

Determinants and Impediments of Innovation in Fermented Food Products: A Qualitative Study

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Abstract

In the context of growing health awareness, demographic ageing, and an increasing prevalence of digestive issues, fermented foods are receiving increased attention from consumers across Europe. Despite their deep historical roots, fermentation remains a niche market within the EU. To explore the factors that facilitate or impede innovation in this developing sector, we conducted qualitative interviews with key stakeholders from European fermentation companies. Using the Technology Acceptance Model (TAM), we develop a semi-structured interview guide to investigate how companies evaluate the practicality and ease of adopting novel technologies and innovations. Our results indicate a prevalent expectation of robust market expansion, coupled with intensifying competitive dynamics. Firms report that consumers place significant value on product quality, transparency, and natural ingredients. At the same time, regulatory frameworks, most notably the Health Claims Regulation, are perceived as substantial barriers to effective marketing and innovation. Furthermore, firms express concerns about the influence of lobbying activities by traditional food industries, such as dairy and meat, which they perceive as contributing to conservative regulations. We conclude that unlocking the innovation potential of the fermentation sector will require regulatory reforms and a more harmonized policy environment.

1. Introduction

Contemporary food systems are confronted with a multitude of interconnected challenges, stemming from demographic growth, environmental degradation, and evolving consumption habits. Global population projections anticipate a rise to over 9.7 billion by 2050 (Farid et al., 2024), which will put immense pressure on agricultural productivity, resource efficiency, and food security. Meanwhile, dietary habits have shifted considerably towards ultra-processed foods, which are often low in nutrients and high in additives, refined sugars, and saturated fats (Conti-Silva & Souza-Borges, 2019; Vahabzadeh et al., 2024). While these products are convenient, they are increasingly implicated in a range of non-communicable diseases, including obesity, type 2 diabetes, and gastrointestinal disorders (Vitale et al., 2024).

Beyond their public health implications, current dietary patterns exert substantial ecological pressure. Animal-based food production, particularly in the livestock sector, accounts for around 14.5% of anthropogenic greenhouse gas emissions, as well as causing significant land degradation, biodiversity loss, and water consumption (McClements & Grossmann, 2021; Poore & Nemecek, 2018). The intensification of these trends necessitates a transition towards more sustainable and health-promoting food systems.

Within this context, fermented food products have emerged as a promising alternative. Traditional fermentation processes are associated with numerous health benefits, such as enhanced digestibility, improved bioavailability of micronutrients and modulation of the gut microbiota via probiotic activity (Caffrey et al., 2025; Tamang et al., 2016; Taylor et al., 2020). Furthermore, modern fermentation technologies, including precision and biomass fermentation, offer the potential to develop novel, protein-rich foods with a significantly reduced environmental impact (Ford et al., 2024; Wolfe, 2023). These innovations also enable the valorization of agricultural by-products, thereby supporting circular economy models in food production (Marti-Quijal et al., 2020).

Despite the clear ecological and nutritional advantages of fermented foods, they remain underrepresented in the market¹. The slow pace of innovation and commercialization in this sector raises important questions about the systemic and organizational factors influencing the development and uptake of fermentation-based food products. Innovation research in functional foods suggests that, as markets become more dynamic, firms need to combine market pull and technology push as complementary drivers of the innovation process (Mark-Herbert, 2004) and invest sufficiently in research and development to remain innovative (Ilori et al., 2000). Moreover, innovation in the multinational agri-food sector appear to be episodic rather than continuous, often occurring short periods of innovations followed by long periods of no activity (Alfranca et al., 2004).

In light of these developments, we seek to address a key question: What are the main determinants and impediments to innovation in fermented food products, as perceived by producing firms? Although the health and sustainability benefits of fermented foods are well documented, recent studies have begun to examine firm-level challenges around commercialization and business-model development in fermentation-related industries (Lei et al., 2025; Thomson et al., 2025). However, evidence remains limited for producer perspectives in fermented food product innovation, we therefore aim to address how firms perceive determinants and impediments at the intersection of technology, regulation, implementation, and market dynamics.

There is an extensive body of literature on fermented foods, particularly with regard to microbiological efficacy (Valentino et al., 2024), nutritional impact (Fitsum et al., 2025), and consumer acceptance (Banovic & Grunert, 2023; Magriplis et al., 2025; Sproten et al., 2025). Fermentation is well-known for its ability to extend product shelf life, enhance protein digestibility and produce health-promoting metabolites such as short-chain fatty acids and bioactive peptides (Farid et al., 2024). Traditional products such as kimchi, yoghurt, kefir and tempeh have received a great deal of scientific attention in relation to their impact on gut health, immune function and metabolic regulation (Pohsнем et al., 2023).

Alongside this, a growing body of consumer research has examined attitudes towards fermented foods and novel fermentation-based products. Studies consistently report that consumer acceptance is influenced by factors such as sensory expectations, familiarity, perceived health benefits, and trust in food technology (Ford et al., 2024; Zollman Thomas & Bryant, 2021). For example, Vahabzadeh et al. (2024) employed an integrated

model incorporating the Theory of Planned Behaviour, Food Technology Neophobia and the Protection Motivation Theory to demonstrate that curiosity and perceived health value are significant predictors of willingness to consume functional fermented foods.

Although consumer-centric studies are abundant, producer-oriented research remains comparatively limited, with only a few studies examine how food companies conceptualize and navigate the opportunities and challenges associated with fermentation innovation (Plummer et al., 2026; Thomson et al., 2025). Existing research tends to focus on the techno-economic viability or safety of fermentation technologies (Risner et al., 2024; Wolfe, 2023) rather than the strategic, regulatory or market-related factors that influence innovation behavior at the firm level.

Furthermore, there is a lack of integration between technical feasibility and organizational capability. For example, although the precision fermentation of dairy proteins has been shown to be technically feasible, its wider implementation is hindered by factors such as regulatory uncertainty, scalability issues, the need for consumer education, and investment risk (Ford et al., 2024; Wolfe, 2023). These multidimensional barriers suggest that innovation in fermented food products is not merely a function of technical efficacy, but is also deeply embedded within broader institutional and systemic contexts.

Our study addresses the limited and fragmented producer-oriented research in the field of fermentation-based food innovation, thereby contributing to the academic discourse. Specifically, it introduces an analytical framework that applies the Technology Acceptance Model (TAM) to investigate the determinants and barriers to fermentation innovation from a company perspective. While the TAM is traditionally used to assess individual user behavior in technology adoption, we adapt it here to explore organizational decision-making processes. These include perceived usefulness, perceived ease of implementation, and the influence of contextual variables such as regulation, consumer demand, and infrastructural readiness. This approach allows us to investigate how firms' perceptions are related to their decisions to pursue innovation in the fermented food sector.

Using a qualitative research design based on structured questionnaires targeting European food processors, our study provides a detailed understanding of how firms evaluate the determinants and impediments of innovating in plant-based fermented food products. This methodological approach enables both sector-specific challenges (e.g. fermentation expertise and supply chain adaptation) and broader systemic factors (e.g. policy frameworks and market acceptance) to be articulated. Furthermore, the study seeks to bridge the micro-level motivations of individual firms with macro-level imperatives related to health, sustainability, and food security. Consequently, it provides a more comprehensive and policy-relevant understanding of how innovation in fermented foods can be effectively supported and scaled.

This paper proceeds as follows. Section 2 presents the theoretical framework, including the TAM-based qualitative interview design. Section 3 describes the data and method. Section 4 presents and discusses the results, highlighting the key drivers and barriers. Section 5 concludes with political and corporate implications, limitations, and suggestions for future research.

2. Technology Acceptance Model

To investigate the drivers and barriers to innovation in plant-based fermented food products, we apply the Technology Acceptance Model (TAM) as the primary analytical framework (see Figure 1). Originally developed by Davis(1986) to predict user's adoption of information systems, the TAM has since been extended to various technological and organizational contexts, including healthcare (Holden & Karsh, 2010), education (Padilla-Meléndez et al., 2013)and, more recently, food innovation (Banovic & Grunert, 2023; Vahabzadeh et al., 2024). The model posits that individuals' intention to adopt a new technology is influenced primarily by two core constructs: perceived usefulness and perceived ease of use. These perceptions shape users' attitudes towards the technology and, ultimately, influence both their adoption intentions and actual usage behavior (Davis, 1989).

In this study, we repurpose TAM to explore not end-users (i.e. the consumers), but food companies acting as technology adopters and innovators. In this context, the 'system' is not an IT platform, but the organizational decision to innovate by using fermentation technologies, whether traditional, biomass or precision-based, to develop and market new food products. This theoretical extension is consistent with recent research suggesting that TAM can be applied to organizational innovation, particularly in sectors characterized by high uncertainty and complex regulation, such as food technology (Banovic & Grunert, 2023).

Source: Own illustration based on Davis (1986)

In our study we operationalize the TAM through four interlinked constructs, adapted to the specific challenges firms face in fermentation-based product innovation (see Figure 1).

In the original TAM Davis(1989)defines *Perceived Usefulness* as “the degree to which a person believes that using a particular system would enhance his or her job performance”. In the context of fermentation companies, we define *Perceived Usefulness* as:

1. **Perceived usefulness:** The degree to which companies believe that innovating in fermented food products will enhance their competitive position, product differentiation, market attractiveness, and consumer value. This includes assessments of consumer demand trends, the health and sustainability attributes of fermented foods, and long-term profitability under competitive conditions.

Furthermore, defines Davis(1989)the *Perceived Ease of Use* as “the degree to which a person believes that using a particular system would be free of effort”. Adapting this effort-based view to innovation in fermentation companies, we define *Perceived Ease of Use* as:

2. **Perceived ease of use (implementation):** The degree of perceived simplicity or complexity when implementing fermentation-based innovations. This includes the technical difficulty of fermentation processes, the availability of skilled labor, access to suitable raw materials and microbial cultures, the robustness of the supply chain, and the regulatory burden associated with introducing new products.

The construct '*Attitude toward Using*' in the original TAM refers to "the degree of evaluative affect that an individual associates with using the target system in his or her job." (Davis, 1986, 1989). In the context of our study, we transform this attitude into a firm-level strategic orientation and define it as:

3. **Attitude towards innovating:** The degree to which the company is strategically oriented towards openness in innovation or expansion.

Following attitude towards use, the TAM framework distinguishes intention to actual use as an action-oriented construct that precedes actual use. While attitude reflects a company's general orientation, intention refers to specific planned actions that the company aims to pursue (Ajzen, 1991). We, therefore, define Davis(1986)*Intention to use* as:

4. **Innovation intention:** The degree to which the company intends to expand, maintain, or reduce its engagement in developing fermented products. This includes planned investments in R&D, entering new product categories, and the adoption of enabling technologies such as precision fermentation or automated production systems.

Each of these dimensions is explored through a semi-structured interview, which is designed to collect in-depth qualitative data from fermented food producers. The model thus enables a nuanced understanding of how innovation is evaluated internally within companies, offering insight that go beyond economic considerations.

The aim of our research is to identify determinants and impediments ("External Variables" in the TAM model) of innovation in plant-based fermentation companies. To do so, we tailor the TAM framework to the specific context of fermented food production as shown in Figure 2. Since our focus lies on the company perspective, we establish three process-oriented organizational categories –consumer, market, and production process – based on Porter(1985)value chain approach combined with the consumer-led new product development concept by Costa and Jongen(2006). These categories reflect the central operational areas of plant-based fermentation companies. Based on our definitions within the TAM, we assign the consumer dimension to *Perceived Usefulness*, the production process dimension to *Perceived Ease of Use*, while The market category can influence both *Perceived Usefulness* and *Perceived Ease of Use*.

Within the consumer category we identified three external variables based on the work of Banovic and Grunert(2023), who also applied the TAM though from a consumer perspective: *perceived benefits*, *food technology neophobia*, and *scepticism & fear*. For the market category we identified the variables *forecast* (GFI, 2023; Urbšienė et al., 2014), *competition* (GFI, 2023; Urbšienė et al., 2014), and *governmental regulation* (Urbšienė et al., 2014). The *forecast* variable is also influenced by the consumer category, as product forecasts depend on past and current demand under changing demographic conditions (Giacalone & Jaeger, 2023). *Governmental regulations* influence not only the market but also the production process dimension of fermentation companies, for example through minimum wage regulations (GFI, 2023). Beyond the governmental framework in which companies operate, the production process is also affected by technological developments (Nout, 2001; Siddiqui et al., 2023)and the availability of human and natural resources (Pandey et al., 2023). In addition, research activities from universities and private research companies play a crucial role in shaping the production process (GFI, 2023).

Siddiqui et al.(2023)note that increasing consumer health awareness and the scientifically demonstrated benefits of fermentation have led to increasing interest among companies in fermentation technologies. This growing interest reflecting the *attitude towards use* in the TAM is also documented in the GFI(2023)report. Skowron et al.(2022)further highlight not only the central role of fermentation in global nutrition but also the increasing need for companies to develop fermented products using high quality ingredients under controlled production conditions. Our adapted TAM framework is summarized in Figure 2.

Notes: Numbers indicate the respective source from the box. Those sources validate the connection between the two boxes.

Source: Authors' own illustration based on the literature shown in the box.

The structure of the questionnaire follows the four dimensions of the TAM. In the interviews we begin with the *Perceived Usefulness*, followed by *Perceived Ease of Use*, *Attitude towards Innovating* and finally *Innovation Intention*. Within each dimension we translate the categories identified in the literature into concrete interview questions. A copy of the full questionnaire is provided in the appendix.

3. Data & Methods

3.1. Data Collection

We collected the data through semi-structured expert interviews with decision-makers from plant-based fermentation-based food companies. Companies were selected using purposive sampling to ensure heterogeneity in company size, product focus (e.g., dairy alternatives, tempeh, kombucha), and innovation maturity. All interviews were conducted online, recorded with informed consent, and transcribed verbatim for analysis.

Confidentiality and data anonymization were assured in accordance with ethical research standards. Accordingly, companies are anonymized through the abbreviation **FC** (Fermentation Company). For confidentiality reasons², only the the number of employees and the type of fermented product produced by each company can be disclosed: 1. Tempeh; 2. Kombucha; 3. Dairy Alternatives; 4. Food, Drinks, and Supplements; 5. Meat Alternatives.

The dataset of 9 interviews is a representative snapshot of the current fermentation market, which remains a niche segment within the food industry. According to GFI, only around 70 companies in Europe specialize in fermentation-based products (GFI, 2025). With a substantial share of these companies located in Germany (> 15%), our sample of which 55% are German fermentation companies partly reflects this distribution. Furthermore, our interviews provide in-depth, expert level insights from key decision makers (e.g. founders, CEOs) and therefore ensure rich qualitative data. Our sample ensures heterogeneity in terms of company size (6–200 employees), product focus (see Table 1), and innovation maturity (ranging from start-ups to established companies). In addition, following Hennink and Kaiser (2022), who suggest that 9–17 interviews are typically sufficient to reach saturation in qualitative research, we observed saturation already after the fourth interview, redundancy suggest that the sample sufficiently covered the heterogeneity of market and firm conditions.

Table 1
List of interviewed Fermentation Companies

Company	Product Focus	Number of Employees	Duration
FC1	Kombucha	6	70 min
FC2	Tempeh	60	45 min
FC3	Dairy Alternatives	> 100	25 min
FC4	Food, Drinks, Supplements	80	65 min
FC5	Kombucha	10	35 min
FC6	Dairy	> 100	30 min
FC7	Tempeh	20	30 min
FC8	Dairy Alternatives	50	40 min
FC9	Meat Alternatives	45	45 min
Source: Own illustration			

3.2. Data Analysis

We analyzed the transcribed interview texts using MAXQDA software. For category development, we applied both deductive and inductive coding, in line with Patton (2015) and Mayring (2022) qualitative content analysis approach and Kuckartz and Rädiker (2019) thematic coding method. Deductive themes were derived from the TAM framework and operationalized into guiding questions while the semi-structured interview format also allowed room for participants to inductively identify novel insights and barriers not anticipated by the theoretical model. To ensure coding quality, we followed a procedure inspired by consensual qualitative research (CQR) (Hill et al., 1997). After jointly developing a TAM-based codebook from the literature, each researcher independently coded an initial transcript in MAXQDA, met to reach consensus, and refined the definitions and examples. Consistent with CQR, we prioritized discussion-based agreement rather than statistical coefficients and did not employ an external auditor. We then applied the revised coding scheme to all transcripts, conducting regular consensus meetings, documenting decisions in an audit trail, and performing cross-analysis to synthesize core themes within domains. Throughout the analysis, we compared inductive findings with TAM constructs to identify convergence, divergence, and negative cases (Hill et al., 1997).

4. Results & Discussion

4.1 Perceived Usefulness

As defined above, *Perceived Usefulness* refers to the degree to which companies expect fermented-food innovations to improve consumers’ perception and enhance the company’s market position. The key impediments and drivers identified within the consumer and market categories are shown in Fig. 3.

Source

Authors own illustration

Looking at the consumer category of TAM, we can confirm several of the predefined topics from our literature-based framework but we also consolidate some of the topics into new categories. In the questionnaire, “*Skepticism & Fear*” and “*Food Technology Neophobia*” were addressed as separate topics, however, during the inductive analysis, these were merged into a new overarching theme, which we call “*Transparency & Quality*”.

Across all interviews companies emphasized that transparency and product quality are the most decisive factors for convincing customers to (repeatedly) purchase fermented products (*"Transparency, trust, and quality are decisive"* FC4). This finding is in line with previous research of Saint-Eve et al. (2021), who show that transparent marketing regarding nutritional and environmental aspects increases consumers' willingness to pay for fermented food products. Furthermore, Moritz et al. (2023) suggest that acceptance of novel food technologies is shaped by addressing the "fear of the unknown" through provision of credible information.

The second topic in the consumer category is *Perceived Benefits*. All fermentation companies report that their consumers value high-quality ingredients, their origin, and an organic production process. FC9 underlines this by stating: *"If it is not ultra-processed, has a good price, and it is also organic and locally sourced, it is a full bingo."* This supports previous research showing that consumers of novel or niche food products place greater emphasis on sustainability in their purchase decisions (Spicher et al., 2025). Furthermore, FC9 states that consumers perceive fermented products as *"not ultra-processed, [...] real food"*, underlining previous research on the negative health effects of ultra-processed foods (Vitale et al., 2024).

In the market category the three literature-based predefined topics of our framework (*Forecast, Competition, Governmental Regulations*) were confirmed. Regarding *Forecast*, the companies consistently state that demand for fermented products will increase in the coming years. FC1 remarks that the *"Hype of fermentation is just starting and is just arriving in the middle of the society"*, while FC1 notes that *"Social Media is pushing Fermentation into the spotlight"*, and FC9 adds that *"Within the niche of plant-based, the demand is definitely going towards something that is less processed."* These company perceptions are in line with market forecasts by GFI (2024) and Statista (2025b), both of which predict strong market growth in the coming years. In our framework *Forecast* is influenced by the consumer category underlining that past and current consumer demand affects expectations of future market development. FC3 confirms this by stating that *"it is up to the consumer to find out the benefits of fermentation"*.

In the *Competition* topic all companies report that there is strong competition in the market. FC1 notes that *"as a market participant every new competitor feels like strong increasing competition"*. FC7 adds that *"the intensity of competition depends on the market segment the company is targeting"*. When companies develop substitutes for traditional foods like meat, cheese, beer, or soft drinks, they are entering an already well-established market. Here, FC1 emphasizes that a clear Unique Selling Proposition (USP) is decisive to differentiate from competitors in the eyes of consumers. FC7 reinforces this point, stating that *"There is a lot competition, but there is also a lot of opportunities."* underlining the necessity of a distinct USP. This is consistent with previous literature (Kunz et al., 2021), which identifies clear product differentiation as a key driver for the success of novel food products. FC4 also reports that its supplier eventually entered the market independently, increasing competition. Conversely, FC2 states that when large retailers enter the market, it can generate additional momentum for market development. However, evidence on the innovation implications of retailer power is mixed. Weiss and Wittkopp (2005) find that greater retailer market power reduces product innovation. By contrast, Chen (2019) shows that stronger retailer bargaining power can increase product variety and quality, but only under specific demand-elasticity conditions. Trott and Simms (2017) show that retailers category management (e.g. variety, depth, and service level) in the shelves influences food innovation. FC2 adds to that *"there is no difference in bargaining with conventional or organic retailers, it only depends on the people sitting at the table"*. We address the topic of *Governmental Regulations* in the chapter of *Perceived Ease of Use* to avoid iterations.

Besides confirming the literature-based determinants and impediments, we identified two additional topics through the inductive coding process. With *Sales Market* and *Marketing*, we cover a broad area of market development for fermented food products. Starting with the *Sales Market*, the companies report that fermented food products remain a niche segment and have not yet reached the mass market (FC2). Since most companies sell their products to organic retailers and (fine-dining) restaurants, target consumers in this niche market are sometimes described as "Eco-Hippies" (FC1). The fact that organic retailers still represent a niche market is also reflected in current German market data, where they account for only 5% of the market share³. Nevertheless, FC9 states that *"In our market, we are more in consolidation phase right now, than we are in a fragmentation phase"*. In industry life cycle terms, the consolidation phase is characterized by declining market growth and increasing mergers and acquisitions, whereas the fragmentation phase represents the early stage of market development (Gomber et al., 2017). This is supported by GFI (2023), which reports a decline in the share of new market participants in the fermentation sector.

The *Marketing* strategies of the interviewed companies for reaching consumers in the niche market varied considerably. While some companies state that price is the most important factor and that consumers are very price sensitive (FC1, FC2, FC6, FC7), others emphasize that quality and transparency are decisive and that prices should not be set too low in order to sustain the market and its development (FC2, FC5, FC9). Additionally, (FC2) notes that consumers who shop at organic retailers tend to have greater health awareness compared to the more price sensitive customers of discount supermarkets. These findings are in line with previous literature highlighting the importance of quality and transparency in niche markets (Olagunju et al., 2025), consumer price sensitivity regarding novel food products (Canavari et al., 2023), and differences in price sensitivity between customers of retailers and discounters (van der Plas et al., 2024). In addition, FC9 states that *"mass communication is though"* and *"We are still working on, finding the right positioning of the brand and products."*, illustrating that upscaling from niche to mass markets is difficult and often influenced by phenomena such as the omnivores dilemma; in which consumer struggle to decide what to eat when confronted with many unfamiliar or novel food options (Tuorila & Hartmann, 2020).

4.2 Perceived Ease of Use

We previously defined *Perceived Ease of Use* as the factors influencing the implementation process of fermented food innovations. Besides market related factors such as *competition* that influence the implementation process, we now narrow our scope to the impediments and determinants within the production process category shown in Fig. 4.

Note

Impediments and determinants of the *Market* category are the same like in Fig. 3.

Source

Authors own illustration.

Within the topic of *Governmental Regulation*, the companies express both shared and differing opinions. Four subtopics were identified: 1) Novel Food Regulation (EU 2015/2283), 2) Health Claim Regulation (EC No 1924/2006), 3) Supply Chain Due Diligence Act (EU 2024/1760), and 4) Lobbyism. While FC4 and FC6 state that Novel Food Regulation does not influence their business development, FC1 and FC9 report that it limits their business development. Regarding Health Claim Regulation, all companies share the view that this regulation restricts their marketing opportunities (*"The EU regulations put some really high demand on what could be health claims"* FC9). The companies also agree that the Supply Chain Due Diligence Act does not affect their business activities, as sustainability and ecological production are already part of their USP. FC2 and FC3 raise the issue of lobbyism stating that policies and regulation are *"vegan-unfriendly"* and *"conservative"* due to the strong lobbying activities by traditional sectors such as dairy and meat. FC4 adds, that *"uniform EU-regulations would be favorable"*. The views of these companies align with previous research showing that lobbying is highly influential in the agribusiness (Swinnen, 2018; Swinnen et al., 2021) and that Health Claim Regulation imposes significant constraints on the development and marketing of novel food products (Domínguez Díaz et al., 2020). Additionally, recent research suggests that the Novel Food Regulation delays consumers' access to food innovation (Le Bloch et al., 2025) and that EU regulations slow down experimental innovations of fermentation products (Plummer et al., 2026).

Besides *governmental regulation*, *technology development* also affects the supply chain of fermented food product. Since there are several approaches to producing fermented products, the determinants and impediments related to technology development are heterogenous. While some companies can rely on technologies used in established businesses (e.g., breweries) (FC1, FC7), FC9 mention that *"we had to develop something new with the suppliers"*, but also highlights *"Luckily, it is more difficult to copy."* Further technological impediments were mentioned. FC4 describes logistical challenges, as products require continuous cooling throughout the entire supply chain. If this is not maintained, strong pressure may build up inside the packaging due to ongoing fermentation. This supports findings from previous literature (Caffrey et al., 2025). All companies mention high investment costs when starting the business and emphasize that substantial know-how is required (*"A handful of scientists, who are doing science stuff on a daily basis."* FC9), underlining the necessity of financial resources and specialized knowledge for implementing novel food products (Shah et al., 2023).

In the topic of *Human Resources*, the companies state that besides needing highly skilled and motivated people, manual labor is still required in the production process. The companies report that finding such employees is not a problem for them (FC1; FC9), *"every two days a job application is coming in"* (FC5). FC4 adds that proximity to universities and research institutions increases the number of job applications, whereas FC9 states that *"We wanted to be a little bit far away from the local factors, because they are sucking all the labor."* Furthermore, FC9 adds that *"It is not an issue of getting candidates, but of course you're really depending on hiring the right people."* This is in line with previous research showing that the success of start-ups is positively influenced by proximity to universities (OECD, 2020), but also that selecting the right employees is decisive for business development (Lewis & Cardon, 2020). In addition, the companies report high employee retention or *"normal"* fluctuation levels (FC5; FC2). This aligns with previous literature suggesting that companies whose employees strongly identify with the organization tend to experience higher employee retention (Curtis & Wright, 2001; Kyndt et al., 2009).

Looking at the topic of *Natural Resources*, all companies emphasize the quality of their ingredients, noting that consumers attach great importance to it. As a result, companies focus on organic (FC4), sustainable (FC1), and vegan ingredients (FC3), making this part of their USP. In addition, many companies incorporate regionality/local embeddedness into their USP and marketing strategies. Besides lower transportation costs, independence from external disruptions (e.g., COVID-19) is another reason for choosing local raw materials (FC1, FC9). FC2 mentions one challenge with the concept of regionality. Regionality is often defined by a specific region or country, but in some cases, it would be more sustainable to source products from a supplier in a neighboring region that is geographically closer than one located within the formal regional definition. These findings are consistent with previous literature showing that consumers of novel food products and health conscious consumers value the regionality of products ingredients (Fernández-Ferrín et al., 2018; Kumar & Smith, 2018). Nevertheless, FC9 states that *"Locally organic sourced ingredients put a limit on our flexibility in terms of sourcing."*, underling results of previous research on the constraints inherent in local supply chains (Aybar Espinoza et al., 2026; EP, 2016).

Besides receiving many job applications from students and researchers, all companies report collaborating with research institutions and universities (FC1; FC9), to close research gaps, exchange information, and benefits from technological equipment, that would require high investment costs if acquired independently. Such cooperation is common among start-ups as a means to reduce costs and exchange knowledge (Audretsch et al., 2023; Yusuf, 2008). Combined research activities from food industry, national ministries and research institutions are quite

common in Germany and support innovations (Menrad, 2004). FC2 point out that cooperation with research institutes must be mutually beneficial, whereas FC9 notes that, in many cases, *“governmental funds bring the parties together.”* This aligns with previous research on the benefits of publicly funded research in fostering collaboration (Garcia-Alvarez-Coque et al., 2015).

4.3 Attitude towards Innovating

In this section we examine companies' attitudes towards expanding their production processes and innovating new products within their existing business area. Most companies state that they do not follow fixed innovation schedules (e.g., launching three new products per year). Instead, they introduce innovations when they arise (FC2; F8). As FC2 notes *“innovation quality before time”*. In contrast, FC1 reports that the company aims to introduce a new product every year. FC5 invests 30% of its resources into research and is therefore continuously engaged in improvements and innovations. Additionally, FC5 states that expanding into large retailers increases the risk of *“losing your company”*, because you lose the often high-valued personal customer relationship. As a result, the company constantly analyzes its decisions: *“Jumping into new shoes and then walk a little bit and look”* (FC5).

With regionality as one of their USPs, some companies also perceive it as a limitation for their sales radius (FC1) and production capacity (FC2). In contrast, FC4 pursues a strategy of exporting to other European countries and FC3 expresses a willingness to meet any demand within its production capacity: *“the demand is there, we want to meet it”*. FC8 adds *“We aim for growth that maintains product quality and aligns with our brand values of sustainability, transparency, and plant-based innovation.”*, underlining the importance of company's values in development of novel foods (Astill et al., 2019).

Overall, the results show that the companies' strategies for expansion and innovation are heterogenous and heavily depend on the owners' attitude towards growth and innovation, supporting findings from previous research (Cucculelli & Peruzzi, 2020). This also aligns with Howells (1997), who frames innovation as a socio-cognitive process shaped by users and firms' interpretations of need, use, and intended use (i.e. market pull). Furthermore, the urge of many companies to constantly innovate their products aligns with previous literature, which states that companies avoid the “decline phase” in their product life cycle through innovation and go back to the “growth phase” (Robertson & Langlois, 1995).

4.4 Innovation Intention

In this section we focus on the companies' future plans, specifically whether they intend to remain in their current business area or shift toward other segments. All companies reported that they have no plans to exit the fermentation sector. Owing to the *“huge market potential”* (FC3, FC4) and in some cases unmet current demand, there is limited willingness to expand into other business areas (FC5). FC2 adds *“Cobbler, stick to your last.”*, emphasizing that optimizing the current business is preferable to pursuing unrelated new ones. Additionally, FC2 mentions that the focus on product innovation quality is more valuable than the focus on quantity: *“A few good ones are better than many bad ones”*.

The literature offers contrasting insights. On the one hand Cohen and Winn (2007) argue that diversification of income streams aligns with opportunity recognition behavior. On the other hand, an overly broad strategy can be associated with a loss of product quality (Manova & Yu, 2017; Yuan et al., 2024), which is highly valued by certain consumer groups (FC1; FC9). Furthermore, FC7 states that *“It is quite complex to launch a new product within the fermented food sector.”*, pointing to the complexity of market structure in the fermented food market. This complexity translates into *“High investment costs before you can sell your first product.”*, which is supported by previous literature highlighting the financial challenges when launching novel food products (Shah et al., 2023).

We link these findings back to our research question on how firms evaluate the determinants and impediments of innovating in fermented food products by comparing the results in Table 2 and Table 3 and refining our TAM framework in Fig. 5. A comparison of the two tables reveals that the areas in which positive determinants clearly outweigh impediments pertain to transparency and quality, perceived benefits, forecast, sales market, competition, human resources and research. This finding serves to strengthen firms' perceptions of the usefulness and ease of use of fermented food innovations. On the other hand, domains such as marketing, governmental regulations, technology development and natural resources are characterized by impediments, which result in lower perceived usefulness or ease of use. Furthermore, the negative influence of governmental regulations on the marketing possibilities of companies is marked by a dotted line. Consequently, this weakens attitudes and intentions to innovate. Figure 5 visualizes this evaluation by integrating the determinants and impediments into an adapted TAM, with dotted lines indicating those areas where firms experience impediments with greater intensity than enabling factors.

Table 2
Determinants of Fermentation Companies

Determinants	
Transparency & Quality	<i>"Quality is an important factor, then a good connection with the supplier, and also a high transparency." (FC5)</i> <i>"Transparency, trust, and quality are decisive." (FC4)</i> <i>"Taste is really king." (FC9)</i> <i>"Digital tools for traceability will become increasingly important." (FC8)</i>
Perceived Benefits	<i>"Consumer value good ingredients, origin and organic production process." (FC2)</i> <i>"Health and Aging are important factors." (FC4)</i> <i>"Health awareness and novelty go hand in hand." (FC7)</i>
Forecast	<i>"The demand is there, we want to meet it." (FC3)</i> <i>"Strong market growth of 30–40%." (FC4)</i> <i>"Hype of fermentation is just starting and arriving in the middle of society." (FC1)</i> <i>"Still a lot of scope for innovations." (FC7)</i>
Sales Market	<i>"Gastro & Fine-Dining Scene" (FC4)</i> <i>"More health aware consumer in the retailer instead the price-sensitive discounter consumer." (FC2)</i> <i>"Fermented foods are trying to go into the mainstream market." (FC7)</i>
Marketing	<i>"You don't want to start with a too low price, because then you destroy the market." (FC5)</i> <i>"Price is the most important factor to reach the consumer." (FC3)</i> <i>"No target-group oriented marketing." (FC2)</i> <i>"If there would be a label saying 'not ultra-processed', I would be very happy." (FC9)</i>
Competition	<i>"As a market participant every new competitor feels like strong increasing competition." (FC1)</i> <i>"The more products there are in the supermarkets and the higher their visibility, the higher the demand even for us." (FC4)</i> <i>"Competition in the fermented food market is intensifying, as more companies recognize it's growth potential." (FC8)</i>
Governmental Regulation	<i>"Regulations are important, before many bad products are offered." (FC4)</i> <i>"Increasing support through funding programs, research incentives, and clearer labeling policies is helping the fermented food sector grow." (FC8)</i>
Technology Development	<i>"Usage of technology from established businesses, brewery or dairy." (FC1, FC7)</i> <i>"Around 30%. We invest very much in research, taste development, process development." (FC5)</i>
Human Resources	<i>"Every two days a job application is coming in." (FC5)</i> <i>"High supply of motivated employees." (FC1, FC6)</i> <i>"There are so many industries where you can pull knowledge and hire from. If you can find them and if you can afford them." (FC7)</i>
Natural Resources	<i>"Regionality is automatically cheaper than exports from far away." (FC4)</i> <i>"Long-term relationships with trusted suppliers, local sourcing, and culture development partnerships to ensure reliability and sustainability." (FC8)</i>
Research	<i>"I would like to collaborate much more with some university in terms of DNA sequencing." (FC1)</i> <i>"Collaborations are a key part of our innovation strategy." (FC8)</i>

Source

Authors' own illustration based on the interview results

Table 3
Impediments of Fermentation Companies

Impediments	
Transparency & Quality	<i>"Greenwashing is a huge factor in the business, and also consumer deception." (FC1)</i> <i>"Ultrafiltration is used to blend consumers." (FC1)</i>
Perceived Benefits	<i>"It is then up to the consumer to find out what is actually better for my body and my diet." (FC3)</i>
Forecast	<i>"Still a niche market." (FC4)</i>
Sales Market	<i>"Bubble is in the bio-area." (FC2)</i> <i>"More consumers are going into the healthier lifestyle, but the price or the income remains a big issue" "Middle- to high-income consumer" (FC6)</i> <i>"You need to have high investments and you need to go for high volume," (FC7)</i>
Marketing	<i>"Fermented products are quite expensive." (FC4)</i> <i>"Health claim regulation is limiting marketing possibilities." (FC5, FC6)</i> <i>"Mass communication is though." (FC9)</i>
Competition	<i>"Strong lobbyism of different food industries." (FC2)</i> <i>"Competition is high, supplier adopted business." (FC4)</i> <i>"Competition never sleeps." (FC4)</i> <i>"Competition is quite strong and the market is price sensitive and difficult to enter" (FC7)</i>
Governmental Regulation	<i>"Some laws simply need to be changed" (FC3)</i> <i>"Tax adjustments would also be an advantage to influence the retail price." (FC1)</i> <i>"Every EU country has its own regulations." (FC4)</i> <i>"Health claim regulation limits the market growth and product marketing." (FC1)</i> <i>"Prohibitive registration process for new product." (FC7)</i> <i>"Novel Food regulation is definitely something that inhibits products coming into the market." (FC9)</i>
Technology Development	<i>"Logistic difficulties due to cooling requirements." (FC4)</i> <i>"Still a lot of manual labor, low automatization and mechanization rate." (FC2)</i> <i>"Every machine production is an insane cost, time and space expenditure." (FC4)</i> <i>"A lot of know-how necessary for production." (FC5)</i> <i>"Limitations remain around upscaling while maintaining product quality and flavor complexity." (FC8)</i>
Human Resources	<i>"Normal Employee fluctuation." (FC2)</i> <i>"Staff with expertise in fermentation and plant-based production are more difficult to find." (FC8)</i>
Natural Resources	<i>"Organic farming is reaching its limits in the price area." (FC3)</i> <i>"Strong price variation of inputs." (FC4)</i> <i>"Regionality is a distance thing, rather than defined by borders." (FC2)</i> <i>"Supply chain disruptions or price fluctuations can have a direct impact on costs and production planning." (FC8)</i>
Research	<i>"Cooperations with start-ups instead of research institutes." (FC3)</i> <i>"It needs to be an improvement for both sides." (FC2)</i>

Source

Authors' own illustration based on the interview results

Notes

The dotted lines indicate connections in which the impediments outweigh the determinants.

Source

4.5 Limitations

Our qualitative research focuses on generating in-depth company-level findings rather than producing generalizable results (Flick, 2016; Polit & Beck, 2010). This focus, together with the heterogeneous characteristics of companies' manufacturing selling locations, may be seen as a limitation of this study. Moreover, during interviews, respondents may be reluctant to share detailed company strategies despite assurance of anonymity (Welch et al., 2002). This introduces the possibility of selective reporting or even potential greenwashing or bluewashing, to protect the company's sustainability related USP.

In addition, although we detected a saturation effect, a larger number of interviewed companies could have generated additional international insights about the fermentation market. Particularly, companies from the U.S. and Asia may have delivered different perspectives regarding technological, regulatory or market conditions. Despite these limitations, our study reveals meaningful patterns regarding determinants and impediments to innovation in fermentation companies. Our results can serve as a foundation for future quantitative studies involving broader samples and more generalizable insights, from which clearer policy implications to improve the business environment in the fermented food market can be derived.

5. Conclusion

As outlined in the previous section, the fermentation market in the European Union is experiencing significant growth, fueled by an increasing number of health-conscious consumers. However, several potential challenges, such as attitude-behavior gap or the possibility that current consumer interest only reflects a temporary hype, may hinder long-term development. The market's growing attractiveness has intensified competition, including the interest from companies outside the traditional fermentation sector. Nevertheless, the market is still considered a niche segment. A consistent theme across the companies is that consumers highly value product quality, organically produced ingredients, and transparency. At the same time, companies raise concerns about greenwashing and consumer deception, which could jeopardize trust and market credibility.

Governmental regulations, particularly the European Health Claim Regulation, are perceived as limiting companies' marketing possibilities. Companies stress the need for a more uniform and supportive regulatory environment across the European Union. Furthermore, although cooperation with academic institutions is generally viewed positively, companies emphasize that such partnerships are pursued only when they are mutual beneficial.

Based on these findings, policy frameworks should be adapted to enable more flexible and evidence-based communication of product benefits. In light of regulatory constraints and rising competition, companies should develop robust unique selling propositions that extend beyond the digestive health benefits of fermentation. Companies should consistently emphasize high product quality, transparent sourcing of ingredients, appealing taste, and excellent customer service. At the same time, consumers are encouraged to critically evaluate marketing claims and remain aware of the potential for greenwashing in this growing sector.

Future studies should extend their geographic scope to include fermentation companies outside the EU, particularly in the United States, where many health food trends originate. Additionally, quantitative research would be valuable for testing and generalizing the qualitative insights presented in this study. More in-depth interviews could also examine internal business metrics, such as profit margins and sourcing strategies (e.g., local versus imported ingredients), although access to such information may be restricted by companies' confidentiality concerns.

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Ethics declaration

Ethics committee approval was not required for this study because it involved professional expert interviews and no sensitive personal data were collected. All participants were informed about the purpose of the study, the recording and processing of the interviews, data confidentiality, and their right to withdraw. Informed consent was obtained from all participants prior to the interviews.

Declaration of generative AI use

During the preparation of this work the authors used ChatGPT to support language editing and wording. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Declarations

Author Contribution

Jost Kamphaus: Conceptualization, Methodology, Data curation, Visualization, Writing - original draft, Project administration
Jutta Roosen: Supervision, Writing - review & editing
Stefan Hirsch: Conceptualization, Supervision, Writing - review & editing

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Footnotes

1. Global fermented food market was valued in 2022 at 575 billion U.S. dollars (including beverages such as Kombucha) (Statista (2025b), the global food market is valued at 7,481 billion U.S. dollars and the beverage markets in 2022 at 1,600 billion U.S. dollars in alcoholic drinks and 1,490 billion non-alcoholic drinks (Statista (2025a). Resulting in a market share of $(575 / 10,571) \approx 5\%$.
2. Location cannot be named within our paper since there is only a small number of fermentation companies and therefore naming the location could allow for a direct identification of the company.
3. According to BÖLW (2025) Germany has around 2,000 organic retailers and according to BMEL (2025) the overall number of retailers is around 36,500 retailers, therefore the market share is around 5%.

Figures

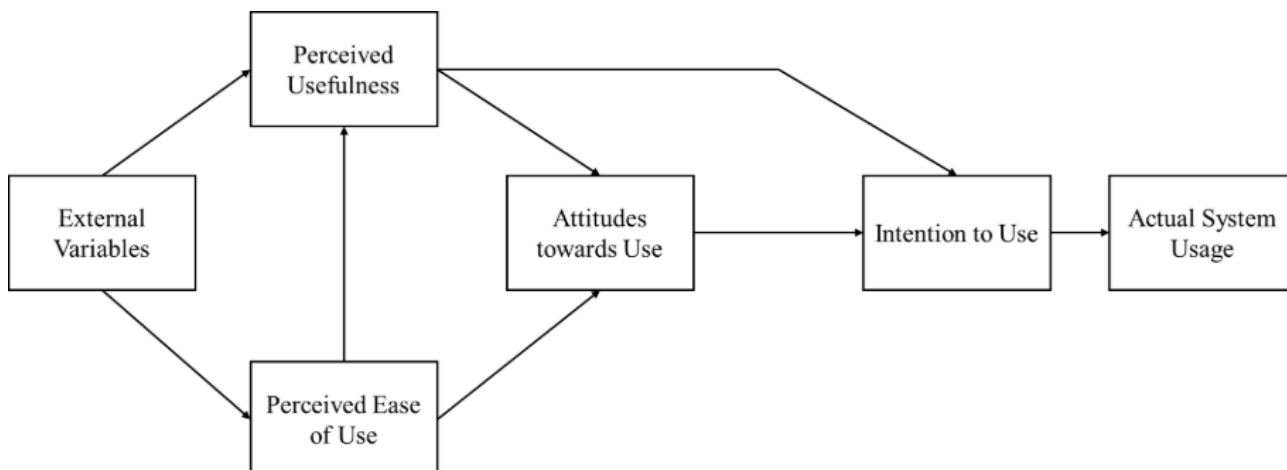


Figure 1

Original Technology Acceptance Model (TAM)

Source: Own illustration based on Davis (1986)

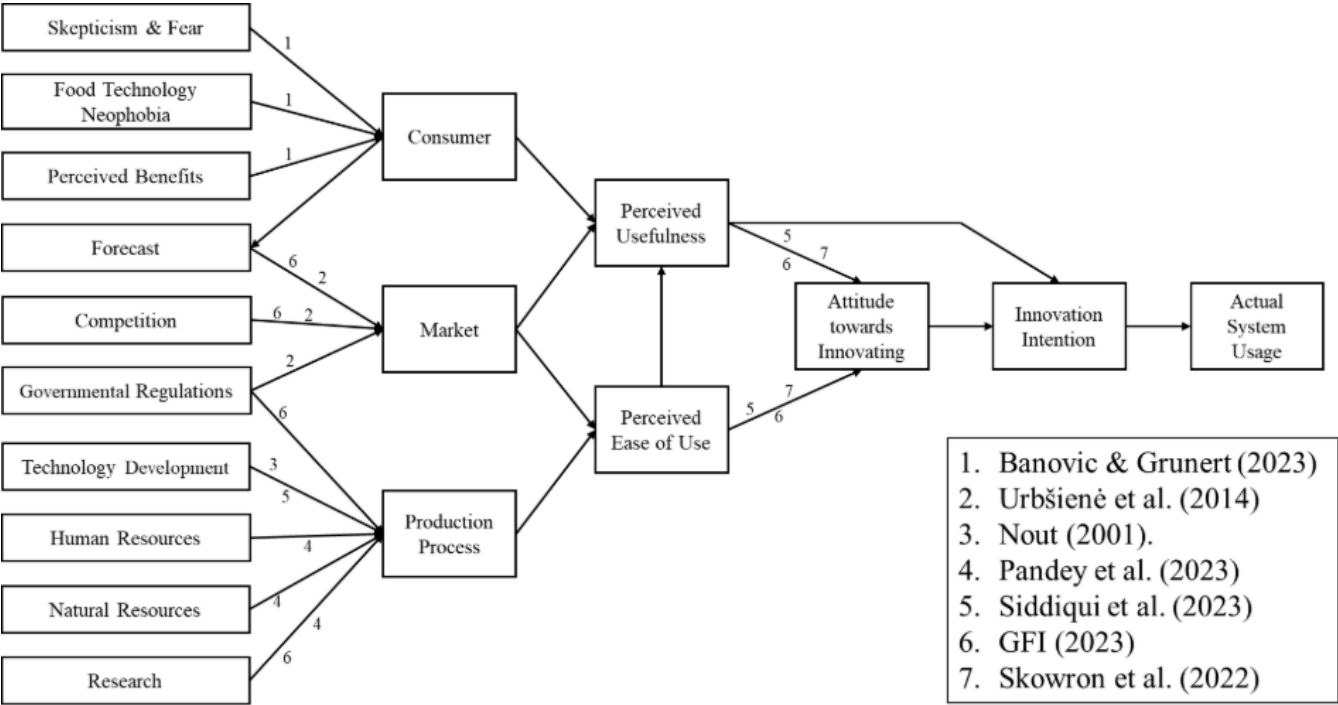


Figure 2

Adapted TAM Framework for Innovation in Fermentation Companies

Notes: Numbers indicate the respective source from the box. Those sources validate the connection between the two boxes.

Source: Authors' own illustration based on the literature shown in the box.

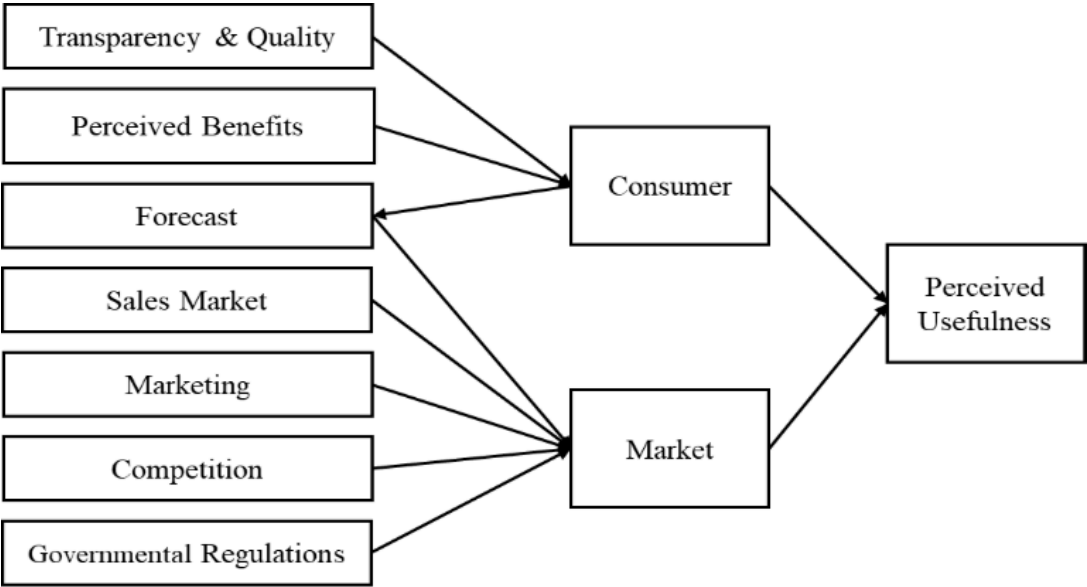


Figure 3

Perceived Usefulness of Fermented Food Products

Source: Authors own illustration

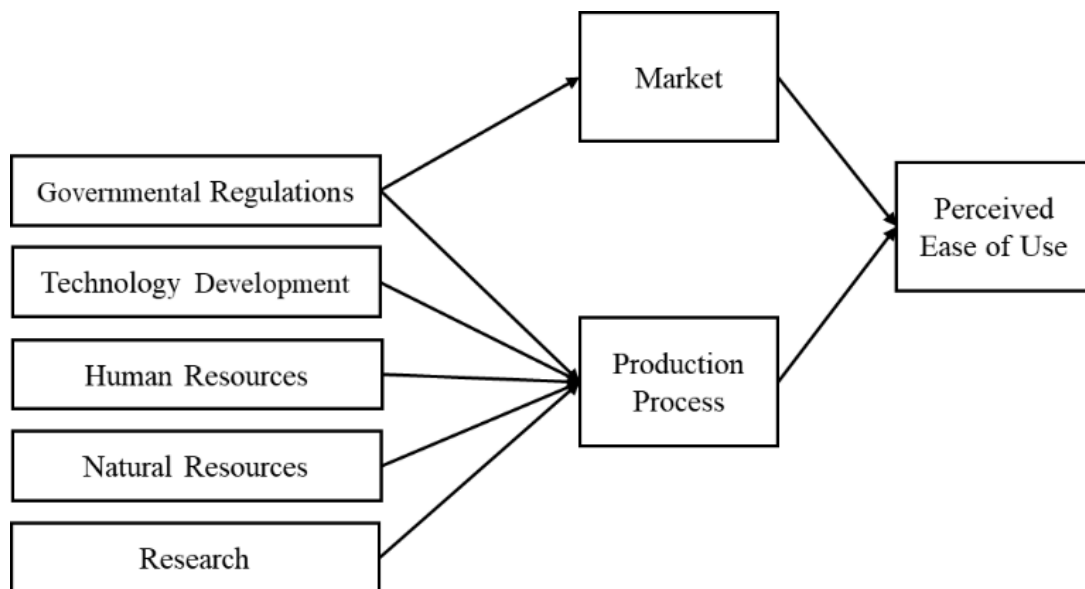


Figure 4

Perceived Ease of Use of Fermented Food Products

Note: Impediments and determinants of the *Market* category are the same like in Figure 3.

Source: Authors own illustration.

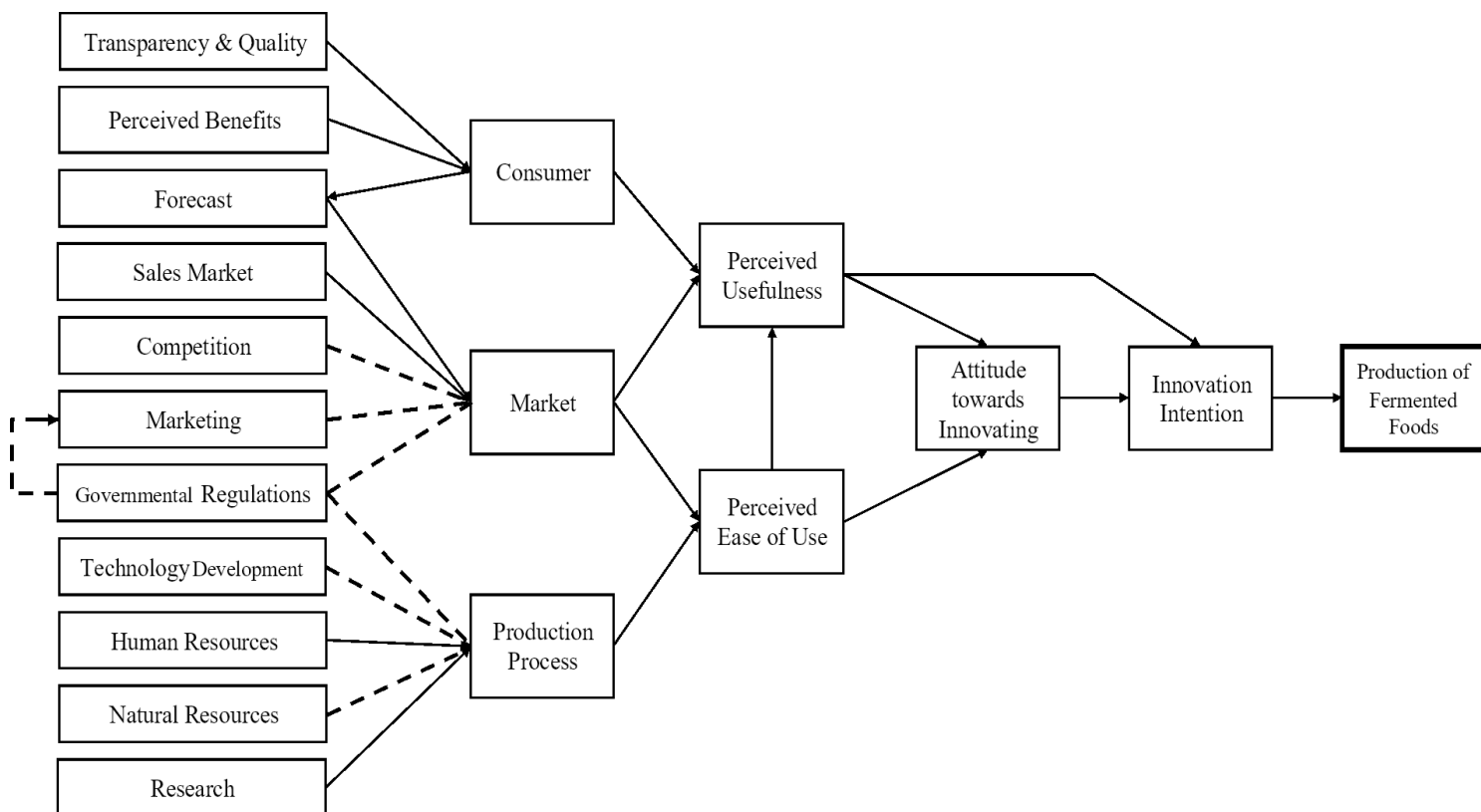


Figure 5

Interview-based adapted TAM model of the determinants and impediments of innovation in fermentation companies

Notes: The dotted lines indicate connections in which the impediments outweigh the determinants.

Source: Authors' own illustration