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Herders' Knowledge, Attitudes, Norms, and Behavioral Intentions Toward Perceived Meat Quality in Mongolia

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ABSTRACT: The quality and safety of meat produced from pasture-based livestock systems are largely influenced by animal welfare and the herder's methods of managing and caring for animals. In Mongolia, herders' attitudes and behaviors significantly affect how livestock are raised-ensuring comfort, health, and productivity which directly impacts the quality of all livestock-derived products. This study investigates how personal attributes of herders including attitudes, perceived behavioral control, subjective norms, and moral norms influence their intention to produce high-quality meat. The behavioral intention is modelled as a mediating variable, while perceived meat quality is treated as the dependent variable. To analyze these relationships, we developed a structural equation model using the Partial Least Squares (PLS) method in SmartPLS. A structured questionnaire was administered to 429 multi-generational herders from Khuvsgul, Tuv, and Dundgobi provinces of Mongolia. The data were collected through direct surveys. The results confirm that the hypothesized factors significantly affect herders' behavioral intentions, which in turn have a positive influence on perceived meat quality. Changes in attitudes and moral norms were found to enhance food safety, reduce foodborne illnesses, and support economic gains. Based on the findings, the study recommends the development of behavioral training programs for herders to improve livestock management practices and ultimately ensure safer and higher-quality meat production.

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1. INTRODUCTION

The quality and safety of food products have become critical socio-economic factors for achieving sustainable development in globally. In Mongolia, the meat industry is capable of satisfying domestic demand and holds potential for expanding into international markets. However, due to persistent concerns regarding perceived meat quality and food safety, the country faces limitations in exporting meat and offering certified, high-quality products in local markets. In response, the government has implemented various policies and national programs, including the Food Law, the National Food Supply and Safety Program, and the "Healthy Food–Healthy Mongolian" initiative. Despite these efforts, issues related to herders' perceived meat quality remain unresolved. The rising prevalence of foodborne and non-communicable diseases has prompted consumers to pay greater attention to the health and safety of meat and meat products.

Animal health and environmental factors have become increasingly important in shaping consumer perceptions, with concerns about chemical residues and veterinary drugs taking precedence [1]. Research has shown that consumer preference for quality meat significantly influences their purchase decisions [2], and perceptions of meat are shaped by a complex interplay of psychological, social, and cultural factors [3]. Key factors affecting consumer decisions include: 1) knowledge about perceived meat quality, 2) animal health and nutrition, 3) health-related risks such as fat and salt content or biological hazards, 4) ethical issues in animal husbandry and slaughter, 5) religious, social, and psychological beliefs, and 6) concerns about food fraud and publicized scandals [4][5][6].

In light of this situation, the management and care practices of herders—including attention to animal health, responsible use of veterinary drugs, and compliance with quality and safety standards—are directly linked to perceived meat quality. While prior efforts have focused on aspects such as meat transport, storage, and hygiene compliance by traders and processors, not many research studies have explored how herders themselves contribute to or are aware of the quality and safety of the meat they produce. Although numerous global studies have investigated farmers' behavior regarding food safety, there remains a gap in understanding the attitudes and behaviors of traditional pastoralist herders in Mongolia.

This study addresses the following key research questions: (1) Does perceived meat quality depend on herders' behavioral intention? (2) Which behavioral attributes of herders most strongly impact their intention to produce high-quality meat? By investigating the behavioral factors affecting herders' meat production practices, this study aims to identify how their attitudes, knowledge, and ethical awareness impact perceived meat quality. The goal is to highlight that the ultimate responsibility of herders is not only to meet household consumption needs but also to contribute to public health by providing clean, safe, and nutritious meat. Therefore, we hypothesize that herders' positive behaviors significantly influence the production of safe and high-quality meat.

2. LITERATURE REVIEW AND HYPOTHESIS

Livestock production is a critical sector that directly influences both environmental sustainability and public health. For herders, sustainable livestock management that minimizes harm to the environment and contributes positively to human well-being is becoming increasingly essential. Numerous scholars have documented the environmental impacts of livestock production, the effects of human practices on animal health [7,8], and how the quality of animal products ultimately affects human health outcomes [9]. These findings underscore the importance of responsible livestock management practices from farm to table. Public health conditions, including disease prevalence, are influenced by multiple factors, one of which is livestock health. According to Ajzen and Fishbein's (1980) Theory of Reasoned Action, an individual's positive attitude fosters a stronger desire to behave appropriately and comply with norms. An extension of this theory, the Theory of Planned Behavior (TPB), has been widely used to examine psychological factors influencing behavioral intentions [10]. The TPB posits that individual decisions are not solely based on intention but are also shaped by knowledge, resources, and situational opportunities. Therefore, livestock health is influenced not only by environmental factors but also by herders' knowledge, attitudes, skills, and ethical standards. In recent years, consumers have shown growing interest in meat from animals raised in humane and welfare-friendly conditions, referred to as "welfare-friendly products" [11]. Numerous studies emphasize the positive relationship between animal welfare and the quality of animal products [12-23]. These findings highlight that herders' approach to animal care significantly affects the safety and nutritional value of meat.

2.1. Herder's Animal Care Knowledge

The quality of livestock products is directly linked to herders' attitudes and behaviors. Much of the herders' knowledge and skills are inherited from traditional, intergenerational practices. Herding requires a comprehensive understanding of animal behavior, grazing ecology, veterinary care, and sustainable land use. Specifically, herders must possess knowledge of feeding regimes, plant species, disease prevention, reproduction, proper medication use, and adaptation to ecological and climatic conditions. We can categorize herders' competencies as follows: 1) Livestock management skills – Includes daily herding, shelter construction adapted to seasonal needs, and housing arrangements that protect livestock throughout the year. 2) Feeding knowledge – involves understanding nutrient requirements, types of fodder and forage, and feeding technologies appropriate for different species. 3) Stress management-reducing animal stress is essential, as stress negatively affects perceived meat quality. Skilled herders know how to handle animals calmly, minimize transportation-related stress, and ensure humane treatment. 4) Breed selection–choosing appropriate breeds that are ecologically adapted to local conditions can improve perceived meat quality and yield distinctive characteristics. 5) Slaughter and meat handling – proper slaughtering and hygienic meat processing techniques are essential to maintain meat freshness and safety. 6) Health monitoring and veterinary drug use –regular health checks allow early detection of illness. In contrast, proper use of antibiotics ensures residue-free meat. According to Mesfin et al. (2024), the improper use of veterinary drugs can result in harmful residues in meat, posing significant health risks to consumers [24]. 7) Ethical animal care – compassionate and ethical treatment of animals reflects not only cultural values but also enhances product quality.

2.2. Behavioral Intention

Behavioral intention is a key construct in predicting actual behavior. It reflects an individual's conscious decision or planned effort to perform a particular action [25]. In the TPB, behavioral intention serves as a central determinant of actual behavior, indicating one's readiness to perform the behavior [26]. Motivation to engage in a behavior is a strong predictor of whether that behavior will be carried out effectively [27]. In the context of pastoral livestock herding, the critical question is: To what extent do Mongolian herders demonstrate a behavioral intention to produce safe and high-quality meat? Numerous studies have confirmed that behavioral intention is strongly associated with personal attitudes and subjective norms [28]. Thus, the more committed a person is to performing a specific behavior, the more likely it is that they will engage in it effectively.

2.3. Herder's Attitude

The scholars suggested that the TPB framework could be used to measure farmers' attitudes toward interactions with livestock [29][30][31]. Research in the field of animal husbandry has emphasized that human-animal relationships significantly impact animal welfare and overall productivity. Attitude is defined as the degree to which an individual values a particular behavior [32]. Farani et al. (2019) describe attitude as a person's positive or negative evaluation of engaging in a specific behavior [33]. In the case of Mongolian herders, it becomes relevant to ask: To what extent does a herder's attitude toward animal care influence their behavior, and consequently, perceived meat quality? Positive attitudes among herders' manifest in practices such as: ensuring animals gain sufficient weight through rotational grazing; providing timely veterinary services; offering warm, clean shelters; and allowing livestock to graze freely according to seasonal and environmental conditions. These practices contribute to better animal health and ultimately to higher-quality meat. However, there is growing concern that traditional livestock management practices are being eroded, leading to increased stress among animals and a subsequent decline in perceived meat quality and safety. Thus, herders' attitudes play a crucial role in determining the overall quality of livestock products.

2.4. Perceived Behavioral Control (PBC)

Perceived behavioral control refers to an individual's perception of the ease or difficulty of performing a given behavior. It reflects a person's belief about their ability to execute the behavior and their level of control over it [34]. This construct is closely related to Bandura's (1997) concept of self-efficacy, which emphasizes a person's confidence in their capability to manage and carry out actions effectively [35]. When individuals believe that their actions are within their control, they are more likely to attempt the behavior, exert effort, and remain persistent in the face of obstacles [26,36]. In the context of livestock herding, perceived behavioral control includes a herder's confidence in their ability to ensure that their actions do not cause harm to others, and their awareness of external factors such as climate and market conditions. Furthermore, herders' perceptions of the safety and quality of the meat they produce are closely tied to their own practices and decisions. Their understanding of the implications of perceived meat quality in market systems also reflects the degree of control they perceive over the outcomes of their production.

2.5. Subjective Norm

Subjective norms are understood as an individual's perception of social pressure to perform or not perform a particular behavior. In behavioral economics and psychology, this concept has been widely applied to model and understand behavior [37]. According to Shin and Hancer (2016), when individuals perceive that others expect them to engage in a certain behavior, they are more likely to form an intention to do so. In group-oriented societies, consistent adherence to social norms often leads individuals to behave in ways that align with group expectations [38]. Studies utilizing the TPB framework have consistently identified subjective norms as a key predictor of behavioral intention [39], especially in food safety behavior [40-42]. Nomadic herders often perceive an obligation to preserve and sustainably continue the livestock practices inherited from their ancestors and family lineage, reflecting a form of subjective norm rooted in intergenerational responsibility. In this regard, evolving societal expectations and consumers' growing demand for high-quality meat products are giving rise to an emerging, market-oriented dimension of subjective norm among Mongolian herders.

2.6. Moral Norm

Moral norms reflect an individual's internalized values and personal sense of responsibility to act in a certain way, often to avoid feelings of guilt or moral conflict [43]. These norms relate to one's beliefs about what is right or wrong and serve as a powerful motivator for behavior [44]. Some scholars argue that subjective norms alone are insufficient predictors of behavioral intention [25][45]. Ajzen (1991) also emphasized the need to consider personal moral responsibility in addition to perceived social pressure [32]. Several studies have demonstrated that moral norms independently predict behavioral intention [46][47][48]. In the context of livestock production, moral obligation plays a pivotal role in ensuring meat safety and quality. Herders must act not only out of compliance with regulations but also from a sense of moral duty to provide clean and safe products to consumers. Recent findings suggest that moral norms act as additional predictors of herders' intentions, complementing the effects of attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC) [49][50]. In this study, the moral norm (MN) is introduced as an extension to the traditional TPB model, enhancing its predictive power regarding behavioral intention (BI).

2.7. Perceived meat quality

The quality of meat varies depending on livestock breed, type of feed, environmental conditions, and geographical location [51][52][53]. In addition, previous studies have demonstrated that perceived meat quality is influenced by animal nutrition, herding and management practices, as well as veterinary services. Moreover, researchers have emphasized that herders' behavioral practices play an important role in producing high-quality meat [54][55]. In Mongolia, where pastoral livestock production is predominantly based on mobile grazing systems, the quality of animal products is largely dependent on the herders' management behaviors and traditional practices. From this model, the following hypotheses are proposed:

H1: Knowledge of animal care has a positive effect on behavioral intention.

H2: Attitude has a positive effect on behavioral intention.

H3: Perceived behavioral control has a positive effect on behavioral intention.

H4: Subjective norms have a positive effect on behavioral intention.

H5: Moral norms have a positive effect on behavioral intention.

H6: Behavioral intention has a positive effect on perceived meat quality.

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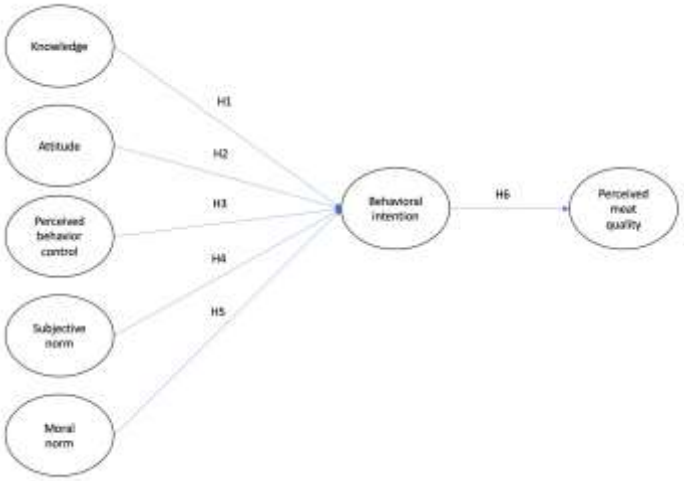


Figure 1. Proposed Model: Behavioural Influences on perceived meat Quality.

3. Materials and Methods

3.1.Bibliometric Mapping of Farmers' Behavioral Research

To obtain a comprehensive understanding of the research landscape on farmers' behavioral studies, a bibliometric co-occurrence analysis was conducted using VOSviewer. A total of 2,445 articles published between 2022 and 2025 were retrieved from the Web of Science Core Collection using the search query "Farmers' behavior" and "agriculture." Full records were exported in plain-text format and analyzed using a co-occurrence method based on author keywords and Keywords Plus. A minimum occurrence threshold of 20 was applied, and 240 relevant terms were selected according to VOS viewer's relevance scoring algorithm (Figure1). The resulting mapping (Figure 1) reveals three major thematic clusters. Cluster 1 (red) represents farm-level production behavior, characterized by high-frequency terms such as farm, crop, yield, performance, animal health, welfare, and loss. This cluster reflects studies focusing on agricultural production practices, livestock management, productivity, and food safety concerns related to farming operations. Cluster 2 (blue) constitutes a behavioral theory and psychological constructs cluster, centered around attitude, intention, planned behavior, subjective norm, behavioral control, and methodological terms such as questionnaire and structural equation model. This cluster represents the theoretical foundation of behavioral intention research and closely aligns with the conceptual framework of the present study, which draws upon the TPB. Cluster 3 (green) reflects technology adoption, policy mechanisms, and farmers' willingness, comprising keywords such as farmers adoption, willingness, government, evidence, mechanism, household, and several China-related terms. This indicates that a substantial proportion of empirical behavioral studies have focused on agricultural policy implementation and technology diffusion, particularly in rural China. Overall, the bibliometric analysis demonstrates that existing research is structured around (1) production behavior, (2) behavioral intention modelling, and (3) policy-driven adoption behavior. The present study is positioned within the behavioral theory cluster, bridging insights from farm-level practices and policy-oriented adoption research. In our study, based on the extended TPB model incorporating moral norms, we propose a conceptual framework that outlines the behavioral antecedents influencing herders' intention to produce safe and high-quality meat. The model includes herder's knowledge, attitude, perceived behavioral control, subjective norm, and moral norm as independent variables, behavioral intention as a mediating variable, and perceived meat quality as the outcome variable.

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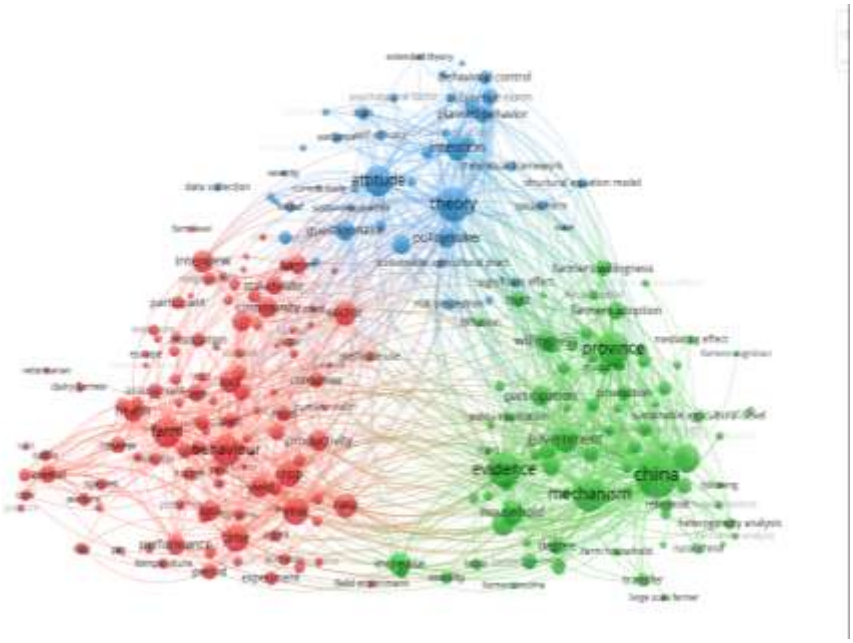


Figure 2. Bibliometric Analysis of Farmers' Behavioural Studies in WoS (2022–2025)

This study employed a quantitative approach, using a structured questionnaire survey to examine how individual psychological constructs influence herders' behaviour and the quality of meat produced. The TPB model was used to identify relevant psychological constructs: attitude (ATT), subjective norm (SN), perceived behavioural control (PBC), and moral norm (MN). These were treated as independent variables, while behavioural intention acted as a mediating variable and perceived meat quality as the dependent variable. All constructs were measured using five-point Likert scales: (1) Strongly disagree, (2) Disagree, (3) Neutral, (4) Agree, and (5) Strongly agree. The measurement items were adapted from prior validated instruments, including: Farmer behaviour questionnaires by Faisal et al (2020), moral and behavioural measures by Rezaei et al. (2019) and Borges et al. (2019), Mongolian national standards: Responsible Nomadic Practice – MNS 6891:2020 and Meat Hygiene Practice – MNS CAC RCP 58:2013, Academic works: Clean Meat and Milk Practices, Traditional Mongolian Herding, and Pasture-Based Mongolian Meat [56-60]. These references were used to develop culturally and contextually appropriate indicators aligned with Mongolia's traditional pastoral system.

3.2. Sampling and Data Collection

The data were collected from herders in Khuvsgul, Tuv, and Dundgovi provinces of Mongolia. These provinces represent the Khangai, Tuv, and Gobi regions, respectively. Khuvsgul province is characterized by a forest-steppe, high-altitude, cool climate with a variety of nutritious pasture plants. As a result, the meat produced in this region is fine-grained, juicy, flavorful, and has a favorable fat-to-protein ratio. The Central region is represented by Tuv province, which is located in a forest-steppe and steppe zone and has a moderate climate with relatively balanced pastures. Consequently, the meat from this region is uniform in quality, has a balanced protein-to-fat ratio, and is suitable for the general consumer market. The Gobi region is represented by Dundgovi province, which is dominated by a dry desert-steppe ecosystem with sparse pastures. Therefore, the meat produced in this region is low in fat, high in protein, and relatively firm; however, it has good keeping quality and is well adapted to the Gobi conditions. According to the 2024 livestock statistics, Khuvsgul province has approximately 20.1 thousand herder households managing 5.2 million head of livestock. Tuv and Dundgovi provinces follow, with an estimated 13.9 thousand and 7.6 thousand herder households herding 4.25 and 3.39 million heads of livestock, respectively [61]. Among the surveyed herders, 64.8% were male and 35.2% were female. A majority (71.8%) were over the age of 30, suggesting that most participants possessed substantial experience in pastoral livestock herding. Furthermore, 58.7% of respondents reported managing multiple types of livestock—typically sheep, goats, cattle, and horses—reflecting the multi-species nature of traditional Mongolian herding practices. Notably, 73.2% stated that they rarely or never used motorized vehicles for herding due to the rugged, forested, and mountainous landscape of their regions, relying instead on horses for mobility (Table 1). It remains one of the few regions where traditional pastoralism is still widely practiced. Finally, based on the data visualization in SmartPLS version 4.0.9.1, the skewness and excess kurtosis values for all indicators fall within the acceptable range of -2 to +2 [62].

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Table 1. Respondents' characteristics.

Questions		All samples	
		Frequency	Percent
Age	Under 20	44	10.3
	21-29	77	17.9
	30-39	140	32.6
	40-49	107	24.9
	50-59	41	9.6
	60 over	20	4.7
Total		**429**	**100.0**
Gender	Man	278	64.8
	Female	151	35.2
Total		**429**	**100.0**
Provinces	Dundgovi	102	23.8
	Tuv	126	29.4
	Khuvsgul	201	46.9
Total		**429**	**100.0**

4. DATA ANALYSIS AND RESULTS

4.1. Measurement model

First, we assessed item reliability by evaluating the internal consistency of the latent constructs in the measurement model [63]. Specifically, items that failed to meet the suggested threshold loading of 0.70—indicating that they explained less than 50% of the variance—were identified and removed from the model [64]. Next, we evaluated internal consistency reliability using three measures: Cronbach's alpha, Composite Reliability (CR and ρc), and Dijkstra-Henseler's rho_A [65]. Convergent validity was then assessed based on the Average Variance Extracted (AVE). According to our evaluation, all item loadings exceeded the 0.70 threshold, the reliability coefficients fell within the acceptable range of 0.733 to 0.925, and all AVE values were above the 0.50 threshold. The results are presented in Table 2, confirming that the measurement scales demonstrated good internal consistency. Next, we assessed discriminant validity for the constructs included in the model. This analysis determines the extent to which each construct is empirically distinct from others, based not only on its correlations with other constructs but also on how well its indicators represent that specific construct alone [66]. To evaluate discriminant validity, we employed the Heterotrait-Monotrait Ratio (HTMT) criterion [67]. A commonly accepted threshold is an HTMT value below 0.85, which indicates sufficient discriminant validity. In our study, all HTMT values met this criterion, confirming that the latent constructs are empirically distinct from one another. (Table 3).

Table 2. PLS-SEM assessment results of reflective measurement models

Constructs	Items	Outer loading	Cronbach's Alpha	CR (rho_a)	CR (rho_c)	AVE
Attitude (ATT)	ATT1	0.844	0.912	0.918	0.934	0.740
	ATT4	0.909				
	ATT5	0.787				
	ATT6	0.899				
	ATT7	0.858				
Behavioural Intention (BI)	BI1	0.925	0.891	0.892	0.932	0.821
	BI3	0.915				
	BI4	0.877				
Knowledge (KN)	KN1	0.829	0.894	0.897	0.922	0.702
	KN2	0.846				
	KN3	0.860				
	KN4	0.822				
	KN5	0.832				
Moral norm (MN)	MN1	0.799	0.842	0.869	0.893	0.677
	MN2	0.867				
	MN4	0.883				
	MN6	0.733				
Perceived Behavioral Control (PBC)	PBC1	0.897	0.912	0.913	0.938	0.791
	PBC2	0.897				
	PBC3	0.911				
	PBC4	0.852				
Perceived meat quality (MQ)	MQ	0.860	0.940	0.944	0.954	0.806
	MQ	0.920				
	MQ	0.920				
	MQ	0.915				
	MQ	0.871				
Subjective Norm (SN)	SN1	0.859	0.904	0.905	0.929	0.724
	SN2	0.881				
	SN3	0.869				
	SN4	0.885				
	SN5	0.754				

4.2. Structural Model

To evaluate the structural model in our study, we followed several key steps. These included examining the initial correlations between variables, assessing the significance and relevance of path coefficients (as presented in Table 3), and analyzing the indirect effects. We also conducted tests to evaluate the model's predictive relevance within the sample and assessed its explanatory power using the R^2 coefficient. Additionally, we calculated the effect size (f^2) to determine the magnitude of influence between constructs (Table 4), R^2 values indicate the explanatory power of the model. Also known as the coefficient of determination, R^2 is computed as the squared correlation between the actual and predicted values of an endogenous variable. In other words, R^2 represents the proportion of variance in an endogenous construct explained by all its associated exogenous variables, both directly and indirectly. Ranging from 0 to 1, a higher R^2 value signifies stronger explanatory capability [65].

In our study, the R^2 value for behavioral intention—explained by personal psychological variables—was found to be 0.582, indicating a strong explanatory relationship. Meanwhile, the ability of behavioral intention to explain the quality of safe and healthy meat production is indicated by an R^2 value of 0.460, representing a moderate level of explanatory power (Table 5).

Similarly, f^2 is considered a measure of the relative impact of a predictor variable on an endogenous construct in the model. It does so by comparing the explained variance (R^2) when the predictor is included versus when it is excluded [67].

To demonstrate a meaningful effect, the f^2 value should be greater than zero. In our study, the endogenous constructs satisfied this criterion, indicating that the predictors contributed meaningfully to the model (Table 4). Hair et al. (2017) recommend the use of a bootstrapping method, which involves generating random subsamples (e.g., 5,000 resamples), to calculate the statistical significance of the hypothesized model [67]. In our study, we conducted bootstrapping analysis based on the proposed model to test the formulated hypotheses. The results indicated that all hypotheses were statistically significant, meeting the criteria of T-statistic > 1.96 and $p < 0.05$, thereby supporting the proposed hypotheses (Table 5).

Using the TPB, it is possible to develop a behavioral model that explains how herders' actions influence the quality of livestock products in pasture-based livestock production. This is supported by the following hypotheses: Hypothesis H1-H4 suggests that the herder's knowledge, attitude, perceived behavior control and subjective norm can influence herder's behavioral intention on the perceived meat quality. However, hypothesis H5 posits that the herder's moral norm negatively influences herder's behavioral intention on the perceived meat quality.

Table 3. Discriminant Validity Analysis (Fornell–Larcker Criterion).

Constructs	ATT	BI	KNW	MQ	MN	PBI	SN
ATT	0.860						
BI	0.666	0.906					
KNW	0.711	0.660	0.838				
MQ	0.702	0.678	0.608	0.898			
MN	0.667	0.550	0.746	0.486	0.823		
PBI	0.816	0.670	0.709	0.652	0.628	0.890	
SN	0.675	0.690	0.734	0.595	0.745	0.684	0.851

[1]ATT: Attitude; BI: Behavioral Intention; KNW: Knowledge; MQ: Perceived meat quality; MN: Moral Norm; PBI: Perceived Behavioral Control; SN: Subjective Norm.

Table 4. f square Matrix.

Variables	Behavioral Intention	Perceived meat quality
Attitude	0.029	
Behavioral Intention		0.852
Knowledge	0.035	
Perceived Meat quality		
Moral Norm	0.016	
Perceived Behavioral Control	0.023	
Subjective Norm	0.113	

Table 5. Summary of Hypothesis Testing Results (Bootstrapping Report).

Hypothesis		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Results
H1	KNW-> BI	0.214	0.213	0.066	3.219	0.001	Supported
H2	ATT-> BI	0.207	0.209	0.07	2.939	0.003	Supported

H3	PBI -> BI	0.183	0.183	0.076	2.399	0.016	Supported
H4	SN -> BI	0.373	0.369	0.07	5.35	0.000	Supported
H5	MN -> BI	-0.139	-0.135	0.071	1.977	0.048	Supported
H6	BI -> MQ	0.678	0.678	0.033	20.333	0.000	Supported
H1	KNW-> BI	0.214	0.213	0.066	3.219	0.001	Supported
Behavioral Intention							
R-square (SR)							0.582
R-square adjusted (SR)							0.577
Perceived meat quality							
R-square (SR)							0.460
R-square adjusted (SR)							0.459

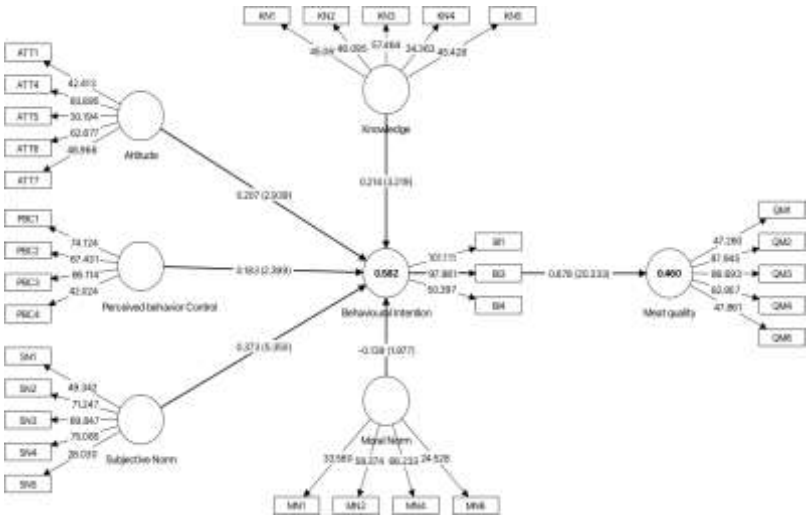


Figure 4. Results of the Proposed Model.

4.3. Mediation analysis

The mediation analysis was conducted using the PLS-SEM approach with bootstrapping to examine the mediating effect of herders' behavioral intentions on the relationships between the independent variables (ATT, KNW, MN, PBI, SN) and perceived meat quality. Bootstrapping with 5,000 resamples was employed to assess the significance of the indirect effects. The results indicated that indirect effects of ATT, KNW, MN, PBI, and SN on MQ through BI were all statistically significant ($p < 0.001$), confirming the presence of mediation effects. To further evaluate the strength of the mediation effects, the variance accounted for (VAF) was calculated. The VAF values ranged from 40.3% to 40.6%, suggesting partial mediation in accordance with established PLS-SEM guidelines. Consequently, all four mediation hypotheses (H1–H5) were supported. The detailed results of the mediation analysis are presented in Table 6.

Table 6. Mediation analysis results.

Relationships	Direct Effect	Indirect Effect	Total Effect	VAF
KN→ BI→MQ	0.214	0.145	0.359	40.4
ATT→ BI→MQ	0.207	0.140	0.347	40.3

PBC→ BI→MQ	0.183	0.124	0.307	40.4
SN→ BI→MQ	0.373	0.253	0.626	40.4
MN→ BI→MQ	-0.139	-0.095	-0.234	40.6

[1] VAF :<0-20% No mediation; 20-80% Partial mediation; Above 80% Full Mediation.[57].

5. DISCUSSIONS

This study is the first attempt in Mongolia to investigate the impact of herders' behavioral intentions on perceived meat quality using quantitative data. The findings indicate that all six hypotheses proposed on the basis of the TPB have statistically significant effects. The main results of the study are focused on the following research question. The first research question, "Does perceived meat quality depend on herders' behavioral intention? reveals that herders' behavioral intentions have a strong and statistically significant effect on perceived meat quality. The structural equation modeling and structural models demonstrate statistically significant correlations, which is consistent with previous studies [47][67][68]. These findings confirm that, according to the TPB, individual attitudes and norms affect behavioral intentions, and that behavioral intentions function as a mediating variable. One important aspect of herders' behavior is raising livestock under safe conditions while ensuring high-quality livestock products. Until now, herders have placed greater emphasis on increasing livestock numbers; however, this approach has negative environmental impacts, such as global warming and increased greenhouse gas emissions [69] [70]. Therefore, it is becoming more important for herders to focus on improving the productivity and quality of livestock products. Increasing livestock numbers can lead to multiple environmental and social challenges, such as reduced product quality per animal and pasture degradation.

Based on the second research question, "Which behavioral attributes of herders most strongly influence their intention to produce high-quality meat?"- the main factors influencing herders' behavioral attempts to produce high-quality meat were identified. These factors include herders' knowledge, personal attitudes, perceived behavioral control, subjective norms, and moral norms. The results indicate that herders' knowledge of quality-oriented animal husbandry, such as feed management, pasture selection, and access to animal health services, has a statistically significant positive effect on their behavioral intentions to produce high-quality meat (B=0.214, t=3.219, P<0.001). It was confirmed that the herders' attitude (B=0.207, t=2.939, P<0.003), perceived behavioral control (B=0.183, t=2.399, P<0.001), and Subjective norm (B=0.373, t=5.350, P<0.001) had a positive and statistically significant effect on the herders' behavioral attempts to produce quality meat. For herders engaged in traditional nomadic livestock production, individual characteristics such as knowledge, attitudes, ethical considerations, and adherence to animal husbandry norms and standards play a crucial role in shaping behavioral intentions aimed at improving the quality of livestock products. From the perspectives of the Theory of Planned Behavior (TPB) and the Theory of Reasoned Action (TRA), attitudes, perceived behavioral control, and social norms have a major impact on their decision-making to produce quality products. Although traditional herders recognize the importance of animal welfare, previous studies have shown that animal health services, rangeland management, climate change and sustainability, forage resources, and limited infrastructure are not considered high priorities [71].

Our study shows that the fourth hypothesis of the study, namely, the adherence to ethical norms by herders, negatively affects efforts to produce quality meat. While studies by Anders et al. (2023) and Savari et al. (2023) have shown that strong ethical norms positively support behavioral efforts to improve perceived meat quality [72][73], other studies suggest that low individual ethical norms have a negative effect [74].

This suggests that the herders' personal ethics are important in the ability to adhere to norms. Our results show that poor moral norms among herders reduce efforts to produce high-quality meat (B=-0.139, t= 1.977, P=0.048) corresponding to a 13.9% decrease. Therefore, it is important for herders to focus on producing high-quality livestock products—including meat, milk, wool, and cashmere—while improving their knowledge of animal welfare standards, veterinary care, feed management, and pasture use, and adopting practices that align with these standards.

A limitation of this study is that it focused on identifying the influence of herder's knowledge and the key factors of the Theory of Plannned Behavior on their intention to produce high-quality meat. In addition, it examined relationship between herder's intention to produce high-quality meat and their perceptions and evualtions of perceived meat quality. To address this, we suggest the following directions for future research:

– Investigate herders' perceptions, attitudes, and values regarding sustainable development, as well as their contributions to sustainability, and examine how these factors relate to their behavior toward producing high-quality meat.

– Assess herders' knowledge, attitudes, practices, and activities related to ensuring food safety, and determine their impact on perceived meat quality.

– Examine the level of implementation of national and international standards related to perceived meat quality, hygiene, and food safety in livestock production, as well as the challenges associated with compliance.

– Explore how market requirements, traceability and origin certification systems, government policies, institutional support, and sustainable production practices influence herders' behavior toward producing high-quality meat.

– Develop a more comprehensive model by investigating the interrelationships among herders' knowledge, behavioral factors, food safety practices, and objective indicators of perceived meat quality.

– Addressing these issues would contribute to a more comprehensive understanding of herders' behavior toward producing high-quality meat and provide valuable insights for developing policies and practical interventions aimed at improving sustainable livestock production, food safety, and perceived meat quality management.

6. CONCLUSIONS

The rapid growth of the global population has intensified the need to ensure access to food products that are environmentally sustainable, socially inclusive, and economically viable—core principles of sustainable development. One of the most pressing challenges today is to meet the growing food demand without compromising environmental integrity or public health. In this context, food products must meet essential nutritional criteria, including adequate levels of protein, vitamins, and other nutrients. Among all food categories, meat remains a key source of such nutrients, and ensuring the supply of safe and high-quality meat is a central responsibility of the livestock sector.

In Mongolia, meat production is rooted in the interconnected system of pasture–livestock–herder, where herders serve as the primary producers. This study aimed to predict the behavior of herders engaged in pasture-based livestock production with respect to producing safe and high-quality meat. Drawing on the TPB and Theory of Reasoned Action, we developed two main structures: first, that herders' behavior intention influences the quality of meat; and second, that herder's knowledge, attitude, perceived behavior control, subjective norm and moral norm influence behavior intention. Our findings support the hypothesis that herders' behavior has a significant impact on perceived meat quality. As stated by Delgermurun et al., (2021) "Antibiotic residues from livestock enter the human body through meat and other animal products," underscoring how herders' decisions in treating and managing livestock are directly reflected in meat safety [75]. Therefore, veterinary services should not be applied arbitrarily by herders, but rather administered through certified veterinarians and supervised institutions. While perceived meat quality is influenced by multiple factors—such as the animals' physical condition, plant diversity in pastures, salt and mineral supplements, grazing intensity, water availability, and climate—herders must be able to manage these conditions appropriately. When herders adapt their behavior in alignment with situational constraints and act with care and responsibility, they are capable of producing meat that is safe, clean, and beneficial to public health. Moreover, the personal traits of herders have a substantial influence on their decision-making behavior (R^2 =0.460). Our analysis revealed that, in accordance with the TPB, herder behavior is affected by individual attitudes, ethical standards, local social norms, and the actions of local authorities and professionals. Thus, a herder's internal disposition—particularly their attitudes—emerges as the most influential factor in behavioral outcomes. Given its clear practical significance, this study recommends that local governments and relevant institutions establish a "Livestock Behavior Standardization Education and Promotion Mechanism" as well as a "Livestock Behavior Traceability System" to enhance herders' behavioral self-awareness and the visibility of production practices. At the same time, the development of a certified veterinary system and village-level livestock service networks should be promoted to regulate herders' practices in disease prevention and livestock management, and to guide them in accessing services and technical support through formal channels. During the implementation process, the guiding roles of "model herder households" and influential community members should be fully leveraged to strengthen the impact of subjective norms on herders' behavioral intentions. Although the scope of this study is limited to three provinces that have preserved traditional pastoral practices and does not represent all ecological zones of Mongolia, the results confirm the theoretical validity of the proposed behavioral model. Future studies should expand the sample to include a broader range of ecological and geographic contexts and explore additional

factors that shape herders' behavior. Ultimately, it is critical to ensure that pasture-based livestock systems are capable of producing food products that fully meet the body's daily metabolic and energy requirements without compromising health or sustainability. Herders' behavior plays a vital role in realizing this objective.

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Abbreviations

The following abbreviations are used in this manuscript:

Herder's	Higher Education Institution
SDG	Sustainable Development Goal
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behavior
ATT	Attitude
KNW	Knowledge
MN	Moral norm
PBI	Percieved Behavioral Intention
SN	Social norm
MQ	perceived meat Quality
CR	Composite Reliability
AVE	Average Variance Extracted
SEM	Structural Equation Modeling
SPPS	Partial least squares structural equation modeling
VIF	Variance Inflation Factor
PBC	Perceived behavioural control
HTMT	Heterotrait-Monotrait Ratio
VOSviewer	Visualization of Similarities Viewer

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