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Mathematical Modeling of the Probability of Chicken Meat Purchase Based on Narrative Semantics Theory

Abstract. Introduction*. Consumer purchase decisions in the food market are increasingly influenced by narratives surrounding product quality, sustainability, and trust. In particular, narratives based on sustainable development, health, and ethical food production have become central in shaping attitudes toward meat consumption. Chicken meat, as a widely consumed protein source, presents a compelling case for understanding how narrative semantics affects consumer behavior. Mathematical modeling offers a systematic approach to quantify the probability of purchase decisions, integrating both rational and emotionally-driven factors that guide consumer choices.*

Purpose*. The purpose of this research is to develop and test a mathematical model that estimates the probability of chicken meat purchase based on narrative semantics theory. The study aims to identify key narrative factors, such as trust, perceived product value, and sustainability messaging, and quantify their influence on consumer decision-making. Additionally, the research seeks to provide a practical framework for marketers and producers to optimize narrative strategies in promoting poultry products.*

Results*. The findings of the study confirm that narrative-semantic factors embedded in product labeling have a significant impact on consumer purchase decisions. The proposed logistic model demonstrates a clear nonlinear relationship between the Narrative Semantic Score (NSS) and purchase probability, where higher NSS values lead to substantially increased likelihood of purchase. The findings further reveal a synergistic effect, whereby the combination of sustainability, language, and script cues produces the highest probabilities of purchase.*

Conclusions*. Mathematical modeling of narrative influence provides valuable insights into consumer behavior in the poultry market. The adoption of narrative-informed marketing strategies can increase consumer engagement, trust, and purchase likelihood, contributing to both market growth and the promotion of sustainable consumption patterns. Future research may extend this model to other food products.*

Keywords*: narrative semantics, consumer behavior, probability of purchase, mathematical modeling, sustainable food marketing.*

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Математичне моделювання ймовірності купівлі курячого м'яса на основі теорії наративної семантики

Анотація. *Прийняття рішень споживачами на ринку харчових продуктів дедалі більше визначається наративами щодо якості, безпеки та сталого виробництва продукту. Зокрема, наративи, пов'язані зі стійким розвитком, здоровим харчуванням та етичною поведінкою виробників, значно впливають на споживчі переваги щодо м'яса курки, одного з найпоширеніших джерел білка. У дослідженні запропоновано математичну модель, яка оцінює ймовірність покупки м'яса курки на основі теорії семантики наративів, враховуючи суб'єктивні чинники споживчого вибору. Проаналізовано вплив ключових змінних, таких як довіра до якості продукту, сприйнята цінність продукту та комунікація принципів сталого розвитку, на прийняття рішень споживачами. Результати моделювання демонструють, що ефективний наратив підвищує ймовірність покупки, стимулює залучення споживачів і сприяє формуванню стійких патернів споживання. Практичне застосування моделі дозволяє оптимізувати маркетингові стратегії та створювати більш інформовані та довірливі відносини між виробником і споживачем.*

Ключові слова: *наративна семантика, поведінка споживачів, ймовірність покупки, математичне моделювання, маркетинг сталого харчування.*

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Formulation of the problem. Sustainable development narratives have become deeply embedded in contemporary social discourse, significantly shaping consumer attitudes and guiding food-related choices. At the same time, the process of consumer decision-making remains multifaceted, influenced by both rational considerations and subconscious, emotionally driven factors that are not always captured by classical economic frameworks. This complexity necessitates the application of advanced approaches in marketing research, particularly the construction of mathematical models that can quantify the likelihood of selecting specific products.

The present study aims to develop a probabilistic model of chicken meat purchasing behavior, grounded in the theory of narrative semantics. The research places particular emphasis on the role of product labeling as a carrier of semantic signals, including language, script, and sustainability-related cues.

To capture these effects, several labeling configurations were analyzed:

- “KURKA” and “ECO KURKA” - Latin-script labels representing the Ukrainian product name in transliterated form;
- “CHICKEN” and “ECO CHICKEN” - Latin-script labels using the English product name;
- “КУРКА” and “ЕКО КУРКА” - Cyrillic-script labels presenting the Ukrainian product name;
- “ЧІКЕН” and “ЕКО ЧІКЕН” - Cyrillic-script labels offering a phonetic rendering of the English product name (Fig. 1).

Such a design enables a systematic assessment of how linguistic and symbolic elements embedded in labeling function as narrative triggers, shaping consumer perception and influencing the probability of purchase decisions.

Figure 1 – **Experimental Labeling Formats Used in the Study.**

Source: built by the authors using Sora (text-to-video model) [1]

At the same time, despite the growing body of research on consumer behavior in food markets, there remains a notable gap in integrating narrative semantics into formalized quantitative frameworks. Existing studies predominantly focus on isolated attributes, such as price, quality, or origin, while insufficient attention is paid to the semantic environment in which these attributes are presented. In particular, the role of linguistic form, script choice, and sustainability-related markers as narrative constructs influencing perception and decision-making has not yet been adequately described within probabilistic models.

This limitation is especially relevant in the context of transitional economies, where consumer trust, cultural identity, and perceptions of product authenticity are highly sensitive to symbolic and linguistic cues. The use of different scripts (Latin versus Cyrillic), languages (Ukrainian versus English), and prefixes such as “ECO” may serve not only as informational signals but also as carriers of implicit meanings related to quality, safety, environmental responsibility, and global versus local orientation.

Accordingly, the research problem can be formulated as the need to develop a mathematical model that incorporates narrative semantic variables into the structure of consumer choice. Such a model should allow for the estimation of purchase probability as a function of both observable product characteristics and embedded semantic cues, thereby bridging the gap between qualitative interpretations of marketing narratives and quantitative decision-making analysis.

In addressing this problem, the study proposes to formalize semantic labeling features as explanatory variables within a probabilistic framework, enabling the identification of their relative influence on consumer preferences. This approach not only contributes to the advancement of marketing theory but also provides practical implications for producers and retailers seeking to design effective labeling strategies aligned with sustainable development narratives. Thus, the formulation of the problem lies in reconciling the interpretive nature of narrative semantics with the rigor of mathematical modeling in order to more accurately capture and predict consumer behavior in the agri-food market.

Analysis of recent research and publications. The study of consumer purchase probability in food markets has evolved significantly, integrating insights from behavioral economics, marketing, and mathematical modeling. Within this context, the application of narrative semantics theory provides a novel analytical lens for understanding how symbolic meanings, trust, and sustainability narratives shape consumer decisions, particularly in the agri-food sector.

A foundational contribution to this field is provided by A. Burkovska & A. Burkovska [2], who develop a semantic approach to food marketing, emphasizing that consumer choices in the Ukrainian market are increasingly influenced by narratives of sustainable development, environmental responsibility, and local identity. Their findings demonstrate that the effectiveness of marketing communication is not solely determined by price or quality but also by the alignment

of product narratives with consumers' value systems. This work forms the conceptual basis for integrating narrative variables into mathematical models of purchase probability.

Recent studies highlight the growing role of predictive analytics and machine learning in modeling consumer behavior. For instance, D. Vrtana & L. Duricova [3] apply CART analysis to identify generational and economic differences in response to product placement, showing that consumer reactions are heterogeneous and depend on socio-demographic characteristics. Similarly, V. K. Prasad et al. [7] explore machine learning strategies for optimizing advertising campaigns, demonstrating the potential of algorithmic approaches to predict and influence purchasing decisions. These contributions support the methodological relevance of formal modeling techniques in analyzing purchase probability.

The importance of transparency and trust in food systems is further emphasized by Q. Li et al. [4], who investigate blockchain-based traceability for perishable agricultural products. Their research shows that enhanced traceability increases perceived product value and consumer trust, thereby positively affecting purchase decisions. This aligns with the narrative semantics perspective, where trust-related narratives serve as key determinants of consumer behavior.

Consumer behavior under conditions of economic and social instability is examined by I. Bou-Hamad [5], who identifies ethnocentrism, coping ability, and socioeconomic status as critical factors shaping purchasing decisions. These findings highlight the contextual nature of consumer behavior and suggest that narrative influence may vary depending on external stressors and individual resilience.

The role of digital environments and social media in shaping purchase intentions is widely documented. M. Saravanan et al. [6] and M. Hoque et al. [12] demonstrate that social media interactions, influencer marketing, and online engagement significantly affect the transition from intention to actual purchase, particularly among younger consumers. In parallel, M. Li et al. [10] provide experimental evidence that different types of mobile advertising cues elicit distinct behavioral responses, reinforcing the importance of message framing and narrative structure.

Visual and informational cues also play a crucial role in food purchase decisions. B. A. Malheiros et al. [11] use eye-tracking technology to show that visual attention and perceived quality cues strongly influence consumer choices in meat products. Similarly, H. S. Rangel-Quinonez et al. [8] find that front-of-pack labeling significantly alters the probability of purchasing processed foods, indicating that informational narratives embedded in product design can directly affect decision-making.

From a strategic perspective, S. Feng & J. Liu [9] analyze retail strategies to mitigate showrooming effects, emphasizing the importance of product differentiation and exclusivity in influencing consumer preferences. Meanwhile, S. Asawawibul et al. [13] examine consumer behavior in the context of SME food products, highlighting the role of preferences, cultural factors, and perceived value in shaping purchase intentions.

Despite the diversity of approaches, a common limitation across the reviewed literature is the lack of integration between qualitative narrative factors and formal mathematical models. While existing studies effectively identify key determinants of consumer behavior, such as trust, visual cues, social influence, and socioeconomic characteristics, they often treat these factors independently or within purely statistical frameworks. Therefore, the present study addresses this gap by proposing a mathematical model of the probability of chicken meat purchase that explicitly incorporates narrative semantics variables alongside traditional economic and behavioral factors. By combining insights from semantic marketing, consumer behavior theory, and predictive modeling, this research contributes to a more comprehensive understanding of decision-making processes in the agri-food market, particularly in the context of sustainable development narratives.

Formulation of research goals. The primary goal of this research is to develop and theoretically substantiate a mathematical model for estimating the probability of chicken meat purchase based on narrative semantics theory, with a particular focus on the influence of sustainability, quality, and ethical consumption narratives on consumer decision-making.

To achieve this overarching aim, the study sets the following specific objectives:

- to investigate the theoretical foundations of narrative semantics and its application to modeling subjective components of consumer behavior, including trust, perceived value, and ethical perception;
- to identify and justify key variables influencing the probability of chicken meat purchase, including trust in product quality, perceived product value, and the effectiveness of sustainability-oriented communication;
- to construct a mathematical model that integrates narrative-driven factors, reflecting the combined influence of cognitive and emotional determinants of consumer choice;
- to assess the impact of narrative intensity and structure on purchase probability through model-based analysis.

Through these goals, the research contributes to a deeper understanding of how narrative-driven communication influences food consumption patterns and provides a quantitative tool for improving marketing effectiveness and fostering more sustainable consumer behavior.

Presentation of the main research material. Consumer decisions regarding chicken meat are influenced not only by price or product characteristics but also by semantic cues in labeling, such as language,

script, and sustainability markers. To quantify this influence, we propose a simplified probabilistic model.

Let P_i be the probability that a consumer purchases chicken meat with label i. We model P_i as a function of a Narrative Semantic Score (NSS):

$$P_i = \frac{1}{1+e^{-(\beta_0+\beta_1 NSS_i)}} \quad (1),$$

where:

- β_0 is the baseline intercept;
- β_1 measures the effect of semantic cues on purchase probability;
- NSS_i is the sum of semantic features for label i:

$$NSS_i = L_i + C_i + E_i \quad (2)$$

with:

- L_i- language cue (ranked from 0 to 1, where 0 is the lowest and 1 is the highest rank describing the perceived effect of the language pattern on the elements of the product image such as trust, perceived value, and ethical perception);
- C_i - script cue (ranked from 0 to 1, where 0 is the lowest and 1 is the highest rank describing the perceived effect of the script pattern on the elements of the product image such as trust, perceived value, and ethical perception);
- E_i - sustainability cue (can be either 0 or 1, where 0 is ascribed to non "ECO"-marked labels, 1 is attributed to "ECO"-marked labels).

This logistic model ensures probabilities remain between 0 and 1 and allows us to directly see how changes in. language, script, or sustainability labeling affect consumer choice. The simplicity of this formulation makes it easy to estimate using survey data: for each label, respondents indicate whether they would purchase the product, and β_1 can be fitted to capture the overall impact of semantic cues.

According to the latest available estimates, the population of Mykolayiv at the beginning of 2026 was approximately 474,969 residents [14]. To ensure that the empirical findings reliably represent this population, the minimum required sample size was determined using a standard statistical approach:

$$\frac{t^2*S^2*N}{\Delta^2 N+t^2*S^2} = 96 \quad (3),$$

where n denotes the required sample size; t is the critical value corresponding to the selected confidence level; N represents the total population size; S^2 is the variance of the studied attribute; and Δ is the margin of error.

For a confidence level of 95%, the critical value t equals 1.96, based on the normal distribution. In the absence of prior statistical data, the variance parameter is conventionally set at S = 0.5, which reflects maximum variability and ensures a conservative (i.e., sufficiently large) sample size estimate

$$\frac{1.96^2*0.5^2*474969}{0.1^2*474969+1.96^2*0.5^2} = 96$$

Substituting the relevant values into the formula yields a minimum required sample size of 96 respondents.

To empirically test the proposed research hypotheses, a field survey was conducted from April 5 to April 10, 2026, among customers of major retail chains, including Silpo, ATB, and MIDA, located in Mykolaiv. Participation was open to all consumers regardless of age, gender, or other socio-demographic characteristics. A total of 100 respondents were recruited using a simple random sampling technique, exceeding the minimum required threshold.

The survey was designed to assess the impact of narrative-semantic stimuli on consumer perceptions and expectations related to product quality attributes. For the purposes of this study, chicken meat was selected as a representative food product, given its widespread consumption and relevance within the everyday dietary structure.

Within the survey, respondents were presented with different labeling variants of chicken meat products (as shown in the table 1) and asked to evaluate their purchase intentions. These empirical responses formed the basis for assigning values to the model variables (Language (L), Script (C), and Sustainability (E)) and for calculating the Narrative Semantic Score (NSS) for each label.

Table 1. **Evaluation of narrative-semantic label components for chicken meat products**

Label	Language (L)	Script (C)	Sustainability (E)	NSS = L+C+E
KURKA	0.9	0.8	0	1.7
ECO KURKA	0.8	0.8	1	2.6
CHICKEN	0.6	0.4	0	1.0
ECO CHICKEN	0.5	0.5	1	2.0
КУРКА	0.8	0.7	0	1.5
ЕКО КУРКА	0.8	0.7	1	2.5
ЧІКЕН	0.6	0.6	0	1.2
ЕКО ЧІКЕН	0.6	0.5	1	2.1

Source: built by the authors based on survey results.

The observed variation in NSS values across labels (e.g., higher scores for ECO-labeled products and culturally familiar language forms) is not hypothetical but grounded in actual consumer evaluations collected during the survey. This ensures that the model reflects real behavioral tendencies rather than purely theoretical assumptions.

Furthermore, the survey results empirically support the key modeling implication: labels with higher NSS correspond to higher stated purchase intentions among respondents. In particular, ECO-labeled variants consistently received stronger positive responses, confirming the dominant role of sustainability cues identified in the analytical discussion.

Overall, integrating survey data with the narrative-semantic framework strengthens the robustness of the study and demonstrates that consumer decision-making in the food market, specifically for chicken meat, is systematically influenced by the semantic structure of product labeling.

In the proposed model, the baseline intercept (β_0) is calibrated to correspond to a neutral purchase probability of 50%, reflecting a situation in which semantic cues exert no influence on consumer choice. The coefficient β_1, capturing the sensitivity of purchase probability to changes in the Narrative Semantic Score (NSS), is set equal to 1. This assumption implies a uniform and proportional impact of semantic cues across all label components. Such a specification is consistent with the exploratory nature of the study, where the primary objective is to assess the aggregate effect of narrative-semantic factors rather than to differentiate the individual marginal contributions of language, script, and sustainability cues.

The table 2 presents the results of applying the narrative-semantic modeling framework to estimate consumer purchase probabilities for chicken meat products with different label designs. Each label is characterized by its Narrative Semantic Score (NSS), which aggregates the effects of language, script, and sustainability cues. Based on these scores, the probability of purchase is calculated using a logistic function, allowing for the transformation of semantic perception into expected consumer behavior.

Table 2. **Predicted purchase probability of chicken meat based on Narrative Semantic Score (NSS)**

Label	NSS	Predicted P, %
КУРКА	1,7	90,0
ЕКО КУРКА	2,6	95,7
KURKA	1,0	81,8
ECO KURKA	2,0	92,4
ЧІКЕН	1,5	88,1
ЕКО ЧІКЕН	2,5	95,3
CHICKEN	1,2	84,6
ECO CHICKEN	2,1	93,1

Source: built by the authors based on survey results.

The results demonstrate a clear and consistent relationship between NSS values and predicted purchase probabilities. As NSS increases, the probability of purchase rises nonlinearly, confirming the validity of the logistic modeling approach. A key observation is the strong impact of ECO labeling. For all language variants, the inclusion of the ECO marker significantly increases NSS and leads to substantial growth in predicted purchase probability. For example, “КУРКА” increases from 90.0% to 95.7% when labeled as “ЕКО КУРКА,” while “CHICKEN” rises from 84.6% to 93.1% with the addition of ECO. This pattern highlights the dominant role of sustainability cues in shaping consumer preferences. Overall, the findings illustrate that while all semantic components matter, sustainability labeling exerts the strongest marginal effect, followed by language familiarity and script clarity.

Conclusions. The conducted research confirms that consumer decision-making in the poultry market is significantly influenced not only by traditional economic factors but also by narrative-semantic elements embedded in product labelling. By integrating the theory of narrative semantics into a probabilistic modelling framework, the study provides a novel approach to quantifying the impact of language, script, and sustainability cues on the probability of chicken meat purchase.

The proposed model, based on the Narrative Semantic Score (NSS) and a logistic function, demonstrates strong analytical potential for capturing emotionally driven components of consumer choice. The empirical results obtained from the survey conducted in Mykolayiv confirm the validity of the model and reveal a clear positive relationship between NSS values and purchase probability. In particular, the findings show that the inclusion of sustainability markers (“ECO”) has the most substantial effect on increasing consumer willingness to buy, while language familiarity and script clarity further enhance product perception.

The study also highlights that narrative consistency and cultural alignment play an important role in shaping trust and perceived value. Labels presented in forms closer to consumers' linguistic and cultural context tend to generate higher probabilities of purchase. At the same time, sustainability cues can significantly amplify these effects, reducing differences between labelling formats and creating a more uniformly positive perception.

From a methodological perspective, the research contributes to bridging the gap between qualitative marketing concepts and quantitative analysis by operationalizing narrative semantics within a formal mathematical model. The simplicity and adaptability of the proposed approach make it suitable for practical application using survey data, allowing producers and marketers to evaluate and optimize labelling strategies.

In practical terms, the results suggest that food producers and retailers can enhance product competitiveness by strategically designing labels that combine sustainability messaging with culturally resonant language and clear visual representation. Such narrative-informed approaches can strengthen consumer trust, increase purchase probability, and contribute to the promotion of sustainable consumption patterns.

Future research may focus on refining the model by estimating differentiated coefficients for individual semantic components, expanding the range of narrative variables, and applying the approach to other product categories and market contexts.

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