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LEVERAGING ON TRACEABILITY AND SUPPLY CHAIN RELIABILITY TO ACHIEVE FOOD SAFETY AND CUSTOMER SATISFACTION

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Abstract

The study contributes towards a healthy and sustainable food supply chain management system. This paper discusses the influence and relevance of traceability in improving food safety within the supply chain in Zimbabwe. This is against the background that food risks have not been easy to rectify once the food product is within the supply chain, especially when it has been distributed to end users already. For methodology, the study employed a quantitative approach with a sample size of 31 food organizations and 65 customers. Evidence points out that food supply chain reliability has a positive and significant influence on food traceability; food traceability has a positive and significant influence on food safety; food safety was found to have an insignificant influence on customer satisfaction; and supply chain reliability has a positive and significant influence on customer satisfaction. However, in the absence of reliable and efficient supply chain management it was found that it is difficult to develop effective and sustainable food traceability. It is recommended that all food producers, intermediaries, suppliers, consumers and other stakeholders contribute positively towards improving efficiency of food traceability to improve food safety and customer satisfaction.

Key words: Food traceability, Supply chain reliability, food safety, customer satisfaction

1.1 Introduction

The study focuses on the importance of traceability within the food industry specifically cold chain foods and beverage industry in Zimbabwe as improve food healthy and customer satisfaction. Despite the fact that international traceability standards exist, each country can enact extra restrictions to improve the comprehensiveness and efficacy of traceability. From safety concerns to ethical issues, food traceability is a growing priority up and down the supply chain. Achieving accurate and 100% food traceability is still a thorn in the flesh within the Zimbabwean food and beverage industry that still has a lot of supply chain irregularities. This implies that in case of any food contamination, necessary

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recalls may not be achieved easily until there are improvements on accurate information flow and enacting of effective systems.

This research sought to fill the knowledge gap on effective traceability within the food supply chain in Zimbabwe. The outline of the study involves the conceptual framework underpinning the study, literature review, study methodology, findings, recommendations and conclusion. The next section looks at the conceptual framework underpinning the study.

2.0 Conceptual Framework

2.1 Traceability and food supply chain reliability

The food supply chain is characterised by a number of faults, contamination and food poisoning that requires a reliable supply chain to assist in effective traceability. Effective traceability can only be achieved when the supply chain is reliable. Anastasiadis, Manikas, Apostolidou and Wahbeh (2022) described a reliable supply chain as one that has systematic stages which can easily be followed with anyone in an organisation in understanding the flow of goods and information relating to such goods/commodities. Organisations should know for example who is the producer of certain food, where was it distributed to and stored for how long, up to a point of the last consumer of customer to which the product had been delivered to. Therefore, in case of any contamination, it will be easy to track and trace the product through the known and systematic channels (Hastig & Sodhi, 2020). For example, the coca cola beverage industry utilises what is known as the route to market, where customers in a given distribution route are known and can be identified easily. Effective traceability therefore requires a reliable supply chain system. From different literature sources consulted, the first hypothetical proposition was developed as provided below.

H1: Food supply chain reliability has a positive and significant influence on food traceability.

2.2 Food traceability and food supply chain reliability

In order to deal with food issues and catastrophes, the food sector is increasingly becoming more customer-oriented and requires faster response times. A successful traceability system reduces the manufacturing and distribution of dangerous or low-quality items, reducing the risk of negative publicity, lawsuits, and recalls. The current food labeling system does not ensure that the food is genuine, safe, or of high quality. As a result, traceability is used as a tool to help ensure food safety and quality while also increasing consumer confidence (Dai et al., 2021). Food traceability has become increasingly important, especially in the wake of multiple food safety events in which traceability systems were either inadequate or non-existent. Traceability looks to be a tool for adhering to regulations and meeting food safety and quality standards. It is thought to be an effective safety and quality system with the ability to raise consumer confidence and connect producers and consumers, as well as improve food chain safety

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(Anastasiadis et al., 2021). The design and execution of entire chain traceability from farm to end-user have become an important aspect of the overall food quality assurance system in order to deliver top-quality, safe, and nutritious foods while also rebuilding public confidence in the food chain (Ding et al., 2020). According to the FAO all participants in the food chain, including governments, industry, and consumers, should share responsibility for food safety and quality (Wang et al., 2019). Food control's primary mission is to enforce the food laws that protect consumers against hazardous, unclean, and fraudulently presented food. Food traceability systems can provide a consistent and accurate information flow in supply chains, as well as detect underlying causes of problems and recall high-risk items from the market (Cao et al., 2021). As a result, food traceability systems can help to reduce knowledge asymmetry among consumers and food safety risks (Ferdousi et al., 2020.Since traceability is primarily a quality assurance tool, its deployment is influenced by a variety of elements relating to the supply chain and trade difficulties (Gao et al., 2020). Traceability's usage as a strategy to promote consumer confidence in food safety is primarily tied to skepticism in the food system, which the government should address. The second hypothetical hypothesis for this research has been presented, based on the many literature sources studied.

H2: Food Traceability has a positive and significant influence on food safety

2.3 Food safety and customer satisfaction

Agricultural techniques, worker behavior, the application of preventive controls during food processing and preparation, the use of chemical materials, the proximity of raw ingredients and water, and storage all contribute to food safety. Hygiene is a crucial component for optimal standards at every step. Customers and food safety are the two most important considerations in the food sector (Monteiro et al., 2021). Customers will pay for the business's services, which will keep it running. Food safety will improve the client experience and keep them satisfied enough to return. According to a research conducted by Nowicki & Sikora (2011) in Poland, the level of customer satisfaction increases proportionately with the perceived increase in food safety and quality.Results of this particular research revealed that food safety has a positive and direct influence on customer satisfaction. Borrowing from literature , the following third hypothetical proposition was developed.

H3: Food safety has a positive and significant influence on customer satisfaction

2.4 Food supply chain reliability and customer satisfaction

A reliable food supply chain system improves effectiveness of all supply chain and logistics activities (effective order processing, planned and efficient food processing, effective distribution and storage, effective flow of information and money). Once a supply chain is effective and reliable the organisation finds it easy to meet customer needs effectively (Yu et al., 2021). The fourth hypothetical proposition has therefore been posited below:

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H4: Supply chain reliability has a positive and significant influence on customer satisfaction

A conceptual framework in Figure 1 was therefore developed guided by the four hypothetical propositions posited

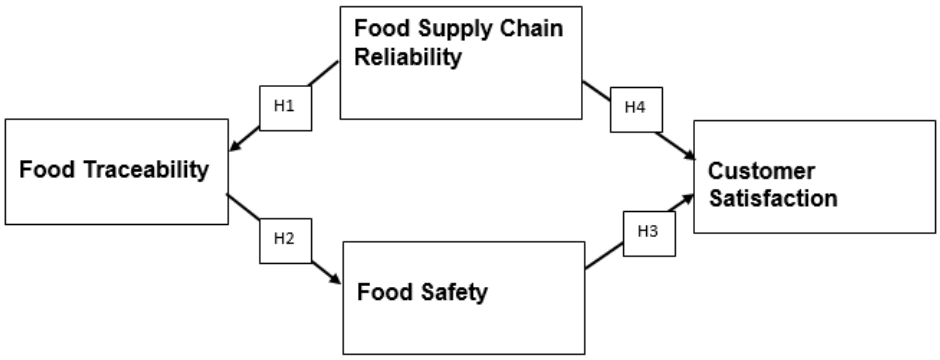

Figure 1: Conceptual framework

Source: Own

3.0 LITERATURE REVIEW

3.1 Food Traceability Overview

3.1.1 Global Perspective

The growing concern among customers about the safety of their food has been a major driving factor for the worldwide food traceability system business over the years. Consumers' trust in the safety of their food has eroded as a result of several food adulteration events and recalls (Ahmed et al., 2021).

Consumer trust can be gained by a hands-on traceability system that allows customers to inspect the product's farm-to-fork history. Governments have also played a role in improving the food business by enacting rules and regulations that support food traceability and make it necessary in some locations. The food safety and traceability system is a necessary to achieve comprehensive food safety and is a solution to a variety of challenges in the food sector. The last two decades have been difficult for logistics traceability, with worldwide events like bovine illness and honey scandals dominating the news. These vulnerabilities exposed the supply chain's inability to clearly record traceability records. Regulators, manufacturers, and consumers have all demanded greater traceability alternatives in the wake of these incidents to help avoid them from happening again. These incidents compelled the worldwide society and institutions, including the Food and Drug Administration and the European Union, to unite and agree on a set of guidelines aimed at improving global traceability. Consumers are

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continuously seeking enhanced traceability, particularly as they become more mindful and conscientious of where their food is produced, thus individuals in the sector should not become comfortable despite these demands. Simultaneously, manufacturers are beginning to recognize that effective traceability systems offer profit and cost-cutting options that can help them remain competitive (Milenovic, 2020).

While traceability is critical for rapidly identifying and correcting a food safety problem, it can also aid firms in recovering from problems and, eventually, preventing future ones. According to Aung et al. (2014) the benefits of food traceability come in four phases:

- **Preparedness:** When the entire the supply chain is connected, food institutions are prepared when a food safety issue arises.
- **Response:** When the supply chain system is well synchronised, timely response to food issues can be achieved for the benefit of all supply chain stakeholders.
- **Recovery:** Consumers can have confidence after a food safety issue with the transparency that traceability provides to the entire food supply chain.
- **Prevention:** When traceability can identify the root cause of a food safety issue then measures can be taken to prevent repeat episodes.

Food traceability also aids food safety by detecting fraud and removing counterfeit products from the supply chain. This has increased the pressure on businesses and large organisations in the region to rapidly implement advanced technological solutions, such as blockchain technology, in order to create a more seamless and cooperative supply chain traceability that provide a more trustworthy product to their customers. Many businesses in the region still use old paper-based data management methods, but blockchain technology now provides a faster, easier, safer, and more cost-effective alternative to store data.

3.1.2 Food Traceability in Zimbabwe

In Zimbabwe, the food control and regulation system is governed by multiple acts administered by various government ministries. The Public Health Act, the Food and Food Standards Act, the National Biotechnology Authority Act, the Control of Goods Act, and the Animal Health Act are the most important statutes. These Acts contain a number of provisions pertaining to food safety. The institutions related to food safety are established by the Acts. The Food and Food Standards Act created the Food Standards Advisory Board, whose primary responsibility is to advise the Minister of Health on all food safety issues (Toriro & Muziri, 2021).

The food safety system in Zimbabwe is controlled through measures such as import and export permits, inspections, licensing, and registration. Despite having these various pieces of legislation, there is still no specific legislation that governs food traceability in the Zimbabwean supply chain. Zimbabwe still has not embraced the food traceability system that is likely to improve the nation's food health system. For example, in recent years, Zimbabwe has been unable to export cattle to attractive markets in Europe and the

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Middle East due to a lack of a traceability system, lowering beef export earnings, which are essential to the country's economy Kanonhuhwa & Chirisa (2021).

3.2 Traceability System

A traceability system is the “the totality of data and operations that is capable of maintaining the desired information about a product and its components through all or part of its production and supply chain.” (Milenovic, 2020). A traceability system captures and records data points when a product moves from one market actor to another, allowing for real-time and ex-post tracking of a product's transit through the supply chain from origin to final destination (Freshbyte Software, 2021). The extent and sophistication of traceability systems varies greatly. They can range from single-firm systems that capture activities within their own supply chain to multi-stakeholder platforms that can trace a product across the whole food system.

3.3 Traceability components

Traceability is divided into two parts: tracking and tracing. Tracing creates a record of a product's journey through the food supply chain. The tracing history, whether for a single unit or a batch, gives information about the product's origin and progress (Tessitore, 2022).

Tracking, on the other hand, is the capacity to locate a product's final destination by following its passage through the food chain from the moment of manufacture to the site of sale or consumption. Tracking, like tracing, can follow a single unit or a batch. "Tracking" refers to the ability to follow a product's downstream course through a supply chain, whereas "tracing" refers to the ability to discover a product's origin and ingredients using information kept upstream in the supply chain (Dabbene et al., 2014; Behnke & Janssen, 2020).

3.4 Relevance of Traceability on food safety

As the food supply chain gets more intricate and global in scope, traceability is more important than ever. Organizations must have a structure and process in place in the case of a food safety risk due to the increased complexity. If this is the case, traceability will help identify the source of the issue as well as the scope of any potential crisis. With a good traceability product that gives visibility and transparency across the food chain, a food company may be prepared in the case of a potential issue (Yu et al., 2022). In the case of an incidence, traceability allows for swift response, diagnostics, and mitigation. Traceability benefits food processors and, in certain circumstances, entire industries, restoring public trust in the product, firm, industry, and food supply chain. Finally, traceability is essential for future preventative actions taken in the aftermath of an incident (Yu et al., 2022).

3.5 The importance of traceability in food supply chains

Traceability reduces contamination, disease, and degradation in the food chain by detecting threats before they reach end-user markets. When dangerous commodities

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enter the system, these technologies allow market players and/or authorities to quickly identify and isolate the source, limiting the consequences. In the event of a product recall, traceability enables for a targeted withdraw of the foods most likely to be affected, eliminating waste and market distortions (Hallak, 2022).

Fresh, perishable food value chains, such as fruits, vegetables, meat, and dairy, can benefit from traceability for food safety objectives because they are more prone to deterioration and contamination. Traceability systems, for example, can protect consumer health on both a national and international level. When systems are cross-border interoperable, they can help facilitate food trade by allowing market actors to check that a product complies with applicable legislation and/or standards.

Food traceability systems have been developed as the public's awareness of food quality and safety has grown (Dabbene et al., 2014; Chen, 2015) The capacity to follow a product and its history across a supply chain from harvest to transport, storage, processing, distribution, and retail is referred to as "traceability" (Kamilaris et al., 2019). This necessitates extensive information sharing within a network of others on product history, specifications, and location (Kumar et al., 2017). It's worth noting that traceability can be categorised based on how information is remembered in a food chain (Aung & Chang, 2014).

Traceability involves the participation of all parties involved in the food supply chain (Dabbene et al., 2014). Because traceability systems generate large amounts of data, automated data collection, preservation, and access become essential (Chen, 2015).

Traceability can improve food safety by allowing for the timely identification of food sources as well as greater knowledge about the reasons of potential food contamination or any other issues that may arise (Astill et al., 2019; Lin et al., 2021). The goals of food supply chain traceability, according to Ene (2013), are to: 1) contribute to food safety by facilitating the characterization of outbreak or hazard sources, controlling safety alerts, and removing contaminated or dangerous products; 2) provide reliable information to users by insuring product authenticity and that specific production practices have been followed; and 3) improve overall product quality and procedures by identifying sources of non-covalent contamination.

The food supply chain traceability system, according to Opara (2003), is made up of six main parts of traceability.

1. Product traceability includes the physical location of a product at any stage in the supply chain, inventory management, product recall, the type of product traceability, and the type of food to be traced.

2. Process traceability: the types and sequences of actions that affect the product (cause, location, time; chemical, physical, environmental, and atmospheric factors), as well as adherence to legislative standards and laws and collaboration among food supply chain organizations.

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3. Genetic traceability: information on the original product's genetic composition, type and origin of ingredients, and information on the planting materials used to make it (seed, stem cuttings, tuber).4. Traceability of inputs: kind and origin of fertilizers, chemical sprays, animals, feed, additives, and preservation chemicals.

5. Epidemiology of pests, bacteria, viruses, and novel diseases that can contaminate food, as well as disease and pest traceability.

Measurement traceability includes length, depth, precision to trace, quality control, and the type of traceability.

In general, supply chain partners must be able to trace their products both internally and externally. Internal traceability entails sharing logistical data, inventory data, contracts, prices, and organic product certification linkages, whereas external traceability entails supplying consumers with food origin information and farmer data (Yon & Woo, 2018; van Hilten et al., 2020; Xiong et al., 2020). As a result, we see customers demanding food safety, while farmers want tracking tools to help them manage their crops more profitably (Xiong et al., 2020; Chen et al., 2021). As a result, there is a rising need to provide traceability from "farm to fork" in order to increase food safety and customer satisfaction.

Information technology, scientific techniques, technology, biotechnology, logistics, supply chain management, and the food sector all use traceability. Security, quality, dependability, and precision can all be improved using traceability systems. These benefits have an impact on consumer safety and business productivity. Traceability allows you to track down a product at any point along the food chain and within the supply chain.

Consumers may trust consumable products and pay the correct price because of traceability. It also reduces the likelihood of health problems, improves environmental sustainability, and prevents the spread of non-native species. Due to flaws in alimentary security and the introduction of genetically modified organisms, according to Qian et al. (2022), the demand for traceability systems has increased dramatically in recent years. These circumstances contribute to a loss of customer trust and a rise in consumer worry about the potential harmful effects of current behavior. To avoid these repercussions, new policies were enacted with the goal of holding accountable those who disregard safety. To determine culpability appropriately, businesses must show that all due diligence procedures were followed. As a result, there is a greater need for a system that can ensure product quality and enables authorities and firms to track the quality and safety of food goods throughout time and place in order to better cope with a future food crisis. As a result, a traceability strategy centred on quality and safety serves as a preventive tool by assisting producers in successfully managing quality, locating, and isolating food safety issues. The advancement of information and communication technology (ICT) has boosted the speed and precision of data collecting, allowing consumers to receive more trustworthy and transparent information. Traceability can be a component of a system that offers data on all stages of production (Santana et al., 2022). To achieve chain-wide

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traceability, all stakeholders must be able to monitor and retain information internally, as well as communicate it externally to link outputs (selling) and inputs (production) (buying).

3.6 Traceability and customer satisfaction

Customer satisfaction refers to a person's mental condition after receiving a reward for sacrificing money and effort. It has to do with the product and what it does (Kotler et al., 2009); customer satisfaction is the match between the organization's product or service and the customer's expectations. Manufacturers can use a traceability system to monitor and discover any production problems or inefficiencies, which can lead to major process improvements. In lean food production, utilising traceability systems can assist drive significant qualitative and quantitative improvements that effect profitability. Customers can see where things are sourced, how they are made, and how they are transported, which gives them confidence in product quality. Food producers can set themselves apart by utilizing the direct and indirect benefits of a traceability system, which include enhancing processes, regulating the supply chain, reducing defect risk, navigating regulatory difficulties, and boosting customer service levels (Zhou et al., 2022).

4.0 Methodology

The study was premised on a quantitative approach with a sample size of 96 participants randomly selected from a population of food organisations and consumers in Zimbabwe. The sample population was broken down into 31 food organisations and 65 consumers/customers.

5.0 Findings

5.1 Measurement Model

Correlations among constructs and the indicators that go with them variables are depicted in the measuring model. As part of the measurement model assessment, Weak factor loadings of less than 0.60 were deleted (Gefen & Straub, 2005). Due to low factor loadings, only FT1 was removed. To measure construct reliability, the coefficients of Cronbach's Alpha, Rho A, and Composite Reliability (CR) were employed, and all had values greater than the 0.7 criterion for internal consistency. Convergent validity was regarded well when the average variance extracted (AVE) surpassed 0.500. (Dijkstra & Henseler, 2015). Table 1 summarizes the instrument's reliability and validity, as well as the factor loadings. The Fornel-Larcker criterion was used to determine discriminant validity. Table 2 shows the square roots of the AVE for constructs with a higher correlation which is stronger than the inter-construct correlation. Furthermore, HTMT coefficients (heterotrait-monotrait ratio coefficients) with values less than 0.90 were used to determine discriminant validity (Hensler et al., 2015). As a consequence, discriminant validity was determined for the constructs (see Table 3).

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Internal Consistency Validity and Reliability

Table 1: Internal Consistency Reliability and Validity

	Loadings	Cronbach Alpha	rho_A	Composite Reliability	AVE
Customer Satisfaction		0.974	0.976	0.978	0.831
CS1	0.918				
CS2	0.919				
CS3	0.906				
CS4	0.954				
CS5	0.943				
CS6	0.911				
CS7	0.802				
CS8	0.923				
CS9	0.920				
Food Safety		0.917	0.920	0.933	0.667
FS1	0.771				
FS2	0.836				
FS3	0.839				
FS4	0.850				
FS5	0.753				
FS6	0.834				
FS7	0.830				
Food Supply Chain Reliability		0.976	0.980	0.979	0.826
FSCR1	0.914				
FSCR2	0.866				
FSCR3	0.779				
FSCR4	0.963				
FSCR5	0.923				
FSCR6	0.896				
FSCR7	0.918				
FSCR8	0.936				
FSCR9	0.930				
FSCR10	0.951				
Food Traceability		0.927	0.933	0.943	0.735
FT2	0.867				
FT3	0.899				
FT4	0.854				
FT5	0.891				
FT6	0.851				
FT7	0.774				

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Table 2: Fornel-Larcker Criterion

Latent Variables	Customer Satisfaction	Food Safety	Food Supply Chain Reliability	Food Traceability
Customer Satisfaction	**0.912**			
Food Safety	0.835	**0.817**		
Food Supply Chain Reliability	0.701	0.791	**0.909**	
Food Traceability	0.852	0.653	0.620	**0.857**

Note: The square root of the AVE is represented by the variables in bold.

Table 3: HTMT

Latent Variables	Customer Satisfaction	Food Supply Chain Reliability	Food Safety	Food Traceability
Customer Satisfaction				
Food Supply Chain Reliability	0.714			
Food Safety	0.714	0.709		
Food Traceability	0.771	0.642	0.661	

5.2 Structural Model

Evaluation of hypotheses, path analysis, and model fit

The structural model is congruent with the study framework's hypotheses, and the model fits (Table 4). The R2 and Q2 scores, and also path significance, were utilized to analyse a structural model. The strength of each structural path, as assessed by the R2 for the predicted variables, determines the model's goodness of fit (Hu & Bentler, 1999). R2 should be more than 0.1 or equal to it. Falk and Miller (Falk & Miller, 1992). Table 4 shows that all R2 ratings are more than 0.1, indicating that predictive capability has been established. Q2 also highlights the usefulness of endogenous components in predicting outcomes. A model with a Q2 score greater than 0 is predictively significant. The data show that the constructions have a high degree of predictability. The Normed Fit Index and the standardised root mean square residual (SRMR) were also employed to measure model fit (NFI). The SRMR was 0.064, which was less than the 0.10 threshold, implying that the model fit was acceptable (Hair, Sarstedt, Ringle, & Guderg, 2018). The NFI was 0.942, indicating that the model fit was satisfactory and good within the allowable range of 0.9 to 1. (Hooper et al., 2008; Moss, 2021).

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The significance of the linkages was assessed using hypotheses. H1 determines the influence of food supply chain reliability on food traceability. The results indicate that food traceability has a positive and significant influence on food supply chain reliability (β=0.620, t=7.170, p=0.000), with a p-value less than 0.050 and a t-value larger than 1.96. As a result, H1 was supported. Grecuccio et al, (2020) reaffirmed the relationship between food traceability and food supply chain reliability in a study conducted on the supply chain of fish products in Malaysia.

H2 determines whether food traceability has a significant effect on food safety. The data reveal that food traceability had a significant effect on food traceability (β=0.905, t=47.575, p=0.000). As a result, H2 was supported. Dai et al., (2021)'s study on the traceability of green vegetables and fruits revealed that food safety improved since emphasis was placed on accurate flow of information. Good traceability systems reduce the production and distribution of unsafe or low-quality items, reducing the risk of negative publicity, lawsuits, and recalls (Aung & Chang, 2014).

H3 evaluated the influence of food safety on customer satisfaction. The results (β =0.191, t=1.685, p=0.093) indicate that food safety does not have a significant influence on customer satisfaction. Given the study results, H3 was not supported. A previous study conducted by Kennedy and McEntire (2019) on the relationship between food safety and customers satisfaction found out that food safety does not have a direct influence on customer satisfaction. The same study depicted that there was an indirect and mediated relationship between the two variables.

H4 evaluated the influence of food supply chain reliability on customer satisfaction. The results of the study reviewed that food supply chain reliability had a positive and significant influence on customer satisfaction (β =0.244, t=4.168, p=0.000). From the results shown H4 was supported. According to Kamath (2018) customers are always looking forward to food supply chain reliability. They really want to be sure of their expectations at each supply chain stage and what they can benefit from improved value. For instance, cold-chain food warehouses are expected to be good enough to maintain the appropriate healthy temperature for food like meat. As long as customers understand how reliable each supply chain stage is, there will be customer satisfaction.

Table 4: Path Analysis, Model Fit and Hypotheses Assessment

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	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	2.50%	97.50%
Food_SC_Reliability-> Food_Traceability	0.62	0.086	7.17	0	0.386	0.745
Food_Traceability-> Food_Safety	0.905	0.019	47.575	0	0.839	0.933
Food_Safety-> Customer_Satisfaction	0.191	0.113	1.685	0.093	0.026	0.41
Food_SC_Reliability->Customer_ Satisfaction	0.244	0.058	4.168	0	0.143	0.375
	R^2	Q^2				
Customer Satisfaction	0.78	0.639				
Food Traceability	0.384	0.306				
Food Safety	0.819	0.535				
	SRMR	Normed Fit Index (NFI)				
	0.065	0.934				

5.3 Recommendations

The study recommends the following

- Traceability of all types of foods should be given priority to guarantee food safety in Zimbabwe
- The government should enact pieces of legislation that govern traceability of food
- Food supply chain stakeholders should be ready to avail information on food production mechanisms, ingredients, storage, distribution and even disposal
- All food supply chain stakeholders should work tirelessly to eliminate bottlenecks in food supply chain system
- Food supply chain stakeholders should always express their concern with regards to food supply systems, this will enable continuous improvement in the food traceability system

5.4 Conclusion

This paper was meant to emphasise the importance of traceability within the food supply chain, specifically on cold-chain and beverage products in Zimbabwe. It can be concluded that there is no legislation that governs food traceability nor a solid system that can be applied universally within all food sectors.

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