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SALLING MELISSZA

Supply Chain Disruption in Fresh Produce Swine Industry: Impact and Mitigation of Disruption

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1. THE PRELUDE OF THE RESEARCH WORK

In the dissertation, I investigate supply chain disruptions with a special emphasis on the African swine fever (ASF) outbreak. Through the research, I aim to illustrate its impact on the domestic market from a stakeholder perspective, and dig into consumer eating pattern changes towards pork.

The pig business serves as an example of more general issues with fresh food supply chains, where disease risks, demand swings, and perishability call for effective mitigation techniques. Recent disruptions, such as the foot-and-mouth disease outbreak in Hungary in 2025 (Nébih, 2025), further highlight the need to present and publish this research. Even if supply chain efficiency has increased due to managerial innovations and technical improvements (Ivanov et al., 2019), systemic vulnerabilities still exist, especially in the face of cross-border crises like the ASF outbreak.

Meat, especially pork, is a vital source of protein in global diets, with consumption patterns deeply influenced by cultural, economic, and demographic factors (Verbeke et al., 2010). However, the stability of meat supply chains is increasingly threatened by external disruptions, including disease outbreaks, trade conflicts, and geopolitical instability (Li et al., 2021). Among these, the ASF epidemic has had devastating consequences for pork production, triggering market volatility, supply shortages, and shifts in consumer behaviour (Salling, 2025). Given pork's economic and dietary significance—especially in China, the world's largest producer and consumer (FAO, 2019), and Hungary, a historically pork-reliant country (Marczin, 2023)—understanding the impacts of ASF on supply chains is critical for ensuring food security, economic resilience, and sustainable agribusiness practices (Salling, 2025).

Few studies offer a comparative study of ASF's implications across multiple markets or empirically evaluate mitigation methods for swine supply chains, even though existing literature extensively investigates consumer adaptability (Verbeke et al., 2010) and supply chain hazards (e.g., Li et al., 2021). The present research fills this gap by examining how ASF has affected and would affect the supply chains for pork in Hungary, with an emphasis on trade adjustments, price volatility, production losses, and consumer eating pattern changes towards pork with from a complex viewpoint. In addition, the present study examines how changes in supply shortages due

to disruption affect consumer preferences and buying patterns towards pork. The research proposes a framework for supply chain resilience by incorporating case studies and qualitative and quantitative modelling.

By enhancing the literature on supply chain risk management, particularly for perishable goods, and by integrating multidisciplinary perspectives from logistics, economics, and agribusiness, this study advances the theoretical understanding. It provides useful information for industry stakeholders (e.g., diversification strategies), policymakers (e.g., disease containment methods), and international food security initiatives. The emphasis on China and Hungary, two disparate but linked markets, allows for the development of generalizable lessons for other areas dealing with comparable crises. This study's theoretical rigour is increased by the incorporation of management science and innovation, which also guarantees that the results are useful and applicable to actual and real situations.

1.1. Literature review and the connection with previous findings on the topic

Londe and Masters (1994) define the supply chain as a collection of autonomous businesses, including raw materials, manufacturers, producers of intermediate goods, producers of finished goods, wholesalers, distributors, retailers, and consumers. Food supply, demand and consumption are also influenced by the factors affecting food production and shifts in consumer preferences (Yuen et al., 2020).

Pork accounts for roughly 40% of total global meat consumption (Statista, 2023). It is projected that the global pork market will reach USD 418.37 billion by 2028 (Sumesh & Roshan, 2020). Over one-third of the world's meat products come from China's pig production system (Zhu & Chen, 2018). According to the research of Salling (2025), pig is the most consumed meat type among Chinese people, with 31.7 kg per capita consumption. Hungary's lifestyle revolves around pork, and the country's deep-seated custom of rearing and consuming pigs is part of its heritage, too (Challenges and Opportunities of the Pig Sector in Hungary, 2021; Salling et al., 2025).

People are gradually changing their eating habits, which can be impacted by many factors, including personal values, national ethics, pricing, food safety measures, and last but not least,

unexpected events, such as animal disease outbreaks and natural disasters, among others (Li et al., 2021). Beltrán-Alcrudo et al. (2017) state that ASF is a transboundary infection with a fatality rate of almost 100%, and it spreads across both domestic and wild hog populations. In August 2018, ASF first appeared in China (Beltrán-Alcrudo et al., 2017). According to the Chinese Ministry of Rural Affairs (MARA, 2019), the estimated economic loss from reduced breeding and culling is USD 681 million. Pork prices have grown considerably over the years due to unanticipated transitory circumstances (Salling, 2025). Based on findings of Salling (2025), three assumptions were tested through empirical analysis: (i) the Chinese market was significantly damaged by the ASF virus outbreak; (ii) a negative relationship between the level of hog meat prices and the reduction in pork production can be seen as a result of the disruption; (iii) a shift in the price level is likely to result in a demand change. In April 2018, the ASF virus outbreak happened in Heves County, Hungary (Boklund et al., 2014), and so far only appeared in wild boar populations (Nébih, 2024). Hungary faced export restrictions after the announcement of ASF; as a result, shipments of live pigs decreased quantifiably (Nébih, 2024).

In case of disruptions, understanding how demand is distributed can help coordinate the interrupted supply chain (Wen et al., 2019). Option contracts have previously been a useful instrument for risk hedging (Turvey, 2001). The study of Yu et al. (2021) determines the ideal wholesale price, marginal profit, food safety investment, and government subsidies; moreover, it also creates a three-stage game model between the government, supplier and processor. According to Yan et al. (2017), companies that had more digital technology assets, such as blockchain, cloud computing, big data analytics, the Internet of Things (IoT), and artificial intelligence (AI), performed better in their supply chains throughout the crisis. The study provides public-based quality management systems and private-based quality management systems as an essential step to overcome supply chain disruptions (Trienekens and Wognum, 2013). Mu and McCarl (2010) concluded that, in 2004, depopulation was the most economical control technique to combat avian influenza in Texas. In Southeast Asia, to stop chickens from moving, quarantine zones were created (Duan et al., 2023). The Chinese political system underwent a major transformation in 2018 (MARA, 2019) to combat ASF by raising the degree of biosecurity protection and putting preventative measures in place in pig farms (Sur, 2019). To stop and prevent the ASF outbreak,

the European Union and Hungary have put in place several rules and limitations (Nébih, 2024): inspections, notifying impacted businesses and persons, and other eradication actions.

One of the other factors influencing people's buying intentions is food risk (Prati et al., 2012). When buying meat in a retail establishment, the majority of customers regarded pricing and quality as the most crucial considerations (Rani et al., 2013). In addition, consumers' choice of protein source when buying meat was influenced by their income (Rani et al., 2013). Consumers who buy unusually large quantities or a wide variety of products following a disaster or perceived disaster, or in anticipation of a significant price increase or upstream shortage, are known to engage in panic buying (Yoon et al. 2017; Yuen et al. 2020). Understanding how consumers make decisions is essential when looking at examples of how their behaviour changes in reaction to financial crises or natural disasters (Lester, 2013). Maslow's Hierarchy of Needs (1943) could be applied because the pyramidal hierarchy illustrates how consumer behaviours are categorised and which categories are thought to be most important for human existence, with a special view in times of crisis (Lester 2013). Mass media are crucial in shaping, reshaping, and guiding public opinion (Yang et al. 2019). Numerous animal diseases, including avian influenza, mad cow disease (BSE), and others, have had multifaceted economic effects in recent decades, necessitating an efficient governmental response (Rich et al., 2011). Additionally, they have caused customers to worry about the quality and safety of food, which could result in a decline in the market share of food (Knox, 2000). From the standpoint of consumer mindset, there is a positive and statistically significant effect, meaning that customers will buy fewer chicken products the more they think doing so could endanger their health (Wen et al., 2019). It was found by Wen et al. (2019) that there is a statistically significant correlation between purchase intentions and the following factors: perceived risk of contracting avian influenza, media coverage, the provenance of chicken products, pessimism, and potential health threats. Both short- and long-term consumer expenditure allocations among meats were significantly impacted by media indices associated with BSE (Burton & Young, 1996). According to Lee et al. (2022), even though ASF is not a food safety concern, 46% of pork consumers would not buy pork if there were an outbreak in the United States. Tang et al. (2021) discovered that in the downstream market, the customer's price sensitivity has the biggest impact on the link between supply and demand.

2. THE OBJECTIVES OF THE STUDY

In general, if disruptions occur in the supply chain, they directly and indirectly affect the players, especially the end-users, of the chain (Salling, 2024). Study objectives (O1, O2, O3, O4, O5, O6, O7, O8, O9) were created in line with the main hypotheses and research questions of the study. The first two pertain to the literature evaluation and secondary research, while the third, fourth, fifth, sixth, seventh, eighth, and ninth pertain to our empirical research. Using both secondary and primary research aims, this study thoroughly examines the complex effects of ASF on the pork sector and consumer behaviour. The study’s initial goals are to determine the main reasons for supply chain interruptions in the swine industry, with an emphasis on the domestic and Chinese pork markets (O1), and to investigate the relationship between ASF outbreaks, shifts in consumer behaviour, and the efficacy of existing mitigating measures (O2). The main study explores domestic pork consumption attitudes and preferences (O3), how ASF-related disruptions affect consumer preferences and behaviours (O4), and how a welfare concept is developed around these behavioural changes (O5). The study also aims to develop models that clarify the factors influencing pork choice during ASF outbreaks (O6) and the economic effects of ASF on the Hungarian pork market (O7). Moreover, to introduce managerial-level mitigation measures for potential ASF outbreaks (O8) and to investigate innovation and innovation management in this context (O9), the study also aims to put a highlight on the subject. The research objectives were formulated and summarised in **Table 1**.

Table 1: Summary of the objectives of the study

Objectives related to secondary research	
O1	Introducing and examining the main causes of supply chain disruptions in the fresh produce swine sectors, by highlighting the pork market at the domestic and Chinese levels.
O2	Exploring the connections between ASF outbreaks and consumer behaviour changes, as well as assessing the industry’s suitability and the efficacy of current mitigating techniques on a managerial level.
Objectives related to primary research	
O3	Exploring the preferences and attitudes related to pork consumption at the domestic level in connection with the influencing factors.
O4	Examining how consumer tastes and behaviours are being affected by ASF-related swine sector disruptions.
O5	Building a welfare idea regarding the changing behaviours due to ASF.
O6	Building a model on the influencing factors impacting pork choice during an ASF outbreak.
O7	Building a model of the economic effects of the ASF outbreak in the Hungarian pork market.
O8	Introducing measures to mitigate a possible ASF outbreak on the managerial level in the domestic market with qualitative techniques.
O9	Exploring innovation and innovation management from a complex viewpoint of the primary research regarding the topic.

Source: Own research, 2025

One of the criteria for picking the present topic was to look at facts that affect our daily lives, lifestyle, health, and quality of life. Pork is one of the most often consumed meats and is traditionally consumed in Hungary (Marczin, 2023). Disruptions like the ASF outbreak could deeply affect business strategies and the supply-demand side. The bibliometric analysis and the goal of the research determine which secondary and primary research methods are used. The comprehensive account of circumstances, incidents, and observed behaviour is the foundation of the secondary research methodology. Primary research was also conducted, which included both qualitative and quantitative data. In addition to developing novel scientific findings, the goal in writing the present dissertation was to fill the above-mentioned research gap and add to the scant literature from which different industries, particularly pork businesses, and other scientific areas, such as management science, veterinary science, marketing science, risk-management science, among others, could benefit. **Table 2** summarises the research questions of the study, which need to be solved during the analysis period.

Table 2: Summary of research questions

RESEARCH QUESTIONS	DESCRIPTION
Q1	Which factors can be impacted by a supply chain disruption?
Q2	How does the ASF outbreak impact the supply-demand balance in China and Hungary?
Q3	How to mitigate and coordinate fresh produce supply chain disruption in the case of an ASF outbreak?
Q4	What are the trends in meat consumption in Hungary, considering pork?
Q5	How do consumers change their consumption patterns due to disruption shocks, especially due to ASF?
Q6	What kind of innovations can be derived from the topic?

Source: Own research, 2025

By answering the research questions, we aim to forecast the anticipated responses of customers regarding pork, especially when the ASF outbreak disrupts the supply chain in the Hungarian market. By assuming a certain consistency between past, present, and future behaviour, estimating the future from the past and present, and enquiring about future intentions, we can gain insight into consumer reactions in the case of the ASF outbreak in the swine market.

3. MATERIALS AND METHODS

This chapter presents the theoretical underpinnings and empirical instruments that can be used to debate and examine the research topic while considering the research problem and the methods currently available for its investigation. The main goal of secondary data collection is to find, gather, organise, and synthesise existing data on the subject to provide a frame for the study. Statistical indices, trend analyses, base and chain ratios, and comparisons with similar datasets are evaluated. Numerous studies were conducted to ascertain the nature of disruption in the supply chain with a specific focus on the ASF, its existence in the Chinese and Hungarian markets, and the disease’s influence on the price distribution of pig meat and other meat types, consumption pattern changes, and to develop a comprehensive defence for the examination of the subject matter. Qualitative and quantitative research were the two categories into which the initial data collection was separated to conduct the primary research.

3.1. Qualitative research

A semi-structured in-depth interview was conducted on a managerial level with Bonafarm Group. Since the survey was anonymous at the company’s request, the identity, position, and division of the interviewees will not be disclosed either during or after the survey’s evaluation. The qualitative research was rewritten and translated conceptually, and provided a complex overview of the subject matter by combining the results received from the survey with those addressing segmented topics. Only approved information from Bonafarm is used in the results. The hypothesis and methodology regarding the qualitative research are summarised in Table 3, also divided by the objectives, and highlighting the method of analysis.

Table 3: The hypotheses and methodologies of the qualitative research and in-depth interview

OBJECTIVE	HYPOTHESIS	SAMPLING METHOD	TOPIC	ANALYSIS METHOD
O8 O9	H1 The corporate business has set prevention methods and mitigation techniques for possible ASF outbreaks.	Qualitative, in-depth interview	Biosecurity measures	Content analysis
O4 O7 O8	H2 The Chinese pork market disruption impacted the domestic pork market in the chosen corporate business due to ASF.	Qualitative, in-depth interview	Trade and consumption	Content analysis
O8 O9	H3 Adopting supply chain diversification (e.g. multiple regional sources) and innovation technologies (e.g. Internet of Things) positively impacts consumer trust and mitigates disruption.	Qualitative, in-depth interview	Commerce activities	Content analysis

Source: Own research, 2025

3.2. Quantitative research

A heterogeneous snowball sampling approach was employed, initiating with a seed population of Óbuda University students and peers, who then referred additional participants through their networks. This non-probability method was selected due to the niche nature of the target population (pork consumers during hypothetical disease outbreaks), budget and time constraints for rapid data collection, and the need to access hard-to-reach consumer segments to capture diverse pork consumers across Hungary. With the seed's initial participation, we were able to increase the sample size and collect data on a national level. Quota monitoring was conducted, meaning regular checks were conducted to prevent overrepresentation of any single demographic. No exclusion criteria were applied, ensuring broad participation but risking self-selection bias (e.g., overrepresentation of younger, educated demographics, network homophily). A standardised, pre-tested online questionnaire (in Hungarian) targeted pork consumers, focusing on behavioural intentions during a hypothetical ASF outbreak, was used as the sampling instrument. For validation, pre-testing with a pilot sample (20 respondents) refined question clarity and reduced ambiguity. However, the lack of probabilistic sampling limits inferential generalizability. The survey's unique scope—pork-specific consumption and consumption shifts under crisis—required hypothetical scenarios, which may introduce hypothetical bias (divergence from real-world behaviour). It was an unintentional one-time survey, published on various online platforms and questionnaire filling groups on social media to target nationwide sample population. Primarily, closed-ended questions were utilised following the traditional 4Ps model (i. Product, ii. Place, iii. Price, iv. Promotion). The close-ended questions contained both nominal (single- and multiple-choice selective questions) and metric level questions as well (Likert and semantic differential scales). 331 evaluable questionnaires were produced.

Using SPSS 27.0 software, the quantitative findings were processed, and the hypotheses were tested using descriptive statistics, bivariate, and multivariate analyses. The analysis of variance (ANOVA) approach for comparing multiple sample means was utilised to look at the correlation of the data measured on the metric scale. For some assumptions, the Chi-square test was used, and the internal relations were measured with the Adjusted Residuals crosstab approach. Only the groupings of background variables that showed significant associations at a 95%

confidence level are described, though. In terms of segmentation, factor and cluster analysis were conducted with varimax, and Kaiser-Meyer-Olkin (KMO) index testing in multivariate statistical studies. Segmentation was run with K-means cluster analysis. The hypothesis and methodology regarding the qualitative research are summarised in **Table 4** and provide an overview of the specifications.

Table 4: The hypotheses and methodologies of the quantitative methods and standardised survey

OBJECTIVE	HYPOTHESIS	TOPIC	SURVEY QUESTION	LEVEL OF MEASUREMENT	METHOD OF ANALYSIS
O3	H4: There are characteristic differences in meat consumption among age groups, specifically with the young generation consuming more chicken.	General meat consumption	III/1	Nominal	Chi-squared test; Adj. Res.
O3	H5: Segments formed based on pork consumption frequencies can be well-defined based on primary characteristics.	Pork consumption trends	III/3	Nominal	Chi-squared test; Adj. Res.
O3	H6: Consumers' pork purchasing behaviour is segmented by income level, with lower-income groups prioritising cheap prices and bulk purchases, while higher-income groups focus on quality.	Pork consumption trends	III/4, 5, 8	Interval (1-4)	ANOVA, descriptive statistics
O3	H7: Age correlates with the importance placed on freshness and Hungarian pork origin, with the older generation putting more importance on them than the younger aged.	Pork consumption trends	III/4, 5, 8	Interval (1-4)	ANOVA, descriptive statistics
O3	H8: The source of pork is determined by the type of place of living, specifically village areas, showing a stronger preference for home-breeding and direct-from-producer sourcing.	Pork consumption trends	III/6, 7	Nominal	Chi-squared test; Adj. Res.
O4 O6	H9: Individuals who believe that ASF poses a health concern are more likely to stop or discontinue their pork purchases.	Pork consumption pattern changes due to disruption	III/9	Interval (1-4)	ANOVA, descriptive statistics
O4 O6	H10: Attitudes towards pork consumption after an ASF outbreak can be segmented based on (1) health concerns, and continued purchase to (2) prior pork consumption frequency.	Pork consumption pattern changes due to disruption	III/9	Interval (1-4)	ANOVA, descriptive statistics
O4 O6	H11: Consumers' continued pork purchase after an ASF outbreak can be segmented based on typical sourcing, with home-breeding and direct-from-producer sourcing tend to exhibit more resilient patterns, while retail purchasers are less resilient.	Pork consumption pattern changes due to disruption	III/9	Interval (1-4)	ANOVA, descriptive statistics
O4 O5 O6	H12: Price sensitivity during an ASF among consumers can be characterised and segmented, with consumers either ceasing purchases or adjusting demand in response to price fluctuations.	Pork consumption pattern changes due to disruption	III/9	Interval (1-4)	ANOVA, descriptive statistics; Hierarchical Cluster, Factor and Cluster analysis
O4 O5 O6	H13: During an ASF outbreak, lower-income consumers (especially those struggling financially) are significantly more willing to purchase reduced-price pork—both raw and processed—than higher-income consumers, as price outweighs perceived health risks.	Pork consumption pattern changes due to disruption	III/9	Interval (1-4)	ANOVA, descriptive statistics
O4 O5 O6 O9	H14: The source of information flow about the ASF outbreak has a significant impact on consumers' choice to stop or continue purchasing pork during the ASF outbreak.	Pork consumption pattern changes due to disruption	III/9	Interval (1-4)	Dichotomisation; ANOVA, descriptive statistics

Source: Own research, 2025

4. NOVEL SCIENTIFIC RESULTS AND DISCUSSION

My doctoral thesis's objective was to determine and examine how ASF could impact the market, especially in the view of stakeholders and end-users. In addition to exploring a model that can be utilised in future real-world cases, the aim was to provide a complex overview and resilience options to prevent and mitigate such disruptions in the supply chain by understanding the key drivers (i.e. consumers), driving factors and motivation in case of disruption and shock. The following novel scientific results were formulated based on the results.

1. I determined the mitigation options in case of disruption in the supply chain based on the synopsis of the theoretical background on a managerial level. **N1**

I compiled the findings of national and international research and models that looked at the variables of mitigating, especially animal disease outbreaks, after a disruption happens in the market.

2. I determined the consumer pattern changes towards pork in the case of disruption in the supply chain based on the synopsis of the theoretical background. **N2**

I compiled the findings of national and international research and models that looked at the variables influencing the fresh food choice of pork after disruption happens in the market.

3. I developed my own study model on the mechanism of action at the managerial level when disruption happens in the supply chain **N3**

Developing a theoretical model for the mitigation and coordination of disruption was one of my thesis's primary goals. I developed my elemental mitigation model by describing the private and public sector's reaction steps to disruption, by the combination of collaboration. After the qualitative phase of the empirical research and the conclusions, it took the shape of a final research model. With the help of my quantitative study, I could demonstrate the connections between the variables in the research model or understand the market's driving factor.

4. I developed my own study model on the mechanism of consumers' changing pork choice patterns due to disruption in the supply chain. **N4**

Developing a theoretical model of influencing factors on consumers' pork choice during disruption was one of my thesis's primary goals. I developed my elemental model by describing how consumers would react to disruptions in their eating patterns, and also by interpreting the influencing internal and external factors based on the hierarchy of needs. After the qualitative and quantitative phases of the empirical research and the conclusions, it took the shape of a final research model. With the help of my quantitative study, I could demonstrate the connections between the variables in the research model and understand it more deeply.

5. I classified the sample according to individual price sensitivity and determined the factors that influence the choice of pork in the case of a hypothetical ASF outbreak. **N5**

In light of other findings from my empirical research, I was able to create consumer target groups that are distinct from one another in terms of price sensitivity during a disruption.

6. I classified the sample according to individual demand shifts on either ceasing or adjusting demand based on price shifts due to the ASF outbreak. **N6**

In light of other findings from my empirical research, I was able to create consumer target groups that are distinct from one another in terms of completely rejecting and avoiding continued pork purchase or adjusting demand on the basis of price fluctuations due to the ASF outbreak.

4.1. Thesis and summary of the results

During the conducted literature search, it can be stated that pork consumption research supplemented by complex network analysis of consumer pattern changes and suppliers' impact and resilience due towards disruption in light of ASF has not yet been masterminded. After presenting the theoretical part of my research, I explained the research plan, the data collection and data cleaning process, and the applied qualitative and quantitative methods. After presenting the methods, I conducted the research, as a result of which I detailed the conclusions obtained by the statistical methods. As a result of my doctoral dissertation, I formulated the following main thesis (T).

T: Pork supply chains and consumer behaviour are severely disrupted by the ASF outbreak, although resilience can be increased by proactive corporate mitigation measures (such as biosecurity measures, diversified sourcing, and AI-driven monitoring). On the consumer side, crisis responses fracture along three main axes: (1) price sensitivity (lower-income group prioritize affordability over health risks), (2) health risk perceptions (avoidant behaviour and price-sensitive active risk-averse behaviour), and (3) present pork consumption and sourcing patterns (frequent pork consumers and home-breeding/direct-from-producer sourcing foster trust and demand stability). **(Related scientific publications: 1, 2, 3, 4, 5, 6, 7)**

The qualitative (H1–H3) and quantitative (H4–H14) findings intersect around ASF impacts and adaptive strategies. The single thesis positions the research as a holistic contribution to crisis management in agribusiness, since it aims to bridge managerial decision-making and consumer behaviour theory.

Table 5 provides an overview and summary of the results and tested hypotheses, which served as a basis for formulating the thesis.

Table 5: Summary of the thesis findings, methods and novel scientific results

Qualitative research								
OBJECTIVE	HYPOTHESIS	SAMPLING METHOD	ANALYSIS METHOD	TOPIC	RESULT	INNOVATION	NOVEL SCIENTIFIC RESULTS	ACCEPT OR REJECT
O8	H1: The corporate business has set prevention methods and mitigation techniques for possible ASF outbreaks.	Qualitative, in-depth interview	Content analysis	Biosecurity measures	Bonafarm has strict regulations and preventive matrices	I1 I4	N1 N3	accept
O4 O7 O8	H2: The Chinese pork market disruption impacted the domestic pork market in the chosen corporate business due to ASF.	Qualitative, in-depth interview	Content analysis	Trade and consumption	Decline in Hungarian pork exports towards China	I3	N1 N3	accept
O8	H3: Adopting supply chain diversification (e.g. multiple region sources) and innovation technologies (e.g. Internet of Things) positively impacts consumer trust and mitigates disruption.	Qualitative, in-depth interview	Content analysis	Commerce activities	Bonafarm uses new tech. to mitigate the ASF impact	I2 I4 I5	N1 N3	accept
Quantitative research								
OBJECTIVE	HYPOTHESIS	TOPIC	SURVEY QUESTION AND LEVEL OF MEASUREMENT	ANALYSIS METHOD	RESULT		NOVEL SCIENTIFIC RESULTS	ACCEPT OR REJECT
O3	H4: There are characteristic differences in meat consumption among age groups, specifically with the young generation consuming more chicken.	General meat consumption	III/1, nominal	chi-square test, Adj. Res.	The younger generation chose chicken (p <0.001) in the biggest ratio as the priority.		N2 N4	accept
O3	H5: Segments formed based on pork consumption frequencies can be well-defined based on primary characteristics.	Consumer trends	III/3, nominal	chi-square test, Adj. Res.	Gender (p =0.001), education (p <0.001), show significance; others (marital status, settlement type, income, etc.) have no significance		N2 N4	partially accept
O3	H6: Consumers' pork purchasing behaviour is segmented by income level, with lower-income groups prioritising cheap prices and bulk purchases, while higher-income groups focus on quality.	Consumer trends	III/4, 5, 8, interval (1-4)	ANOVA, descriptive statistics	Lower-income individuals place higher concerns on price than quality (p <0.001); rather choose new but cheaper products (p <0.001); and buy in bulk (p = 0.005).		N2 N4	accept
O3	H7: Age correlates with the importance placed on freshness and Hungarian pork origin, with the older generation putting more importance on them than the younger aged.	Consumer trends	III/4, 5, 8, interval (1-4)	ANOVA, descriptive statistics	Older generation respondents, put a higher importance on freshness (only processed pork: p =0.006), and on Hungarian-origin products (p <0.001).		N2 N4	partially accept

O3	H8: The source of pork is determined by the type of place of living, specifically village areas, showing a stronger preference for home-breeding and direct-from-producer sourcing.	Consumer pattern changes due to disruption	III/6, 7, nominal	chi-square test, Adj. Res.	People in rural areas appear to source from home-breeding or directly from producers (only raw pork: $p=0.002$)	N2 N4	partially accept
O4 O6	H9: Individuals who believe that ASF poses a health concern are more likely to stop or discontinue their pork purchases.	Consumer pattern changes due to disruption	III/9, interval (1-4)	ANOVA, descriptive statistics	Higher risk perception reduces or stops continued pork purchase ($p \leq 0.006$).	N2 N4	accept
O4 O6	H10: Attitudes towards pork consumption after an ASF outbreak can be segmented based on (1) health concerns, and continued purchase to (2) prior pork consumption frequency.	Consumer pattern changes due to disruption	III/9, interval (1-4)	ANOVA, descriptive statistics	Higher risk perception reduces or stops continued pork purchase ($p < 0.001$); frequent consumers are more about to continue their consumption habits, regardless of price changes ($p \leq 0.038$).	N2 N4	accept
O4 O6	H11: Consumers' continued pork purchase after an ASF outbreak can be segmented based on typical sourcing, with home-breeding and direct-from-producer sourcing tend to exhibit more resilient patterns, while retail purchasers are less resilient.	Consumer pattern changes due to disruption	III/9, interval (1-4)	ANOVA, descriptive statistics	Home-breeder and direct-from-producer tend to continue purchasing after ASF, regardless of price shifts ($p \leq 0.037$)	N2 N4	accept
O4 O5 O6	H12: Price sensitivity during an ASF among consumers can be characterised and segmented, with consumers either ceasing purchases or adjusting demand in response to price fluctuations.	Consumer pattern changes due to disruption	III/9, interval (1-4)	ANOVA, descriptive statistics; Hierarchical Cluster, Factor and Cluster analysis	Clusters are characterised based on price sensitivity (price-sensitive group and price-ignoring group), and segmented based on consumer pattern changes (avoidant-hesitant buyers and price-sensitive active buyers) (all $*p \leq 0.001$)	N2 N4 N5 N6	accept
O4 O5 O6	H13: During an ASF outbreak, lower-income consumers (especially those struggling financially) are significantly more willing to purchase reduced-price pork—both raw and processed—than higher-income consumers, as price outweighs perceived health risks.	Consumer pattern changes due to disruption	III/9, interval (1-4)	ANOVA, descriptive statistics	Struggling consumers are more willing to buy cheapened pork due to the ASF outbreak ($p \leq 0.014$)	N2 N3 N4	accept
O4 O5 O6 O9	H14: The source of information flow about the ASF outbreak has a significant impact on consumers' choice to continue purchasing pork during the ASF outbreak.	Consumer pattern changes due to disruption	III/13, interval (1-4)	Dicotomisation, ANOVA, descriptive statistics	8 out of 56 testing show significance ($p \leq 0.040$), however, rather than being causal correlations, the observed associations most likely reflect endogenous consumer biases.	N2 N4	partially accept

Source: Own research, 2025

4.2. Model creation based on results – the Novel Scientific Results explained

The objective of the study is to formulate an own model (^{07, 08, 09}) which concludes the possible response to supply chain disruption on the managerial level, both in perspectives from the public and private sectors, and to understand how consumer eating patterns change in the case of disruption (^{03, 04, 05, 06}). Because, according to our knowledge, a similar model has not yet been formulated at the domestic level, we used several literature and our qualitative research from which we formulated our model. These references helped us by providing the model’s pillars, which are summarised in **Table 6**.

Table 6: Systematic literature review for mitigation model formulation and sub-areas

Model factor	Description	Reference
Profitability	The literature describes that companies and states always try to gain profitability in the market.	Kim and Tomlin (2013); Bonafarm Group
Demand learning	As consumers are the driving factors at the end of the supply chain, learning and interacting with them is inevitable.	Wen et al. (2019); Li et al. (2021); Salling (2025)
Management and risk management	An ideal management strategy could help mitigate and coordinate disruption.	Towney (2021); Xiao and Chen (2012);
Safety and investments	Safety and investments are inevitable in a growing business.	Yu et al. (2021);
Public support	Governmental responses are necessary to avoid big economic falls when disruption happens.	Yu et al. (2021);
New technology, AI and information flow	Innovation of modern lifestyles includes different high-tech solutions to coordinate the market.	Bottani et al. (2019); Wu et al. (2024); Hossain et al. (2017); Ivanov et al. (2019); Reynolds (2024); Etkowitz (2008)

Source: Author’s illustration

Figure 1 models the response and steps on the managerial level for supply chain resilience due to disruption. In terms of mitigation from the public sector, to decrease the negative effects on the economy or market, control measures need to be implemented. In the case of ASF, pig culling, protection zone application, and new behavioural techniques are all inevitable for the control of infected cases. By relieving the budget, the government can be prepared for such unexpected events. Moreover, which can elevate the partnership between the public and private sectors, is providing different incentives and projects for implementing modern technologies. That is how PPP is forming in case of disruption, which is an innovation initiative according to Etkowitz (2008). Partnerships between the public and private sectors that combine resources and knowledge to spur innovation are frequently under the direction of policy objectives (Etkowitz, 2008), especially when disruption affects the market (Yu et al., 2021).

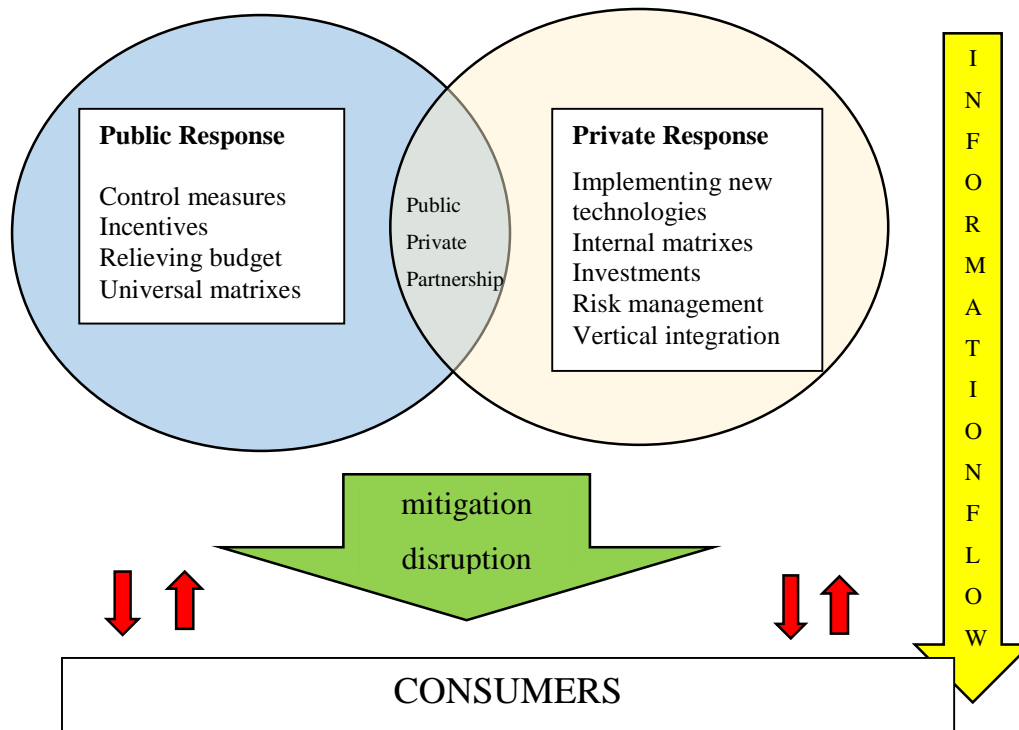


Figure 1: Modeling the managerial response due to disruption in supply chain resilience
Source: Own research (2025), based on qualitative results and Table 6

Government initiatives include tax breaks for research and development as well as direct public venture investments. Public venture programs fill up the gaps left by a lack of private investment, while policies like R&D tax credits assist businesses in high-risk industries (Etzkowitz, 2008). In the case of the private sector, it is inevitable to do internal matrices and risk management to mitigate disruption. Implementing new technologies and techniques, including AI initiatives, and innovative behaviour models, are all types of mitigating and coordinating disruption. Which we could see from our qualitative research. Bonafarm Group implements mitigation techniques such as an internal matrix, preventive measures, investments in new approaches, and so on, while implementing governmental requirements based on zone distribution, control measures and information flow across players. The bottom of the stage is the consumer who is highly dependent on some factors; since the economy's production, consumption, and trade sectors are all significantly impacted by outbreaks (Çakır et al., 2018), according to some experts, people's life

experiences—such as their values, character qualities, resources, and so on—have a major impact on their dietary decisions (Frost & Hartl, 1996). Food risk is also one of the other elements affecting people’s purchasing decisions (Prati et al., 2012). Therefore, consumers and the entrepreneurial stage back and forth impact each other. By the flow of information and transparency by using new technologies, the disruption impact can be directly mitigated. Digital technology is one type of business asset that organisations may utilise to provide end-to-end transparency and further reduce demand uncertainty during high-impact events (Ivanov et al., 2019).

Another model was created based on the previous literature and our quantitative research. The model’s objective is to have a broad overview of the psychological, social and economic influences on individuals, by which we can evaluate decisions when disruption happens. These references helped us by providing the model’s pillars, which are summarised in **Table 7**.

Table 7: Systematic literature review for consumer choice model formulation and sub-areas

	Model factor	Description	Reference
INTERNAL FACTOR	General driving factors	The literature describes the basic factors that drive individuals to choose a good, such as culture, habits, and family beliefs.	Fishbein (n.d.); Solomon (2024)
	Influencing factors	When choosing goods, besides the general factors, there are other influencing factors which impact choice (life experience, personal traits, personal values, etc.).	Prati et al. (2012); Forbes (2017)
	Fear of animal disease	The extent to which individual fear of animal disease poses a risk to personal health.	Çakır et al. (2018); Foster & Just (1989); (Weyl & Fabinger, 2013)
	Price sensitivity	Status and income influence the preferences of an individual.	Zamani et al. (2024)
	Psychological factors	Maslow’s hierarchy of needs in consumer behaviours is categorised, and which categories are thought to be most important for human existence. Psychological drivers.	Forbes (2017); Lester (2013); Samli (2012);
	Socio-economic aspect	Depends on the attributes of the country’s socio-economic factors to a broader extent (religion, values, etc.).	Taha (2207); Solomon (2024)
EXTERNAL FACTOR	Government policies and information flow	How does the government react to the economy, and society influence consumer choices, and the way it is communicated?	Yang et al. (2019); Pieri (2018); Bessler et al. (2008)
	Disruption impact	Unexpected events could indirectly impact the consumer choice (stock-out, perishability, safety, etc.).	Yoon et al. (2017); Yuan et al. (2020)
	Substitutes and the price of goods	Price fluctuation can cause changes in consumption habits, and the availability of other substitutes could reshape consumer patterns.	Foster & Just (1989); Zamani et al. (2024); Weyl & Fabinger (2013); Salling (2025)

Source: Author’s illustration

Figure 2 is a graphic representation of a hierarchy of requirements and decision-influencing elements, based on Maslow's Hierarchy of Needs and expanded to incorporate other decision-making-related factors. It models how consumer food choice patterns change due to disruptions throughout Maslow's hierarchy of needs.

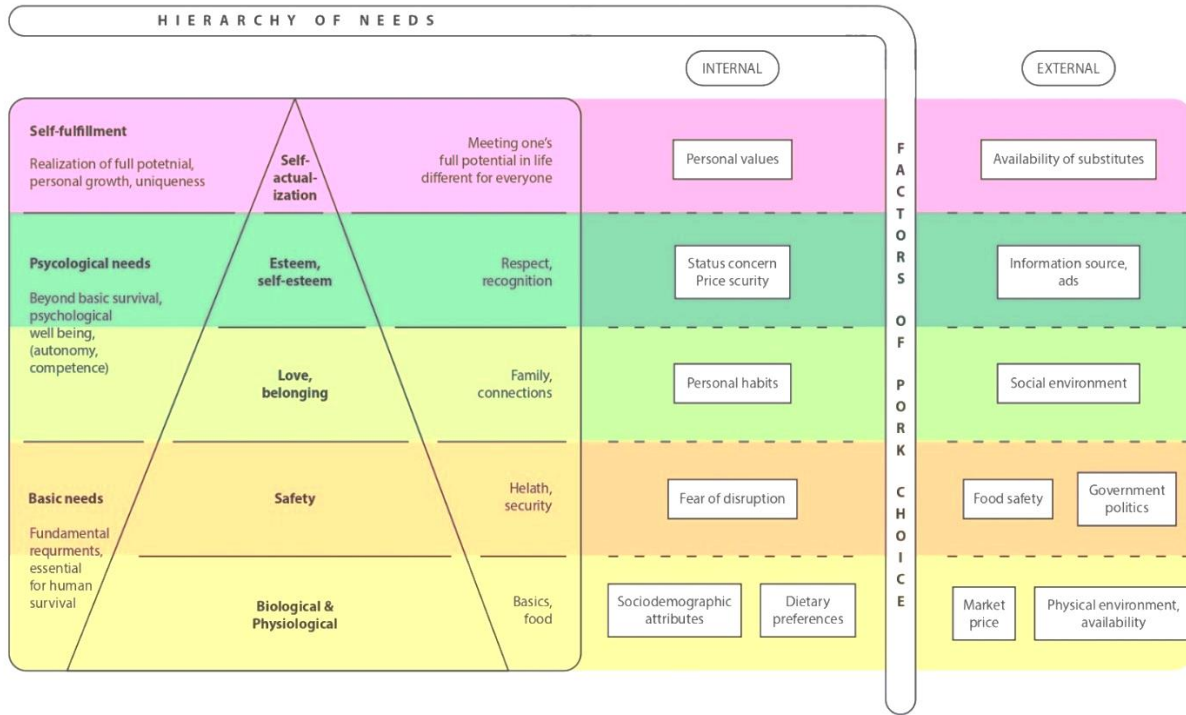


Figure 2: Modelling the pork choice of consumers after disruption
Source: Own research (2025), based on qualitative results and Table 7

The most necessities for survival are *biological and physiological needs*, which include things like food, water, and shelter. *Safety needs*: After basic survival is guaranteed, people look for stability, safety, and security (e.g., financial security, health). *Love & Belonging*: Humans seek relationships, social ties, and a sense of belonging (such as family and friendships) after safety. *Respect & Recognition*: As one moves up the hierarchy, people look to others and themselves for respect, acknowledgement, and *self-worth*. *Self-Fulfilment (Self-Actualisation)*: At the summit of the hierarchy, people work to develop personally, reach their greatest potential, and accomplish their objectives.

The diagram's right side lists the internal and external elements that affect decision-making, especially when it comes to dietary preferences and other consumer behaviours. Going from top to bottom, internal factors are character traits and principles that influence a person's decisions. Personal values are the fundamental ideas and standards that direct one's actions. Fear of disruption is the opposition to change or disturbance of daily patterns. Features such as age, gender, income, and educational attainment are examples of sociodemographic attributes which could also impact choices. Dietary preferences or personal preferences, dietary limitations, or decisions pertaining to health. External factors are outside forces that affect how decisions are made. Substitute availability is the existence of substitutes in the market. Advertising, marketing, and other information channels are examples of information sources which could impact choices. The social environment highlights the impact of friends, family, and social conventions. Food safety issues pertaining to the quality and safety of food and nations' concern about it. Government policies, rules and guidelines that influence decisions, especially in the case of disruption. The price of products and services is known as the market price. Physical environment and availability shape the availability and accessibility.

From the model, it is observable that pork choice will be affected by different factors, including some internal factors and some external factors. All these aspects are derived from Maslow's hierarchy of needs. The hierarchy's first pillar includes basic needs and fundamental requirements essential for human survival. In the case of our model, pork is a fundamental and essential meat for human survival. In terms of our research topic, the first stage stands for individual socio-demographic attributes and dietary preferences. From the results, we could see how income, place of living or age differences, among others, have significance on pork consumption in general. On a broader extent, the nation's psychological environment and availability of protein determine the pork choice, besides their prices. Stepping forward, the safety and well-being stages formulate health and security requirements (i.e. fear of ASF from an individual viewpoint; and food safety and government policy from an external aspect). From our results, we could understand that individuals' opinions of ASF posing a risk to their health could impact pork choice. Government measures could help mitigate scepticism. Psychological needs

are the second pillar of the triangle, which includes love and belonging. From the individuals' perspectives, it can be derived as personal or family habits, while from a national perspective, the social environment of a nation. Self-esteem includes respect and recognition, which, from our findings, result in price sensitivity and status. Respect and recognition from external factors are the information sources, such as official websites, radio and ads, which could also shape and impact pork choice during disruption. The third pillar is self-actualisation and self-fulfilment of uniqueness. From an internal aspect, the third pillar includes personal opinions and values. An individual by its uniqueness, could decide on pork consumption choices before, during or after a disruption. From an external perspective, the availability of substitutes shapes self-actualisation, which indirectly impacts pork choice.

4.3. Innovation brought by the research

Based on the complex viewpoint of the study, the difficulties presented by supply chain interruptions, such as those brought on by ASF outbreaks, can spur and catalyse important advances and innovations. In the face of such changes, these solutions seek to increase sustainability, efficiency, and resilience. These innovations are referred to as I1, I2, I3, I4, and I5, respectively and are based on Etzkowitz (2008).

The innovativeness of the study is summarised and explained in **Table 8**. The table can present us on how the innovativeness was brought by the research results.

Table 8: Innovativeness brought by the results

Innovation	Description
I1 Diffusion of new biosecurity management.	The technology, which is implemented to prevent ASF outbreaks, is a way of behavioural innovation. Findings present that dividing farms into risk zones, introducing new entry matrices, and slaughter plans fall into innovation and innovation management science, which is optional among entrepreneurs.
I2 Implementation of modern monitoring technologies (AI, IoT, smart farming, etc.).	Modern life brings opportunities and challenges to businesses. Innovativeness shapes a business and economy by using modern techniques, which can have a positive effect on labour and finance, among others. Our findings show that using an AI pig-counting system can help provide more reliable data and more traceability through IoT systems, even if we do not put a high focus on AI-related technical content. On the other hand, it can reduce labour costs and administration.
I3 Policy and regulatory innovations	New policies and regulations from the government, their diffusion is a type of innovation, which is collective, also known as group consensus. In terms of our topic, implementing risk zones and obligatory preventive measures to combat ASF are all types of policy innovations and new advanced behavioural innovations.
I4 Public-Private Partnership (PPP) model	Promoting partnerships between academics, businesses, and governments to solve supply chain issues and spur innovation and establishing government incentive schemes to promote spending on supply chain technology and preventive measures against interruptions are examples of innovation management. Our results show that there have been several acts of collaboration of the triple helix model even before the appearance of ASF. Since the appearance of ASF, there has been a more elevated strategy followed by key players in the market to combat consumer trust and market share.
I5 Customer-centric innovations	In addition to addressing the difficulties brought on by supply chain interruptions like those brought on by ASF, an educational campaign can be an effective means of fostering sustainability, resilience, and knowledgeable consumer behaviour. Information flow and communication channels aimed at the public on how to prevent ASF, as well as its causes and effects, by which it is possible to restore consumer trust in pork and other impacted items' quality and safety.

Source: Own research, 2025

5. SIGNIFICANCE OF RESEARCH FOR THE ECONOMY, THEIR PRACTICAL APPLICABILITY AND THE POSSIBILITIES FOR FURTHER DEVELOPMENT

The fresh produce industry, especially the swine sector, requires far more unique strategies due to its sensitivity towards disruptions. Although generic suggestions cannot be provided, each pork business requires a unique plan to mitigate, especially when interruptions happen in the chain. Developing a devoted clientele, better segmentation, learning the demand, and understanding how they would react to disruptions is essential, and in our opinion, far more crucial. The results have shown that chicken is the most consumed meat type among Hungarians, which means that the focus on elevating pork products, highlighting its nutritional and health benefits, could help popularise it. Furthermore, because of trade restrictions and a possible pig culling of affected swine, ASF outbreaks could result in a considerable decrease in pork production. Policymakers and industry stakeholders can evaluate economic losses and create plans for alternate solutions to prevent or stop an outbreak. Price shifts brought on by reductions in the supply of pork may have an impact on consumer spending trends. Since food safety is an important factor when purchasing pork products among respondents, it could be an ideal approach to put more attention on emphasising the safety levels of consuming pork during ASF. The information flow between the chain players is necessary in terms of different aspects, from sharing information to the use of campaigns on prevention, especially through institutional portals. If there is a closer attachment between the government and the private sector, it could help dispel doubts. By using the model, companies can understand some external and internal factors which could impact pork choice during disruptions.

The applicability of research findings of shifting pork consumption patterns brought on by ASF is broad in a variety of fields, such as economics, policymaking, business practices, and consumer behaviour. To reduce financial losses, research can direct the creation of more efficient surveillance systems, biosecurity protocols, and outbreak response plans. Governments can create equitable compensation plans to assist impacted producers and preserve pork sector stability with the use of quantitative data on farmer losses. Knowledge of the effects of import and export restrictions can guide trade discussions and assist nations in creating backup plans to lessen

economic disruptions. Businesses can create focused marketing initiatives to restore customer confidence in pork products or promote alternatives with the use of qualitative insights into consumer preferences and anxieties. In order to guard against future epidemics, businesses can use research to create risk management plans or insurance products. Retailers and food service businesses can use research to predict shifts in customer demand and modify their stock and menus appropriately. Results on consumer worries regarding ASF might direct public awareness initiatives to reassure customers and enlighten them about the safety of pork products. Research findings can spur innovation in sustainable farming methods, biosecurity technologies, and disease-resistant cattle breeding. Particularly in areas where pork is a main meal, the results can help guide initiatives to address any food security issues brought on by decreased pork availability. In summary, research on shifting pig consumption patterns brought on by ASF has a wide range of applications, addressing both short-term economic issues and long-term plans for sustainability, innovation, and resilience in the world food system.

Future studies on the social and economic effects of shifting pig consumption habits brought on by ASF can look at a variety of subjects to fill in knowledge gaps, tackle new issues, and spur innovation. For instance, examine how ASF affects GDP, employment, and trade balances over the long run in both the domestic and international economies. Assess whether the intake of pork has changed temporarily or if this is a sign of a long-term change in dietary choices. Examine the growing potential of alternative proteins as pork alternatives. Examine how the pig sector may enhance supply chain management, biosecurity, and traceability through the use of digital technologies (such as blockchain, IoT, and AI). Examine how precision agricultural technologies might improve pig farming's disease monitoring and control. By using our model, businesses could consider mitigating similar animal disease disruptions, such as the actual issue of foot-and-mouth disease in the Hungarian beef market (Nébih, 2025).

5.1. Contribution of the study

The main contribution of the study is that businesses in the fresh produce, swine and meat industries can create more robust supply chains by using the study's identification of efficient

mitigation and coordination techniques. This guarantees steady production and delivery while lowering financial losses brought on by interruptions like ASF, natural calamities, or pandemics. The study contributes to theoretical knowledge of supply chain disruptions, especially as they relate to pork livestock. By adding disease-related disruptions like ASF, which have received little attention in conventional domestic supply chain literature, it broadens the scope of current frameworks. The study fills a significant void in innovation management science by investigating the relationship between shifting consumer behaviour and managerial tactics. It emphasises how supply chain decisions can be influenced by consumer-driven demands and vice versa. To address supply chain issues, the study makes use of case study analyses, simulation methods, and qualitative and quantitative models. This enhances the discipline's methodological arsenal by illustrating how management science concepts can be used practically to solve real-world issues. The study promotes supply chain management innovation and marketing, which aids companies in maintaining their competitiveness, specifically in times of disruption.

5.2. Limitations

In order to enroll Hungarian pork consumers, this study used a quantitative online survey with heterogeneous snowball sampling, which started with peers and students at Óbuda University. Although this method allowed for quick data collection, self-selection and network homophily may have caused it to overrepresent younger, more educated demographics. Although social desirability bias (e.g., underreporting price sensitivity) and hypothetical bias (difference from real-world behaviour) are still limitations. Notwithstanding its limitations, this approach laid the foundation for future probabilistic sampling by offering crucial early insights into behavioural changes brought on by crises. For specialised targeting (pork consumers during crises), snowball sampling was practical; however, for robustness, future research should include a random sample as well.

Although the study's conclusions offer insightful information about how consumers behave during an ASF outbreak, there are drawbacks due to the sample size ($N = 331$). The statistical power for in-depth segment comparisons is diminished by small subgroup sizes (such as

older adults and rural customers, etc.). Self-reported intentions may also be exaggerated beyond real-world cases due to the survey's hypothetical character. These limitations require caution when extrapolating data. To improve representativeness and validity, future studies should use stratified random sampling and real-time data collection during real outbreaks.

The results, particularly the cluster findings are best understood in light of crisis communication around pork and ASF. The extent of another crisis and the product's cultural and consumer relevance determine whether it can be generalised. For instance, hesitant-avoidant behaviour may be similar in the case of zoonotic epidemics, but priorities may differ in segments based on price sensitivity. The results might not be applicable to nations with differing regulatory systems or pork consumption patterns (such as Asia versus Europe). Long-term behavioural changes following a crisis, such as whether avoidance continues after outbreaks have subsided, cannot be captured by cross-sectional data. It would be beneficial to test the clusters' stability in different product categories in future studies.

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7. OWN PUBLICATIONS RELATED TO THESIS

I have 11 independent publications expanding both domestic and international literature. The highest citation rate is for my research entitled *Optimal pricing and production strategies for two manufacturers with industrial symbiosis* published in the INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS in 2021. 14 references consist of Scopus and Web of Science citations, focusing on topics such as supply chain coordination under demand and supply, by-product synergy, supply uncertainty, and industrial symbiosis.

**Publications list of Salling, Melissza
MTMT publications and citation summary table**

Data of Salling, Melissza (07.07.2025)		
	Scientific publications	Independent references
All scientific publications and independent references	11	29

Source: MTMT, 07.07.2025.

The following publications refer to the research thesis T:

1. Yu, Y., He, Y., & Salling, M. (2021). Pricing and Safety Investment Decisions in Food Supply Chains with Government Subsidy. *Journal of Food Quality*, 1-28.
2. Tang, X., Yong, H., & Salling, M. (2021). Optimal pricing and production strategies for two manufacturers with industrial symbiosis. *International Journal of Production Economics*, 235, 108084.
3. Li, Sh., He, Y., & Salling, M. (2022). Strategic rationing and freshness keeping of perishable products under transportation disruptions and demand learning. *Complex & Intelligent Systems*, (8), 4513-4527.
4. Salling, M. (2024). Analysis of the Impact on Prices of African Swine Fever in China. In: EBES, Publications (Eds.) 48th EBES Conference: Program and Abstract Book. Istanbul, Törökország: *EBES Istanbul*, pp. 61-62., 2 p.

5. Salling, M. (2025). Assessing the price effects of African swine fever in the China market. *Exploration of Foods and Foodomics*, (3)101064, <https://doi.org/10.37349/eff.2025.101064>
6. Salling, M. (2025). Az afrikai sertéspestis hatása a sertéstermelésre és fogyasztói társadalomra Kínában, és a kínai esemény jelentősége a magyar sertés piacon. In: Klemensits, Péter (szerk.) VII. Eurázsia hajnala konferencia - Absztraktfüzet: A Neumann János Egyetem Eurázsia Központja által tartott konferencián elhangzó előadások kivonatai Budapest, Magyarország: Neumann János Egyetem, *Eurázsia Központ*, 35 p. pp. 14-15., 2 p.
7. Salling, M., Szigeti, O., & Garai-Fodor, M. (2025). A magyar sertéshús fogyasztási szokások jelentősége. In: Hajdú, Péter (szerk.) Doktoranduszok Fenntarthatósági Szimpóziuma - Absztraktkötet, p. 46 , 1 p.
8. Salling, M., Garai-Fodor, M., & Szigeti, O. (2025). Eating patterns of Hungarians towards pig meat. In: Szakál, Anikó (szerk.) 19th IEEE International Symposium on Applied Computational Intelligence and Informatics SACI 2025: Proceedings. Danvers (MA), Amerikai Egyesült Államok: IEEE (2025) 755 p. pp. 413-417. , 5 p.

8. OTHER PUBLICATIONS

9. Salling, M. (2021). Tanulmányi utam Szabadkától Kínáig. In: Krmpotity, Bacsó Gabriella (szerk.) A támogatások fontossága az egyén, a társadalom és a régió tükrében. Szabadka, Szerbia, Csíkos Holding Nyomda, 90 p. pp. 25-31., 7 p.
10. Salling, M. (2024). The Influence of Labor Flow on Economic Growth: Analysis Based on EU Regions. In: Anadolu, University (Eds.) EconAnadolu'24: VII. Anadolu International Conference on Economics: Conference Proceedings Book Eskisehir, Törökország: Anadolu University (2024) pp. 1-13., 13 p.
11. Salling, M. (2024). The impact of the free labor mobility on the economy in the European Union. In: Beke, Judit; Nagy, Milada (szerk.) 20 Years of Central and Eastern Europe in the European Union: Book of Abstract, p. 40, 1 p.