Tackling food loss in Vietnam Logistics sector via technology

Tang Minh Huong[1], Ho Thi Thu Hoa[2], Do Doan Trang[1], Nguyen Quynh Phuong[1], Nguyen Quynh Lam[1], Vo Trong Cang[1]

[1]IMALOG, Binh Duong University, Binh Duong, Vietnam

[2]International University (IU), Vietnam National University, Ho Chi Minh City, Vietnam
Corresponding author: Tang Minh Huong. E-mail: tmhuong@bdu.edu.vn

Abstract: Food loss in Vietnam is a major concern for the government, commercial sector, and regulators, and many others. Food loss is exacerbated during epidemics, when the supply chain is disrupted, border crossings are blocked, aircraft are restricted, etc., necessitating the state and enterprises to develop policies and effective ways to address this problem. There are already numerous firms in Vietnam that have excellent solutions for dealing with food loss, and employing technology is one of the most effective ways for businesses to control food loss and drastically reduce the rate of food loss throughout the food supply chain. The article will analyze technology solutions used by Vietnamese enterprises to prevent food loss, as well as existing and potential technologies around the world that can help to lessen food loss.

Keywords: Technology; food loss; logistics; Vietnam logistics.

1. Introduction

Digital technology is transforming supply chain processes and operations. Industries, businesses, and organizations must adapt or risk falling behind. Digital technology is transforming business operations and opening up new global opportunities for value creation across industries. Many businesses benefit significantly from digital technology, which has piqued the interest of businesses worldwide [1]. Digital technology has a significant impact on the food industry. When digital technology is applied to various aspects of the food supply chain, management efficiency improves and food loss is significantly reduced. Robots, RFID, air conditioning technology, temperature monitoring devices, location tracking devices, cold chains, biological preservation, smart packaging, and other exceptional and highly effective food loss reduction technologies include.

CEL Consulting created a pioneering survey in the first quarter of 2018 to estimate food losses across three food chain sectors (fruits and vegetables, livestock, and fish and seafood) from major Vietnamese agricultural regions. The survey's scope includes losses during production as well as post-harvest handling, storage, and transportation activities. However, it excludes processing losses as well as food waste by retailers and consumers.

The survey revealed that, on average, a quarter of the food produced within the three studied sectors is lost before it actually reaches processing plants or distribution centers.

Total losses are estimated to be 8.8 million tons, or $3.9 billion USD (2 percent of Vietnam GDP; 12 percent of Vietnam Agriculture GDP). Given that

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Vietnam has 117,100 km2 of agricultural land (World Bank, 2018 data), a 25% loss equals 29,696 km2, or 9% of total Vietnam area (equivalent to T.P. Ho Chi Minh, Binh Duong, Dong Nai, Baria – Vung Tau, Long An, Tien Giang, Ben Tre, Vinh Long, and Dong Tap combined). If the SSA region benchmark for food loss during processing activities and food waste is extrapolated to Vietnam, the total average loss and waste for Vietnam would be more than half of what is produced [2].

With approximately 7.3 million tons lost per year, the fruits and vegetables group accounts for the highest percentage of food loss (25 percent of production and 7 percent of handling, storage, and transportation). Losses in the meat industry total 14 percent (2 percent of handling, storage, and transportation) or approximately 694 thousand tons per year. Losses in the fish and seafood industry account for 12% of total production (about 804 thousand ton per year).

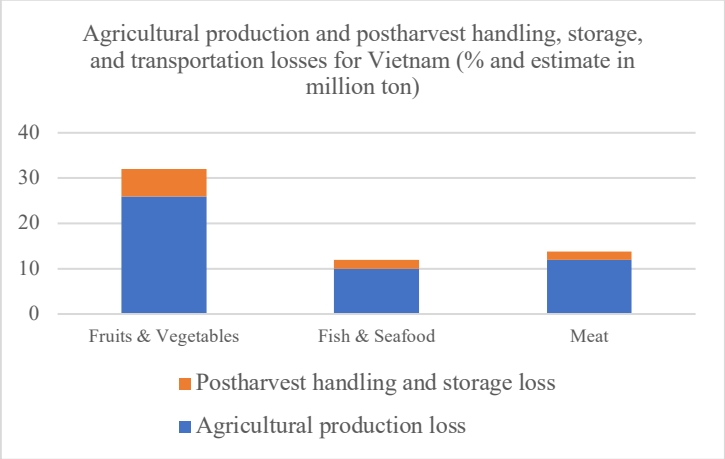

Figure 1. Agricultural production and postharvest handling, storage, and transportation losses for Vietnam (% and estimate in million ton) [2].

To illustrate the magnitude of the loss, this total amount converted into bananas would represent around 168 million units lost per day. For the meat industry, losses reach 14% (roughly 694 thousand ton per year General Statistics Office of Vietnam (GSO). Livestock population as of annual 1st October by Items, Year and Livestock), which can be translated into an equivalent of around 2,000 cattle, 11,000 pigs and 139,000 chickens per day4, when this loss percentage is calculated over the total amount of animal heads in the country. Finally, in the fish and seafood group, losses represent 12% of production (about 804 thousand ton per year). Considering that a pangasius fish has an average weight of 0.95kg when fished, this total loss amount can be illustrated as an equivalent of losing 2,3 million pangasius per day.

Based on the data presented above, it is clear that the issue of food loss in logistics in Vietnam is a serious one that must be addressed. Many businesses are

interested in digital technology in today's era because of the values and benefits it brings to businesses. Particularly since the covid-19 epidemic, digital technology has gotten a surge of popularity. Recognizing the value that technology brings to assisting in the solution of the problem of food loss in Vietnam, the authors chose this topic for research, assisting in the provision of useful knowledge about the situation of technology used by Vietnamese businesses to overcome food loss, as well as technologies that are being applied or have potential in the world to assist in the solution of the problem of food loss in the supply chain.

2. Literature review

2.1.Technology

Technology is defined as “a system created by humans that uses knowledge and organization to produce objects and techniques for the attainment of specific goals” [3].

Here are six different categories of technology with examples for each:

- Communication: Communication technology consists of any pieces of technology people use to communicate with one another. Some early examples of communication technology include Morse code and the telegraph. For example, TV, internet, cellphones.

- Electrical: Many pieces of modern technology use electricity in some form. A few examples of electrical technology include: computers, circuitry, artificial intelligence, software, Audio and visual technology.

- Energy: Energy technology aims to help generate, store and transmit energy for a variety of purposes. Common examples of energy technology include: solar panels, wind turbines, batteries.

- Mechanical: Mechanical technology is the application of engineering principles to achieve tasks more efficiently. People use this technology in a wide variety of machinery, with some common examples of mechanical technology including: manufacturing, heavy engineering.

- Medical: Medical technology helps improve people's quality of life in a number of ways. Some examples include: diagnostics, pharmaceutical, surgical, monitoring.

- Transportation: It's much easier to travel than it once was thanks to improvements in technology. Examples of transportation technology include: GPS, flight, vehicles.

2.2.Food loss

Food” refers to any substance—whether processed, semi processed, or raw—that is intended for human consumption or, more specifically, ingestion. “Inedible parts” refers to components associated with a food that, in a particular food supply chain, are not in-tended to be consumed by people. Examples of associated inedible parts could include bones, rinds, and pits. What is considered inedible depends strongly on the cultural con-text. In this publication we note if associated inedible parts are included in the data [4].

Food loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retail, food service providers and consumers [5].

"Food loss" is typically considered unintended and caused by poor functioning of the food production and supply system or by poor institutional and legal frame-works. Examples include food that rots in storage because of inadequate technology or refrigeration, or food that cannot make it to market because of poor infrastructure and goes unconsumed. The term "food loss" is often used with reference to what occurs between the farm and the retail store [4].

3. The methodology and the research questions

The qualitative research method is used for this study with in-depth interviews (commonly abbreviated as IDIs) and focus groups to collect primary data and depth opinions from target group of interviewees.

The authors conducted in-depth interviews with representatives from seven well-known logistics companies, including Transimex, AJ total, Lineage, Ratraco, CMU, Gemadept, and Cass. These firms store and transport five major food categories: vegetables and fruits, meat and seafood, dairy products, and cereals.

We collect and analyze reliable secondary data and associated reports from Vietnam and international organizations in order to assess the present state of food loss in the logistics sector. Additionally, these data contribute to understanding about the technologies being employed and their potential in Vietnam and throughout the world to assist in resolving food loss situations.

To solve the earlier-mentioned problem, the authors must answer the following research questions:

1. What technologies are used by Vietnamese logistics firms, and how effective are they in addressing the issue of food loss?

2. What technologies have been used and are being developed around the world to help overcome the problem of food loss in the logistics sector?

4. Vietnam's cold chain and the technology employed by logistics firms in the country

4.1. Vietnam's cold chain

Cold supply chain is attracting investors' interest due to the strong demand for this segment at the moment, particularly as a result of the covid-19 pandemic, which has increased demand for storing items such as needs, food, medicine, and vaccines to fulfill the market's high demand.

4.1.1. Vietnam's cold storage

Vietnam's cold storage real estate segment is developing and is expected to reach 295 million USD in 2025 with a growth rate of 12 percent a year, according to real estate consultancy Savills Vietnam. [6]

According to the data collected by the authors, As of December 2021, Vietnam only had 53 cold storage warehouses with a capacity of about 845,409 pallets. Foreign investors account for approximately 60% of the market, logistics companies account for 14%, and members of the Vietnam Logistics Business Association, such as Transimex, Gemadept, and Saigon Newport, account for the remainder.

The graph below depicts the annual increase in cold storage capacity from 1998 to 2021, and the data includes the designed capacity of 53 cold storages in Vietnam. It should be noted that we do not cover small-scale cold storage facilities with designed capacities of less than 1,000 pallets.

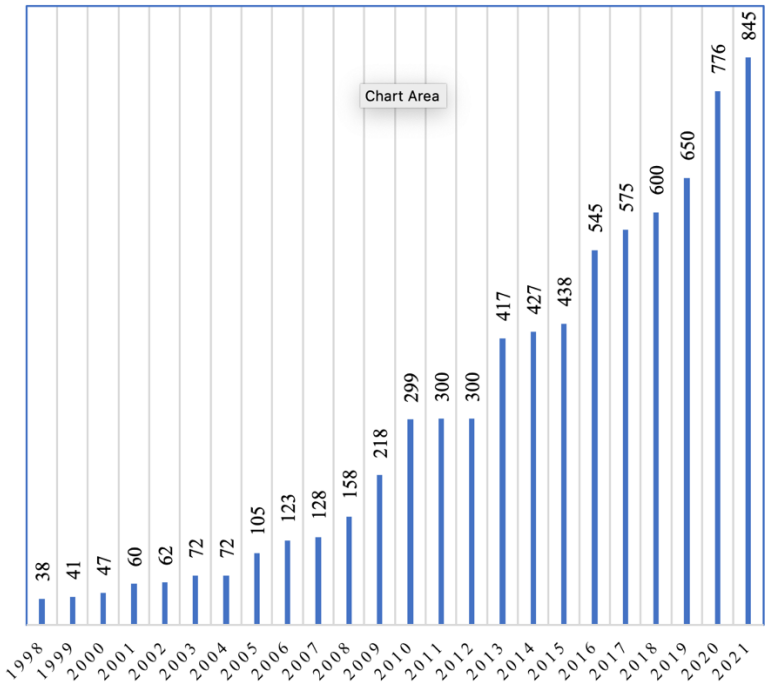

Figure 2. Designed capacity of rented cold storage in Vietnam (thousand pallets).

CEL's research 2018 also revealed that only 14% of Vietnamese manufacturers are linked to cold chain solutions, of which the seafood industry accounts for 42.1% of the total number of manufacturers. In addition, while cold chain usage is 66.7% for exporters, cold chain is adopted by only 8.2% of manufacturers supplying the domestic market. This disparity reflects the high quality and cold chain standards imposed by export markets to which Vietnamese exporters must comply, but shows the ease of the domestic market and the potential danger to the domestic market. with the health of Vietnamese consumers [2].

4.1.2. Vietnam's cold transportation

From several players in initial stage of the cold transportation development, Vietnam now has around 22 professionally-managed refrigerated truck providers, many small

independent providers and in-house truck teams of food manufacturers, supermarket, CVS, etc. Small independent providers normally focus on distribute products from main depot to POS in the province/city while professionally-managed refrigerated truck providers are able to provide both short-haul and long-haul route.

More than 702 refrigerated trucks from 1 ton to 25 tons are delivering frozen and chilled products to all provinces in Vietnam. However, they are mostly for frozen/chilled food, pharmaceuticals and ice-cream & yogurt. According to our discussion with market players and industry experts, food group accounts for approximately 80% of cold transportation demand in Vietnam currently [7].

The market is fragmented, with many small and medium-sized businesses competing fiercely. ABA Cooltrans, Binh Minh Tai, Tan Nam Chinh, and Quang Minh are examples of domestic refrigerated transport companies. Their competitive advantages include a high-productivity refrigerated truck fleet, a professional staff, and high-quality service (on-time delivery, temperature control and value-added solutions).

4.2. Technologies utilized by Vietnam's logistics companies to minimize food loss

Following primary data collection and interviews with leading logistics enterprises about the technologies used and their potential to help overcome food loss. The authors summarize a number of technologies being used by businesses in Vietnam to help them overcome this situation, such as robots, remotely monitoring and tracking the temperature, time, and location of refracted containers and cargo, insulated food cabinets, controlled atmosphere technology, RFID, and blockchain.

4.2.1. Robot

Cold storage warehouses are essential for keeping things like perishable food items and blood at the correct temperature before they go to their final destinations. Challenges pose obstacles for companies dealing with cold storage, but robots are helping to overcome them. Here are four examples: Protecting workers from frigid temperatures while maintaining productivity, Preparing Chilled and Frozen Foods More Efficiently, Reducing Product Waste, Enhanced Energy Usage and Savings.

4.2.2. Remotely monitor & track the temperature, time and location of refrigerated containers & cargo.

The use of remote monitoring and tracking systems to monitor and track the temperature, time, and position of refrigerated containers and cargo is an effective way to minimize food loss. According to the businesses interviewed, food loss is significantly reduced when these devices are used, especially when something goes wrong, such as when the refrigerated container is cut off. When something goes wrong, such as when the refrigerated container is cut off, the problems are quickly resolved. Additionally, the usage of this

device enables the shipper and consignee to quickly track the status of products and resolve problems arising during the transport and preservation of goods.

4.2.3. Insulated food cabinets

Insulated food cabinets are a type of technology that is used in the final mile of goods delivery to the consumer. With this equipment, goods do not need to be transported in refrigerated trucks, saving money on refrigerated transport services or investing in refrigerated trucks. With insulated food cabinets to help stabilize food temperature, extending shelf life and reducing food loss rate.

4.2.4. *C*ontrolled atmosphere technology

A modern refrigeration system combined with controlled atmosphere technology – CA that can adjust the temperature, humidity, and concentration of gases (N_2, O_2, CO_2, C_2H_4...) throughout the warehouse to reduce the respiration intensity of agricultural produce, kill harmful microorganisms, and ensure good storage conditions while maintaining the flavor and quality of the products. Many studies around the world show that under CA conditions, many products can be stored up to 2 – 4 times longer than under normal cold storage conditions. Apples can now be stored for up to 12 months.

Combining controlled atmosphere technology – CA – and automated storage and retrieval system – ASRS – overcomes disadvantages such as high cost and difficult execution conditions because people cannot work in an oxygen-deficient environment. As a result, the loss is reduced by up to 75% when compared to the current situation, and customer profits are increased.

4.2.5. Radio frequency identification (RFID)

RFID is a newer technology that has been used to speed up the handling of manufactured goods and materials. RFID is a catch-all term for technologies that use radio frequency waves to identify objects. RFID allows an object to be identified from a distance without requiring a direct line of sight. RFID tags can also carry additional data, such as product and manufacturer information, as well as measured environmental factors like temperature and relative humidity. RFID readers can also distinguish between multiple tags in the same area without the assistance of a human. Traditional barcode technology, on the other hand, is more expensive than RFID technology [8]..

In supply chain management, RFID tags are used to track food products during distribution and storage. RFID systems can be used to ensure that food products such as meat, fruit, and dairy products remain within a safe temperature range during transportation and storage. RFID technology has also been used to track the ripening of tropical fruits as they are transported and sold [9]. With the applications that RFID has, this technology contributes significantly to lowering logistics production costs.

4.2.6. Blockchain

The ability of blockchain to track ownership records and resist tampering can be used to solve urgent issues in the current food system such as food fraud, safety recalls, supply chain inefficiency, and food traceability. Food traceability has been at the forefront of recent food safety debates, particularly in light of recent advancements in blockchain applications. Due to the nature of perishable food, the food industry as a whole is extremely vulnerable to making mistakes that could endanger human lives. When foodborne diseases endanger public health, the first step in root-cause analysis is to identify the source of contamination, and there is no room for error. As a result, traceability is essential for the food supply chain. Because some involved parties are still tracking information on paper, the current communication framework within the food ecosystem makes traceability a time-consuming task. The blockchain structure ensures that each player along the food value chain generates and securely shares data points, resulting in an accountable and traceable system. Large amounts of data with labels indicating ownership can be recorded quickly and without modification. As a result, the journey of a food item from farm to table can be tracked in real time.

Traceability and food-related information will make it easier to manage all stages of the food supply chain, reducing food loss and ensuring food safety and quality.

4.2.7. Electronic Data Interchange (EDI)

The information systems conducted by the requirements of the internationalization of activities, by the organization of firms in networks and by the evolution of Information and Communication Technology, tend more and more toward the sharing of information in real time. The Electronic Data Interchange (EDI) is among the tools that guarantee this exchange. EDI is a quick and effective means of transfer of business documents and ensures the optimization of the information flows of and their synchronization with the physical flows in the Supply chain [10].

With these characteristics, EDI aids in the solution of the problem of information exchange between supply chain members, thereby avoiding information bottlenecks. One of the primary causes of food loss is clogged information flow and difficult information exchange among members of the food supply chain.

5. The world's technologies contribute to the reduction of food loss

Interventions to combat food loss should be tailored to each individual case and country, as low- and high-income countries typically require different measures [11] and [12].The food loss causes in the critical loss points shown in Table 1 indicate that developing countries require interventions to address handling and management issues in addition to

insufficient agricultural product treatment [13]. Smallholder farmers in Africa, for example, may lose nearly half of their output due to insect or mold growth. In such cases, the emphasis should be on grain drying safety training as well as the use of airtight bags and silos for storage. Such practices, however, may not be applicable in developed countries or in different climates. Furthermore, even under ideal conditions, poor handling of a product in one stage can result in rapid deterioration in the subsequent stage [14]. Inadequate pasteurization or preservative treatment, for example, may result in losses during storage and transportation.

Table 1 shows innovative technologies with high potential in relation to the critical loss points mentioned above. Technology-based solutions can provide insight into harvesting time optimization as well as forecasting and early warning of potential stress situations. Traceability of contamination, for example, can improve food safety, and information and communication technology (ICT) can ensure detailed optimization of handling and management practices on-farm, as well as provide solutions during post-harvest operations, storage, and transportation [15].Similarly, the Fourth Industrial Revolution, also known as Industry 4.0, refers to the ongoing rapid automation of traditional manufacturing and industrial practices and includes a slew of new digital solutions to optimize the entire food value chain, remake manufacturing and production systems, and improve product traceability [16]. Technologies that improve the cold chain, such as super chilling, or product moisture conditioning, such as innovative drying technologies, can reduce food loss during packing, storage, and transportation [17]. Non-thermal technologies are also novel tools for food preservation and pasteurization, and smart, active, and biodegradable packaging has the potential to reduce food loss during transport and at the retail level [18].

Table 1. Innovative technologies with high solution potential in critical loss points [19] .

Critical loss points	Solution needs	Potential technologies
Agricultural production/harvest/slaughter/catch		
Harvesting	– Reschedule harvesting and improved methods – Early warning systems – Collaborative planning and forecasting – Determination of maturity points and harvest time	– Satellite-based early warning systems – Insect warning systems – Geographic Information Systems (GIS), GPS and mobile apps
On-farm storage	– Inadequate storage	– Improved sensor and monitoring systems

Critical loss points	Solution needs	Potential technologies
	– Protection of crops from occasional extreme weather conditions – Proper ventilation – Improved storage room/containers	– Various forms of improved storage techniques
Stocking in the field	– Usage of biological agents	– Application of bio-predators and/or bio-pesticides
Post-harvest/slaughter/catch operations		
Packing	– Improvement of cold chain – Improved monitoring of humidity and temperature	– Innovative drying methods (e.g., osmotic dehydration, microwave, vacuum and hybrid drying) – Hot water dipping
Slaughtering	– Innovative sanitation techniques	– Electrolyzed water – Application of biosurfactants
Processing		
Food production	– Innovative food pasteurization and preservation techniques – Automation of the process	– Non-thermal technologies (e.g., high pressure processing (HPP), pulsed electric fields (PEF), etc.) – Mobile app automation – Robotics
Storage/Transportation		
Transportation	– Improvement of cold chain	– Emerging freezing technologies (e.g., high pressure, ultrasound freezing, magnetic resonance freezing and microwave freezing) – Internet of Things (IoT) in the cold chain
Storage	– Improvement of refrigeration systems – Modernization of milking equipment	– Superchilling
Storing Practices	– Proper handling	– Information technologies
Packaging/ Wholesale/Retail		

Critical loss points	Solution needs	Potential technologies
Packaging	– Smart packaging and utilization of bio-based materials	– Intelligent and active packaging – Utilization of bio-based materials
Whole supply chain		
Agricultural production, processing and storage	– Measuring food loss in the supply chain	– Value stream mapping
Agricultural production, processing and transportation	– Optimizing manufacturing and traceability across the supply chain – Monitoring of human errors and breakdown of the cold chain	– Industry 4.0 for supply chain management

6. Conclusion

A number of companies are currently using technology to solve the problem of food loss in Vietnam, and the results have been significant. There are low-cost technologies, such as devices that remotely monitor and track the temperature, time, and location of refracted containers and cargo, that provide high efficiency. However, not all businesses effectively apply technology; it is necessary to select the right technology for the characteristics of the organization; additionally, successfully deploying technology into the business is a challenge. It necessitates leadership dedication, time, and employee cooperation. For Vietnamese businesses, the cost of investing in technology is also a major issue, particularly for agricultural products where the value of the goods is low, so selecting the right technology is critical. important. It is important to note that when using technology, attention must be paid to synchronization in order to achieve high efficiency in solving the problem of food loss.

Aside from technological solutions, other solutions in terms of management, people, regulations, and policies are required to completely overcome Vietnam's serious food loss situation.

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