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Environmental sustainability based on artificial intelligence: Marketing benefits of local products

Durabilité environnementale basée sur l'intelligence artificielle : Bénéfices marketing des produits de terroir

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Abstract

This scientific article presents a conceptual research model designed to analyze the marketing benefits of local products within the context of environmental sustainability, utilizing artificial intelligence (AI). The model investigates how marketing benefits differ across three key variables: consumer behavior, geographic location, and product types.

The primary objective is to establish a theoretical foundation for future research by identifying essential factors, such as consumer preferences, geographic context, and product categories while exploring their interactions. By employing AI for data analysis and pattern recognition, this model aims to provide a comprehensive understanding of sustainable consumption behavior and to offer actionable insights for developing more effective marketing strategies for local producers.

Informations sur l'article

Mots-Clés :

Durabilité environnementale, Intelligence artificielle, Marketing des produits de terroir, Emplacement géographique, Types de produits de terroir, Développement durable.

Résumé

Cet article scientifique propose l'élaboration d'un modèle conceptuel de recherche pour analyser les bénéfices marketing des produits de terroir dans le cadre de la durabilité environnementale, en utilisant l'intelligence artificielle (IA). Le modèle se focalise sur les variations des bénéfices marketing selon trois variables principales : le consommateur, l'emplacement géographique et les types de produits.

L'objectif est de développer un cadre théorique pour guider les futures recherches, en identifiant les facteurs clés et leurs interrelations. En utilisant l'IA, ce modèle conceptuel vise à offrir une compréhension approfondie des dynamiques de consommation durable et des stratégies marketing efficaces pour les produits de terroir. Les résultats attendus incluent une meilleure compréhension des comportements des consommateurs et des pratiques de consommation durable, ainsi que des recommandations pour optimiser les stratégies marketing des producteurs locaux.

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Introduction

A local product from an environmental point of view has a lower impact on the environment compared to an ordinary product, due to its ecological materials, its production and distribution processes, its recycling, and its functionality (Ottman, 2011). Numerous studies show that the perceived environmental sustainability of a local product positively influences consumers' purchasing intention (Choi & Ng, 2011; Koller et al., 2011; Nyilasy, 2014), thereby increasing business profitability despite higher costs (Fraj-Andrés et al., 2009). As a result, many companies are looking to improve the environmental sustainability of their products to gain marketing advantages and increase profitability (Frank et al., 2015).

Digital transformation has recently garnered significant attention from practitioners, researchers, and the public. New technologies, particularly artificial intelligence (AI), have emerged to enhance the sustainability of local products. AI, defined by Poole et al. (1998) as intelligence exhibited by advanced machines, encompasses capabilities such as autonomous environmental understanding, learning, decision-making, and communication (Russell & Norvig, 2009).

AI applications enable local products to autonomously address environmental challenges, such as robots that clean farms and cities (Uçar et al., 2020) or monitor the health of plants and the presence of invasive species (Polverino et al., 2019; Rizk & Habib, 2018). Additional uses include optimizing agricultural processes (Di Vaio et al., 2020; Kaab et al., 2019; Najafi et al., 2018), conducting sustainability assessments (Carlson & Sakao, 2020; Nilashi et al., 2019), managing energy consumption (Nižetić et al., 2019), and reducing CO2 emissions through robotic vehicles (Nosratabadi et al., 2019).

AI-enabled sustainability can be categorized into two types: standalone environmental benefits and static environmental benefits. The latter are determined before a purchase is made (Ottman, 2011). Currently, there has been no research investigating the impact of AI-enabled sustainability on the local produce market. This study aims to address a gap in the existing literature by exploring how companies can leverage AI-enabled sustainability to gain marketing advantages for local products. Utilizing signal theory (Connelly et al., 2011), the research identifies the theoretical effects of both static and autonomous environmental benefits on consumers' purchasing intentions. Additionally, it examines how these effects differ based on factors such as consumer demographics, geographical locations, and types of local products. This analysis helps clarify the effectiveness of environmental signals (Herbas Torrico et al., 2018).

AI is a powerful tool for modernizing and optimizing marketing strategies. It offers opportunities to better understand and target consumer expectations while enhancing the appeal of local products. This leads to our research question: How can AI be used to improve the communication and marketing of local products by taking into account variations in consumer perceptions and expectations based on their profiles, locations, and product types? Furthermore, how can this approach contribute to increased environmental sustainability?

Based on this, several research questions arise, each focusing on a specific aspect of the intersection between environmental sustainability, artificial intelligence, and the marketing of local products. This study aims to provide clear, evidence-based answers to the following questions:

- How do consumer characteristics influence their perceptions and preferences for local products?
- How does the geographic location of consumers modify their perception of local products?
- How do different types of local products vary in terms of perceived marketing benefits?
- What is the contribution of artificial intelligence in optimizing marketing strategies for local products?
- How can the use of AI in the marketing of local products support sustainable and environmentally friendly practices?

1. Background of the study and conceptual model of the study

1.1. The mechanisms linking environmental sustainability and the intention to purchase local products

Consumers often look for products that offer the highest perceived value, which is defined as the difference between the benefits received and the sacrifices made (Zeithaml, 1988). Companies aim to optimize this perceived value by either increasing profits or lowering prices (Babin & Harris, 2021). While traditional product benefits typically focus on individual gain, the advantages of environmental sustainability extend to both nature and society as a whole (Ottman, 2011). Research conducted since the 1990s has demonstrated that perceived environmental sustainability has a positive impact on consumer attitudes and intentions towards local products (Choi & Ng, 2011; Koller et al., 2011; Nyilasy, 2014). Several theories have been employed to explain this connection. Stakeholder theory highlights the significance of sustainability in developing and

maintaining long-term relationships with stakeholders (Herbas Torrico et al., 2018). In contrast, signaling theory suggests that sustainability can communicate valuable yet unobservable qualities to consumers, especially during their initial purchases (Connelly et al., 2011; Spence, 2002).

This study is primarily based on signaling theory, which is especially relevant for local technological products that are innovative. The environmental sustainability of these products signals strong ethical values, which in turn fosters positive consumer attitudes and intentions. Consumers resonate with these values and are motivated to share them to enhance their social relationships (Koller et al., 2011; Martínez & Rodríguez del Bosque, 2013). Moreover, sustainability signals reliability, allowing consumers to infer the unobservable qualities of the product (Herbas Torrico et al., 2018; Martínez & Rodríguez del Bosque, 2013). Therefore, signaling theory (Connelly et al., 2011; Spence, 2002) is employed to develop the hypotheses of this study.

1.2. Artificial intelligence and environmental sustainability of local products

In the field of engineering, several studies explore how artificial intelligence (AI) can enhance the environmental sustainability of local products. Additionally, many companies that produce local products are developing solutions in which AI plays a key role in improving environmental sustainability. However, there is a lack of research examining how AI-based improvements in environmental sustainability impact the attitudes and behaviors of market participants in the production business. To contribute to the literature on local products, this study investigates the effects of AI-enhanced environmental sustainability on consumers' purchase intentions (Frank, 2021).

This study compares two types of environmental sustainability associated with local products: those enhanced by artificial intelligence (AI) and conventional ones. The environmental benefits are categorized into two types. The first type, static environmental benefits, includes impacts that arise from the design, production, and distribution processes before purchase. These impacts, such as CO2 emissions during manufacturing or the choice of materials, are fixed and cannot be changed later. They align with traditional concepts of sustainability (Choi & Ng, 2011; Koller et al., 2011). The second type, dynamic environmental benefits, refers to advantages that can evolve and be optimized over time. This includes a product's potential to reduce its environmental impact through modifications made during its use or disposal phases. Within this category, autonomous environmental benefits are specific to AI-enhanced local products. These benefits

pertain to the ability of local producers or cooperatives to utilize AI to identify and address environmental issues after purchase. For example, AI tools might analyze consumer habits, suggest more sustainable alternatives, and optimize production or supply chain processes to minimize the product's environmental footprint (Martínez & Rodríguez del Bosque, 2013).

Current literature on the environmental marketing of local products has not yet explored these autonomous benefits. Using signaling theory (Connelly et al., 2011; Spence, 2002), this study examines the effect of standalone environmental benefits on consumer behavior and compares them to static benefits. It also explores how these effects vary according to gender, need for cognition, location, and type of local product. According to signal theory, the influence of a signal depends on the receiver's interpretation and the value of the signal in the receiver's specific context. Figure No. 1 presents the conceptual framework of this study for local products.

2. Development of research hypotheses

2.1. Types of environmental sustainability: Impact on consumer intention to purchase local products

Drawing on signal theory (Connelly et al., 2011; Spence, 2002), researchers suggest that the perception of a local product's environmental sustainability positively influences purchase intentions. This perception serves as a signal of the reliability and values of the company offering the product (Herbas Torrico et al., 2018). Such a signal enhances consumers' perceptions of quality (Koller et al., 2011; Martínez & Rodríguez del Bosque, 2013), fosters their identification with the brand (Martínez & Rodríguez del Bosque, 2013), and increases their desire to use the product as a way to communicate their values to the social environment (Koller et al., 2011). Consequently, these mechanisms strengthen consumers' intentions to make a purchase (Choi & Ng, 2011; Herbas Torrico et al., 2018; Koller et al., 2011; Martínez & Rodríguez del Bosque, 2013; Nyilasy, 2014).

While this argument primarily focuses on the traditional concept of perceived environmental sustainability, referred to in this study as static perceived environmental benefits, it can also be expanded to include the dynamic environmental benefits of AI-enhanced local products. These dynamic benefits transcend static perceptions of sustainability by incorporating autonomous, non-predetermined behaviors driven by AI technologies, thus amplifying the environmental impact of local products. When consumers recognize these dynamic benefits, they are likely to see them as enhancing the environmental sustainability signal, which leads to a stronger

consumer response. For instance, when a consumer employs advanced sustainable growing techniques supported by AI to produce local products with a reduced environmental footprint, society is likely to interpret these actions as a strong signal of the consumer's values (Frank, 2021).

- **H1a:** The perceived static environmental benefits have a positive effect on the intention to purchase local products.
- **H1b:** The perceived autonomous environmental benefits have a positive effect on the intention to purchase local products.

2.2. The Effects of Environmental Sustainability Types: Differences by Customer

According to signal theory (Connelly et al., 2011; Spence, 2002), the impact of a signal – such as the environmental sustainability of local products – depends on how the receiver interprets it. Since different customers may have varying interpretations of the environmental sustainability signal for these products, the effects of static and stand-alone environmental benefits on purchase intention can differ among consumers. Specifically, these effects may vary between male and female consumers, as their distinct social roles can influence their sensitivity to various unobserved characteristics of local products. Additionally, consumer interpretation may be affected by their cognitive processing style, as signals can differ in abstraction levels and may require differing amounts of cognitive effort to understand (Frank, 2021).

2.2.1. Differences by gender

Research indicates that women are generally more risk-averse than men, making them more sensitive to signals of trustworthiness (Schwartz & Rubel, 2005). This characteristic often influences their purchasing decisions (Frank, 2021). Additionally, traditional gender roles can lead women to have a stronger desire to demonstrate adherence to social norms, whereas men might experience more freedom – or even encouragement – to deviate from those norms as a way to display audacity and bravery (Holmes, 1995).

As a result, the literature suggests that the environmental sustainability of local products may have a stronger impact on women's purchasing behavior compared to men's (Lee, 2009; Sudbury Riley et al., 2012; Wang et al., 2018). Most of this research focuses on perceived static environmental benefits that do not relate to AI. However, this argument can be extended to include the perceived standalone environmental benefits of local products enhanced by AI, which

contribute positively to society. Such enhancements are viewed as signals of reliability and socially valued principles. More specifically, the differences in the importance that consumers place on signaling their values may be more pronounced for the autonomous environmental benefits of AI-enhanced products compared to static benefits. This is because consumers may feel more empowered over the non-static actions of these products, leading their social environment to connect these actions with the consumers' values. The expectation of social recognition could increase the motivation for consumers, particularly women, to purchase local products as a means of signaling their values to others (Koller et al., 2011).

- **H2a:** The effect of perceived static environmental benefits on the intention to purchase local products is stronger among women than among men.
- **H2b:** The effect of perceived autonomous environmental benefits on the intention to purchase local products is stronger among women than among men.

2.2.2. Differences in need for cognition.

The perceived environmental sustainability of local products serves as a signal of their values and reliability (Herbas Torrico et al., 2018; Koller et al., 2011; Martínez & Rodríguez del Bosque, 2013). However, the concept itself – such as the relationship between agricultural practices and environmental conservation – can be abstract and challenging to understand (Ottman, 2011; Vainio, 2019). Additionally, the environmental impact of production processes and the materials used are often complex and difficult to observe, requiring comprehensive knowledge and careful consideration (Ottman, 2011; Sen et al., 2006). As a result, greater cognitive engagement helps consumers better appreciate the significance of static environmental benefits, which is necessary for interpreting these benefits as indicators of trustworthiness and values. In psychology, this engagement is commonly measured by the need for cognition, which reflects an individual's preference for deep and complex thinking rather than simple, less demanding reasoning (Cacioppo et al., 1984).

Thus, this study suggests that a higher need for cognition strengthens the interpretation of static environmental benefits as a signal of trustworthiness and values, consequently increasing the effect of perceived static environmental benefits on purchase intention. Although research on this mechanism is limited, one study supports this link in analyzing the effects of social (non-environmental) communication (Yang, 2018), while another research work does not confirm this in the analysis of environmentally friendly food choices (Vainio, 2019).

Unlike the previous moderating effect, this study posits that the need for cognition weakens the effect of autonomous environmental benefits on purchase intention for two reasons. First, standalone environmental benefits come from the use phase of an AI-enhanced local product, making their effects easier to observe and understand. Second, the main appeal of standalone environmental benefits lies in their autonomy and their ability to free the consumer from laborious thinking and decision-making. Thus, autonomous environmental benefits can particularly attract consumers with a low need for cognition, seeking to minimize cognitive efforts (Frank, 2021).

- **H3a:** The effect of perceived static environmental benefits on the intention to purchase local products is stronger for consumers with a higher need for cognition.
- **H3b:** The effect of perceived autonomous environmental benefits on the intention to purchase local products is weaker for consumers with a higher need for cognition.

2.3. The effects of types of environmental sustainability: differences by situational context

According to signaling theory (Connelly et al., 2011; Spence, 2002), the influence of a signal, such as the environmental sustainability of local products, depends on its value in the receiver's situational context (e.g., the location and context of the product). When consumers interpret the environmental sustainability of a local product as a valuable signal for their situation, they are more likely to purchase the product.

2.3.1. Place of residence of the consumer

Research indicates that the impact of static environmental benefits on purchasing behavior differs between urban and rural areas (Tanner et al., 2004) as well as among countries (Liobikienė et al., 2016). This study investigates how the effects of environmental benefits are influenced by perceived environmental well-being, which refers to the consumer's assessment of the local environment where they reside. In locations where perceived environmental well-being is low, consumers may view the environmental benefits of local products as significant, as these products represent a potential means to improve their surroundings. Consequently, low perceived environmental well-being enhances the influence of environmental benefits on purchase intentions (Liobikienė et al., 2016; Tanner et al., 2004). On the other hand, a more degraded environment may lead consumers to become desensitized to environmental issues and their

solutions. This familiarity mechanism suggests that lower environmental well-being could reduce consumer sensitivity to the environmental benefits signal, thereby diminishing its impact on purchase intentions (Frank, 2021).

To balance these two opposing effects, this study highlights the place where the environmental benefits of local products manifest themselves. Autonomous environmental benefits are realized in the consumer's location, where the AI-enhanced local product engages in autonomous actions that help solve local environmental problems. These benefits are all the more valuable in places where perceived environmental well-being is lower, thus strengthening their impact on the consumer's purchasing intention. In contrast, static environmental benefits arise from the design, production, and pre-purchase distribution phases of a product (Ottman, 2011), which often take place in locations distinct from the consumer's local community. Therefore, in a place with lower perceived environmental well-being, the mechanism of lower sensitivity to static environmental benefits may predominate over the mechanism of increased value of static environmental benefits in contributing to environmental improvement (Frank, 2021).

- **H4a:** The effect of perceived static environmental benefits on the intention to purchase local products is stronger in a consumer's place of residence with higher environmental well-being.
- **H4b:** The effect of perceived autonomous environmental benefits on the intention to purchase local products is weaker in a consumer's place of residence with higher environmental well-being.

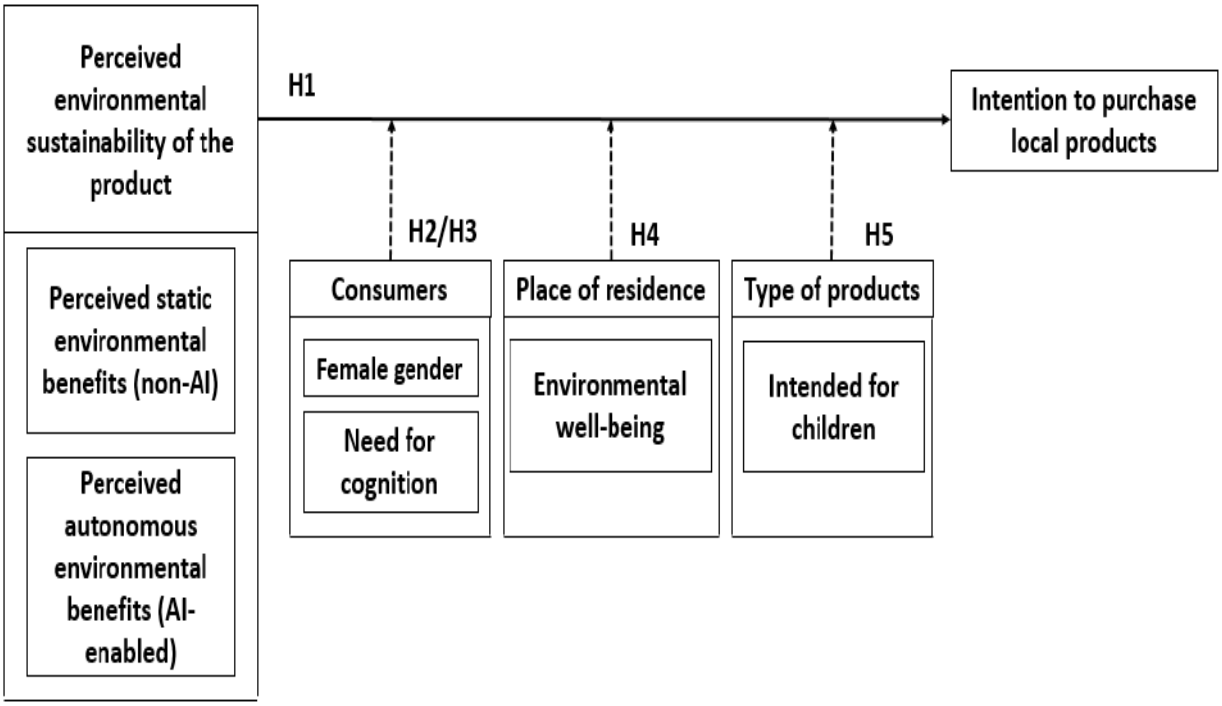
2.3.2. Type of local product

While the environmental benefits of local products serve as a signal of reliability, the importance of this signal depends on the protection the customer attributes to the product's intended use. Given that consumers often tend to instinctively seek to protect children, the environmental benefits of products aimed at children may be perceived as considerably important. Thus, this study posits that the effect of static environmental benefits, as a trustworthiness signal, on purchase intention is stronger when consumers purchase local products aimed at children (e.g., specific food products for children), compared to those intended for themselves or other adults (for example, adult products like clothing) (Martínez & Rodríguez del Bosque, 2013).

While this mechanism also applies to autonomous environmental benefits, the autonomous actions of an AI-enhanced product, lacking human empathy and instinctive sensitivity to child protection, could be perceived as less trustworthy or potentially risky for children (Xu & Lin, 2016). This could therefore weaken the interpretation of autonomous environmental benefits as a signal of trustworthiness among adult consumers purchasing AI-enhanced local products for children. Therefore, this study posits that the effect of autonomous environmental benefits on purchase intention is weaker when consumers purchase local products intended for children than when they purchase products intended for themselves or others. Other adults (Xu & Lin, 2016).

- **H5a:** The effect of perceived static environmental benefits on purchase intention is stronger for local products intended for use by children than for those intended for use by an adult consumer.
- **H5b:** The effect of perceived autonomous environmental benefits on purchase intention is weaker for local products intended for use by children than for those intended for use by an adult consumer.

Figure No. 1: Theoretical model and basic research hypotheses



Source: Developed by us based on the literature review

Conclusion

The study on environmental sustainability based on artificial intelligence and the marketing benefits of local products allowed us to develop a detailed conceptual model, highlighting the multiple factors influencing consumers' purchasing intention.

Indeed, the fundamental hypotheses explored in this research revealed very significant insights:

1) **Positive effect of environmental benefits**: The perceived environmental benefits, whether static or autonomous, significantly increase the intention to purchase local products. Consumers prefer products that contribute to environmental sustainability.
2) **Gender differences**: Women are more sensitive to environmental benefits than men, suggesting the need for tailored marketing strategies to reach this segment more effectively.
3) **Impact of the need for cognition**: Consumers with a high need for cognition react differently to environmental benefits: they are more influenced by static benefits than by autonomous ones.
4) **Influence of place of residence**: Consumers living in areas with high environmental well-being are more receptive to static benefits but less to autonomous ones, highlighting the importance of contextualizing marketing strategies according to the living environment.
5) **Use by children**: Local products intended for children benefit from a stronger effect of perceived environmental benefits, indicating that environmental concerns are particularly important for parents.

In summary, this research highlights the complexity of the factors influencing the purchase intention of local products and underlines the importance of a personalized marketing approach. By integrating artificial intelligence to analyze and anticipate customer behaviors, producers and marketers can develop more effective strategies, aligned with environmental concerns and the specific needs of different consumer segments. This conceptual model provides a solid basis for future studies and for the development of marketing policies aimed at promoting local products sustainably and responsibly.

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