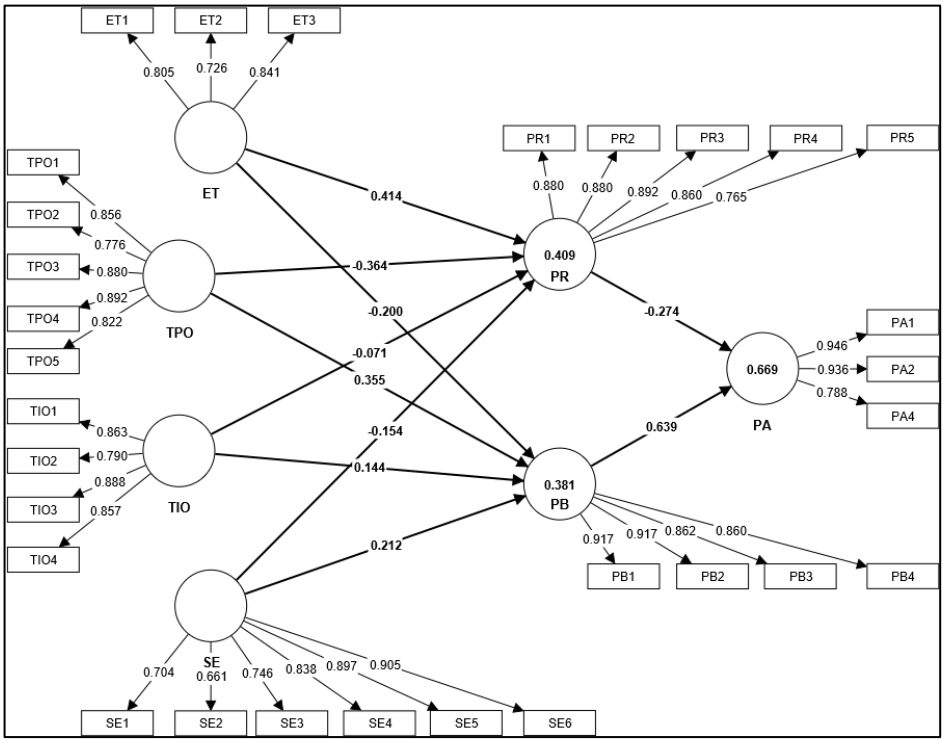

Figure 2 Hypothesis results summary extracted from SmartPLS4.0

Table 5 Hypothesis testing results

Hypothesis and relations		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
H1	ET→PA	-0.241	-0.243	0.045	5.380	0.000	Rejected
H2	TPO→PA	0.326	0.324	0.048	6.735	0.000	Supported
H3	TIO→PA	0.112	0.112	0.060	1.872	0.061	Rejected
H4	SE→PA	0.178	0.184	0.048	3.693	0.000	Supported
H5	PR→PA	-0.274	-0.278	0.064	4.316	0.000	Supported
H6	PB→PA	0.639	0.635	0.059	10.892	0.000	Supported
Mediating Effect							
H5a	ET→PR→PA	-0.114	-0.115	0.030	3.727	0.000	Supported
H5b	TPO→PR→PA	0.100	0.101	0.025	3.917	0.000	Supported
H5c	TIO→PR→PA	0.019	0.021	0.024	0.794	0.427	Rejected
H5d	SE→PR→PA	0.042	0.046	0.021	2.004	0.045	Supported
H6a	ET→PB→PA	-0.128	-0.128	0.038	3.396	0.001	Supported
H6b	TPO→PB→PA	0.227	0.224	0.042	5.414	0.000	Supported
H6c	TIO→PB→PA	0.092	0.091	0.057	1.633	0.103	Rejected
H6d	SE→PB→PA	0.135	0.139	0.045	2.983	0.003	Supported

Notes: ET - Epistemic trust; TIO – Trust industrial organizations; TPO – Trust public organizations; SE – Self-efficacy; PR – Perceived risks; PB – Perceived benefits; PA– Public acceptance.

Hypothesis Testing

The hypothesis testing results, as detailed in Table 5, offer valuable insights into the dynamics between the various constructs of the study. The findings reveal significant relationships in most hypothesized links, with some exceptions. Notably, H1 (ET→PA) demonstrates a significant negative effect, with a coefficient of -0.241 and a p-value of 0.000, leading to the rejection of the hypothesis. Similarly, H2 (TPO→PA) and H4 (SE→PA) show significant positive effects, with coefficients of 0.326 and 0.178 respectively, both supported by p-values of 0.000. H5 (PR→PA) also indicates a significant negative effect, reinforcing the hypothesized relationship. However, H3 (TIO→PA) is not supported, as indicated by a p-value of 0.061. Moreover, H6 (PB→PA) is strongly validated with a notable positive coefficient of 0.639, emphasizing its significant impact.

Mediating Effects

The study also examines the mediating effects of perceived risks and benefits through a set of hypotheses (H5a, H5b, H5c, H5d, H6a, H6b, H6c, and H6d), as shown in Table 5. The results for perceived risks indicate mixed outcomes. Specifically, H5a (ET→PR→PA) and H5b (TPO→PR→PA) are validated, with coefficients of -0.114 and 0.100 respectively, and low p-values, suggesting significant mediation. However, H5c (TIO→

PR→PA) and H5d (SE→PR→PA) are not supported, as seen by their higher p-values and low coefficients, indicating a lack of significant mediation by perceived risks in these relationships.

In terms of perceived benefits, H6a (ET→PB→PA) and H6b (TPO→PB→PA) are both supported, with coefficients of -0.128 and 0.227 respectively, and low p-values, highlighting the significant mediating role of perceived benefits. On the other hand, H6c (TIO→PB→PA) is not supported due to its higher p-value and moderate coefficient, suggesting that perceived benefits do not significantly mediate this relationship. However, H6d (SE→PB→PA) is confirmed, with a positive coefficient of 0.135 and a low p-value, indicating a notable mediating effect of perceived benefits.

DISCUSSION

Due to the evolving nature of public perception and regulatory challenges in the nanotechnology sector, particularly in the context of Nanotechnology in Edible Food Materials (NEFM), it is crucial to establish robust frameworks for consumer trust and policy guidance (Zhang et al., 2019; Liu et al., 2019). Numerous studies have concentrated on the dynamics of public acceptance and regulatory compliance in the field of food technology (Monticone et al., 2023; Parsons et al., 2021; Sastry et al., 2011), yet their applicability to NEFM, especially in the Chinese context, remains under-explored. In this vein, our study's in-depth examination of the determinants influencing public acceptance of NEFM in China marks a significant contribution to the field. While aligning with and enriching the existing body of research on nanotechnology's public perception (Hu et al., 2020; Jani, 2011), our study underscores the unique facets of NEFM's public acceptance, thus providing vital insights for policymakers and industry stakeholders. The establishment of transparent, evidence-based communication strategies, coupled with informed policy frameworks, emerges as an essential pathway towards bolstering NEFM's integration into the food industry, akin to the strategies employed in enhancing trust and acceptance in related fields (Del-Real and Díaz-Fernández, 2021; Ghoochani et al., 2016).

The relationship between ET and PA revealed a surprising negative correlation. This contradicts the expected positive influence of ET on PA, as seen in studies like Hu et al. (2020). This outcome suggests a nuanced public perception where increased scientific knowledge doesn't automatically translate into acceptance. This finding challenges the traditional view of ET and signifies the complexity of public attitudes towards scientific advancements in the food industry. Contrary to the significant positive impact of TPO on PA, our study found that TIO does not significantly influence PA. This divergence highlights the public's discerning attitude towards different organizational narratives. While trust in regulatory bodies plays a crucial role in acceptance, as Gao et al. (2022) suggested, trust in industrial organizations doesn't have a similar effect. This distinction is critical for policymakers and industry stakeholders, emphasizing the need for credible and transparent communication from public organizations to foster NEFM acceptance. Consistent with the literature, such as Jani (2011) and Wang (2021), SE demonstrated a significant positive influence on PB underlining the importance of individual confidence in decision-making. This relationship suggests that individuals with higher SE perceive greater benefits of NEFM, stressing the need for educational and informational campaigns to boost public understanding and acceptance of NEFM.

This study offers a refined perspective on the impact of PR on PA of NEFM. Consistent with the broader literature, such as the insights from Hu et al. (2020), a clear inverse relationship is observed: as perceived risks increase, public acceptance tends to decrease. This pattern underscores the critical need for addressing and mitigating potential negative consequences and uncertainties associated with NEFM. Aligning with the skepticism and caution towards new technologies noted by Kamarulzaman et al. (2020), this study reinforces the argument for implementing rigorous safety standards, transparent testing procedures, and clear regulatory guidelines. Such measures are not just best practices but essential in enhancing public acceptance and trust in NEFM technologies.

In contrast, the relationship between PB and PA of NEFM demonstrates a positive correlation, echoing the findings of Del-Real and Díaz-Fernández (2021) and Wang (2021). This study found that as the public recognizes more benefits such as improved food quality, enhanced nutritional value, and extended shelf life, their acceptance of NEFM increases. This observation is pivotal, as it suggests that effectively communicating the tangible benefits of NEFM in public outreach and consumer education programs could substantially boost public interest and acceptance. It also implies that continued research and development efforts to enhance and

highlight these benefits will likely be a key driver in securing broader public approval and integration of NEFM into the food industry. These findings align with the initial discourse presented in the work of Chaudhary (2023) and Sahani and Sharma (2021), which emphasized the transformative potential of NEFM in the food industry, thus adding a crucial dimension to the existing literature on NEFM public acceptance.

In examining the mediating effects, we uncovered several intriguing parallels and distinctions. Regarding the mediating effects of perceived risks (PR), our findings align with Hu et al. (2020) in confirming the significant negative correlation between perceived risks and public acceptance. This inverse relationship, also observed by Zhang et al. (2019), underscores the importance of risk perception in determining the acceptance of NEFM. However, our study extends beyond this general understanding by delving into the specific nature of perceived risks associated with NEFM, which differ from other technologies due to unique concerns about food safety and health impacts. This distinction justifies our findings and highlights the necessity for strategies tailored to address NEFM-related apprehensions. Regarding the mediating effects of perceived benefits (PB), our study corroborates with Del-Real and Díaz-Fernández (2021) and Wang (2021) in finding a positive correlation between perceived benefits and public acceptance of NEFM. This suggests that perceived benefits are pivotal in encouraging acceptance, a trend in other technology contexts. However, our research points to a potentially greater influence of these benefits in the NEFM domain. The focus on NEFM's potential to enhance food quality and safety, as proposed by Sahani and Sharma (2021), may be a more influential driver of acceptance than other technologies. This emphasis on food-specific benefits provides a nuanced perspective on the factors driving NEFM acceptance, suggesting that the benefits related to food technology may be more persuasive in influencing public attitudes.

Theoretical Implications

Integrating insights from the SCT and the TPB, this study significantly advances the theoretical framework for adopting NEFM (Bandura, 1986; Ajzen, 1991; Rana and Dwivedi, 2015). The study illuminates how ET, TPO, TIO, and SE interact with PA within this theoretical context of NEFM.

Firstly, our analysis highlighted the critical role of epistemic trust in shaping public perception of NEFM's potential benefits and risks, as evidenced by the inverse relationship with perceived benefits (H6a) and a direct relationship with perceived risks (H5a). This finding contributes to a deeper understanding of how trust in expertise alters the internal cognitive analysis individuals conduct when encountering new technologies, offering a nuanced perspective compared to previous research by Sharon et al. (2020) and Hu et al. (2020), where the focus was more broadly on trust's influence on technology acceptance. Secondly, the study affirmed the significant role of perceived benefits and risks in NEFM acceptance (H5 and H6), echoing the effectiveness of these factors in predicting behavioral intentions in the context of other technology adoptions, as noted in studies like those by Del-Real and Díaz-Fernández (2021) and Hu et al. (2020). Interestingly, the positive correlation between self-efficacy and perceived risks and benefits (H5d, H6d) contributes a unique angle to the existing discourse. This result contrasts with findings from Gupta et al. (2016), where perceived self-efficacy did not directly predict behavioral intentions, enriching the dialogue surrounding self-efficacy's role in technology acceptance.

Thirdly, our findings delineate the distinct impacts trust in different types of organizations has on public perception. TPO significantly influenced PA of NEFM, mediated by PR & PB (H5b and H6b). In contrast, trust in industrial organizations did not show a notable correlation (H5c and H6c). This contrast with the findings of Liu et al. (2019), who emphasized demographic factors in societal trust, underscores the complexity of trust dynamics in technology acceptance and necessitates more tailored public communication strategies. Fourthly, the absence of a significant relationship between trust in industrial organizations and both perceived benefits and risks concerning public acceptance of NEFM (H3, H5c, and H6c) marks a deviation from expected outcomes based on literature like that of Wang et al. (2021). This suggests an opportunity for future research to delve into these relationships further, potentially exploring additional factors that could clarify these complex dynamics.

Policy Implications

Building on the insights from Sastry et al. (2011) regarding nanotechnology, which emphasized the necessity for ex ante assessment of its societal implications, conducting a similar forward-looking evaluation for the policy formulation surrounding the emerging NEFM technology today becomes imperative. The interplay

between social and epistemic trust, individual self-efficacy, perceived benefits, anticipated risks, and public endorsement of nanotechnology in food materials necessitates a focused policy response. Policymakers and industry stakeholders must prioritize addressing the role of epistemic trust within public discourses about nanotechnology in consumable substances. As policy implications, initiatives aimed at enhancing credibility and trustworthiness of experts and authoritative conduits of information should be developed. By doing so, public understanding and acceptance of nanotech food applications could be fortified, bolstering government regulatory stances and augment the perceived legitimacy of relevant public entities.

Simultaneously, policy initiatives to foster individual self-efficacy could empower citizens to make informed independent decisions concerning nano-food technology. This equates to policy investments in public education about nanotechnology. However, as the theory-led associations between trust in industrial organizations and the perceived benefits and potential risks failed to achieve validation, policymakers should refrain from over-reliance on trust instilled by these institutions in swaying public perspectives. The policy discourse instead should concentrate on cultivating higher levels of public epistemic trust and faith in public organizations, whilst improving comprehensive understanding regarding technology's inherent risks and benefits about nano-food materials. Consequently, paving the way for an informed, data-driven policy dialogue that ensures balanced, transparent, and ethical integration and regulation of nanotechnology in food materials.

Despite this, the study's methodology bears several limitations with corresponding policy implications. Using self-reported measure risks introducing social desirability bias, potentially leading respondents to overstate their trust in authority figures and public institutions. From a policy perspective, future surveys employing indirect questioning or anonymization may mitigate this bias, thus offering a more accurate gauge of public sentiment, crucial for effective policymaking. Secondly, the study's cross-sectional nature impedes the establishment of causality among the variables. Policymakers, therefore, should be aware that the identified associations may not suggest a cause-effect relationship. Future policy-oriented research should consider longitudinal studies to elucidate the causal dynamics between epistemic trust, social trust, and public acceptance of nanotechnology in food, aiding more informed policy formulation.

Furthermore, the investigation's focus on the Chinese socio-cultural context could limit the applicability of the findings. Policy interventions founded on these results may not translate to similar effects in differing socio-cultural contexts. Cross-cultural comparative studies are recommended to form more globally applicable policies, illuminating how societal and cultural factors mediate the perceived risks, benefits, and acceptance of nanotechnology in food. Lastly, the lower response rate may have produced selection bias in the sample. Policymakers should maintain cognizance of this while interpreting the findings and using them to guide policy agendas. Future surveys should strive for more representative samples to provide policy-relevant findings generalizable to broader populations. This would form more encompassing and effective policies about public acceptance of nanotechnology in food substances.

The snowball sampling strategy was leveraged to expedite participant recruitment across various regions in China, advancing our study on the nation's sentiment towards nanotechnology in food. While this method efficiently taps into diverse participant networks, it may introduce selection bias, subtly affecting the sample’s representation of the wider population. Although our collection encompassed respondents from various Chinese localities and demographics, caution remains to be exercised in generalizing these results. To enhance the representativeness of future research, alternative strategies such as probabilistic or respondent-driven sampling could be contemplated, which are poised to approximate the broad demographic tapestry of the population more closely.

CONCLUSION

This study investigation reveals significant insights into the intricate roles of epistemic trust, social trust, self-efficacy, and the public perception of benefits and risks in determining the acceptance of Nanotechnology in Edible Food Materials (NEFM). This study has established that epistemic trust, social trust, and self-efficacy each play distinct and influential roles in shaping NEFM public acceptance, albeit through different pathways and directions.

The analysis found that epistemic trust inversely affects public acceptance, primarily mediated by the perceived benefits and risks. This outcome prompts a critical recommendation for policymakers: to prioritize transparency and foster open communication regarding the benefits and risks associated with NEFM, as these elements are pivotal in shaping epistemic trust. In social trust, we discerned that trust in public organizations significantly influences NEFM acceptance through the perceived benefits and risks. In contrast, trust in industrial organizations does not exhibit a similar impact. This finding underscores the necessity for policy strategies that encourage meaningful engagement with public organizations, reflecting their significant influence on public opinion towards NEFM. Furthermore, self-efficacy was shown to positively impact NEFM public acceptance via perceived benefits, indicating that initiatives to enhance personal efficacy in understanding and using NEFM are crucial.

This study aligns with the existing body of knowledge and extends it by providing a comprehensive understanding of the factors that foster public acceptance of NEFM. These insights are instrumental for policymakers and stakeholders in developing strategies to enhance public perception and acceptance of such technologies, thereby promoting the growth and advancement of NEFM.

For policy formulation, especially in China, paying attention to the positive antecedents identified in this study is crucial. In contexts where NEFM technologies are being introduced, leveraging public institutions and platforms for community engagement emerges as a beneficial approach. Such engagement should be integral to the policy process, potentially easing policy implementation and enhancing the acceptance of NEFM-related foods. In contrast, an over-reliance on industrial entities for policy enactment may not garner optimal public support for this emergent food technology.

Future research should delve into the diverse cultural and contextual factors that influence these relationships, possibly exploring comparative responses across various demographics and societies. Such investigations will contribute to developing more robust policy frameworks and market strategies, specifically tailored to facilitate the acceptance and integration of NEFM in China and globally. This study, thus, lays the groundwork for future explorations in this domain, highlighting areas ripe for further research and policy development.

ACKNOWLEDGEMENT

This study acknowledges the invaluable assistance provided by the students and faculty members from The Hong Kong Polytechnic University and Universiti Kebangsaan Malaysia during the research process.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc.

Bastus, N. G., & Puntes, V. (2018). Nanosafety: Towards safer nanoparticles by design. *Current Medicinal Chemistry*, *25*(35), 4587-4601.

Bearth A., & Siegrist M. (2016). Are risk or benefit perceptions more important for public acceptance of innovative food technologies: A meta-analysis. *Trends in Food Science & Technology*, *49*, 14-23.

Bieberstein, A., Roosen, J., Marette, S., Blanchemanche, S., & Vandermoere, F. (2012). Consumer choices for nano-food and nano-packaging in France and Germany. *European Review of Agricultural Economics*, *39*(1), 131-151.

Campbell, C., Tanzer, M., Saunders, R., Booker, T., Allison, E., Li, E., O'Dowda, C., Luyten, P., & Fonagy, P. (2021). Development and validation of a self-report measure of epistemic trust. *PLOS ONE*, *16*(4), e0250264

Chaudhary, S. (2023). Chitosan nanoemulsion: A sustainable approach for quality preservation of fish and fishery foods. *Food Control*, *151*, 109790

Chen M. F. (2008). An integrated research framework to understand consumer attitudes and purchase intentions toward genetically modified foods. *British Food Journal*, *110*(6), 559-579.

Connor M., & Siegrist M. (2010). Factors influencing people's acceptance of gene technology: The role of knowledge, health expectations, naturalness, and social trust. *Science Communication*, *32*(4), 514-538.

Del-Real C., & Díaz-Fernández A. M. (2021). Lifeguards in the sky: Examining the public acceptance of beach-rescue drones. *Technology in Society*, *64*, 101502.

Gao, L., Jiang, J. J., He, H. N., Zhou, Q., Wang, S. Y., & Li, J. (2022). Uncertainty or trust? Political trust, perceived uncertainty and public acceptance of personal carbon trading policy. *Environmental Geochemistry and Health*, *44*(9), 3157-3171.

Ghoochani, O., Ghanian, M., Baradaran, M., Alimirzaei, E., & Azadi, H. (2016). Behavioral intentions toward genetically modified crops in Southwest Iran: A multi-stakeholder analysis. *Environment, Development and Sustainability*, *20*, 233-253.

Gupta A., Eral H. B., Hatton T. A., & Doyle P. S. (2016). Nanoemulsions: Formation, properties, and applications. *Soft Matter*, *12*(11), 633-652.

Hair J. F., Risher J. J., Sarstedt M., & Ringle C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2-24.

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling*. Thousand Oaks, CA: Sage.

He X., & Hwang H-M. (2016). Nanotechnology in food science: Functionality, applicability, and safety assessment. *Journal of Food and Drug Analysis*, *24*(4), 671-681.

Hu L., Liu R., Zhang W., & Zhang T. (2020). The effects of epistemic trust and social trust on public acceptance of genetically modified food: An empirical study from China. *International Journal of Environmental Research and Public Health*, *17*(20), 7700.

Hu X., Zhu W., & Wei J. (2021). Effects of information strategies on public acceptance of nuclear energy. *Energy*, *231*, 120907.

Huang H. T., Kuo Y. M., Wang S. R., Wang C. F., & Tsai C. H. (2016). Structural Factors Affecting Health Examination Behavioral Intention. *International Journal of Environmental Research and Public Health*, *13*(4), 397.

Jani A. (2011). Escalation of commitment in troubled IT projects: Influence of project risk factors and self-efficacy on the perception of risk and the commitment to a failing project. *International Journal of Project Management*, *29*(7), 934-945.

Kamarulzaman, N. A., Lee K. E., Mokhtar M., & Zainal Abidin, S. (2020). Public benefit and risk perceptions of nanotechnology development: Psychological and sociological aspects. *Technology in Society*, *62*, 101329

Kline R. B. (2015). P*rinciples and practice of structural equation modelling. 4th ed., Methodology in the Social Sciences*. Guilford Press, New York, NY.

Kuang, L. N., Burgess, B., Cuite, C. L., Tepper, B. J., & Hallman, W. K. (2020). Sensory acceptability and willingness to buy foods presented as having benefits achieved through the use of nanotechnology. *Food Quality and Preference*, *83*, 103922

Kuttschreuter, M., & Hilverda, F. (2019). "Listen, did you hear...?" A structural equation model explaining online information sharing on the risks of nanotechnology in food. *Food Quality and Preference*, *76*, 118-132.

Liu, P., Yang, R., & Xu, Z. G. (2019). Public Acceptance of Fully Automated Driving: Effects of Social Trust and Risk/Benefit Perceptions. *Risk Analysis*, *39*(2), 326-341.

López-Navarro, M. A., Llorens-Monzonís, J., & Tortosa-Edo, V. (2013). The Effect of Social Trust on Citizens' Health Risk Perception in the Context of a Petrochemical Industrial Complex. *International Journal of Environmental Research and Public Health*, *10*(1), 399–416.

Magnabosco, P., Masi, A., Shukla, R., Bansal, V., & Carletti, P. (2023). Advancing the impact of plant biostimulants to sustainable agriculture through nanotechnologies. *Chemical and Biological Technologies in Agriculture*, *10*(1), 117.

Mah, D. N. Y., Cheung, D. M. W., Leung, M. K. H., Wang, M. Y., Wong, M. W. M., Lo, K. V., & Cheung, A. T. F. (2021). Policy mixes and the policy learning process of energy transitions: Insights from the feed-in tariff policy and urban community solar in Hong Kong. *Energy Policy*, *157*, 112214.

Monticone, F., Barling, D., Parsons, K., & Samoggia, A. (2023). Identifying food policy coherence in Italian regional policies: The case of Emilia-Romagna. *Food Policy*, *119*, 20-30.

Parsons, K., Lang, T., & Barling, D. (2021). London's food policy: Leveraging the policy sub-system, programme and plan. *Food Policy*, *103*, 1-10.

Rana N. P., & Dwivedi Y. K. (2015). Citizens' adoption of an e-government system: Validating extended social cognitive theory (SCT). *Government Information Quarterly*, *32*(2), 172-181.

Sahani S., & Sharma Y. C. (2021). Advancements in applications of nanotechnology in global food industry. *Journal of Food Measurement and Characterization*, *342*, 128318

Sastry, R. K., Rashmi, H. B., & Rao, N. H. (2011). Nanotechnology for enhancing food security in India. *Food Policy*, 36(3), 391-400.

Sharon A. J., Yom-Tov E., & Baram-Tsabari A. (2020). Vaccine information seeking on social Q&A services. *Vaccine*, *38*(12), 2691-2699.

Sjöberg, L. (2008). Genetically modified food in the eyes of the public and experts. *Risk Management-an International Journal*, *10*(3), 168-193.

Talebian, S., Rodrigues, T., das Neves, J., Sarmento, B., Langer, R., & Conde, J. (2021). Facts and Figures on Materials Science and Nanotechnology Progress and Investment. *PAS Nano*, *15*(10), 15940-15952.

Tian, G., Wang, Y. M., Gong, Y., Tian, Y., Piao, X. X., & Zhang, T. Y. (2024). The contagion mechanism and governance strategy of corporate social irresponsibility of Chinese food companies. *Food Policy*, *122*, 45-55.

Wang Y., Shen C., Zuo J., & Rameezdeen R. (2021). Same tune, different songs? Understanding public acceptance of mega construction projects: A comparative case study. *Habitat International*, *118*, 102461.

Wang, S. Y., Wang, J., Lin, S. F., & Li, J. (2019). Public perceptions and acceptance of nuclear energy in China: The role of public knowledge, perceived benefit, perceived risk and public engagement. *Energy Policy*, *126*, 352-360.

Zezza, A., Martuscelli, A., Wollburg, P., Gourlay, S., & Kilic, T. (2021). Viewpoint: High-frequency phone surveys on COVID-19: Good practices, open questions. *Food Policy*, *105*, 102153 https://doi.org/10.1016/j.foodpol.2021.102153

Zhang, W., Xue, J., Folmer, H., & Hussain, K. (2019). Perceived risk of genetically modified foods among residents in Xi'an, China: a structural equation modeling approach. *International Journal of Environmental Research and Public Health*, *16*(4), 574.

Zhu, G., Chen, Y. C., & Zheng, J. L. (2020). Modelling the acceptance of fully autonomous vehicles: A media-based perception and adoption model. *Transportation Research Part F: Traffic Psychology and Behaviour*, *73*, 80-91.

Zhu, G., So, K. K. F., & Hudson, S. (2017). Inside the sharing economy: Understanding consumer motivations behind the adoption of mobile applications. *International Journal of Contemporary Hospitality Management*, *29*(9), 2218–2239.