



# Knowing about your food from the farm to the table: Using information systems that reduce information asymmetry and health risks in retail contexts



Chul Woo Yoo<sup>a</sup>, Srikanth Parameswaran<sup>b</sup>, Rajiv Kishore<sup>b,\*</sup>

<sup>a</sup> Department of Information Technology and Operations Management, College of Business, Florida Atlantic University, USA

<sup>b</sup> Department of Management Science and Systems, School of Management, SUNY at Buffalo, USA

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## ABSTRACT

We combined the most relevant variables from the principal agent theory and the technology acceptance model to develop a parsimonious model of technology acceptance for food traceability systems, which are voluntary, direct consumer-use decision support systems that reduce health risks for consumers by reducing information asymmetry between consumers and sellers in retail settings. Results from a survey about a beef traceability system show novel findings about the important roles played by consumers' perceived regulatory effectiveness as an exogenous antecedent, and by their trust in seller and willingness to pay a price premium as mediators, that shape their intentions to use a BTS and conduct a purchase transaction.

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## 1. Introduction

Conventionally, retailers in the packaged food and grocery industry provide only limited information to consumers in terms of nutrition and content information on product labels to comply with various regulatory requirements. Although nutrition information remains important for consumers, food-safety concerns resulting from the increasing potential for the contamination of food products with harmful chemicals and microorganisms within the increasingly complex food supply chain has created a need for consumer information about when, where, and how their food was produced and shipped for retail sale. This development is not surprising; consumers want to ensure the quality of the products before buying them because poor-quality food products can pose significant health risks to them and their family. Moreover, we live in an

information age that has made consumers hungry for information about the products they want to buy. However, information about the when, where, and how of food production and distribution, i.e., the food supply chain, has hitherto been available mostly to the producers, distributors, suppliers, and retailers of food and grocery products, and consumers are mostly out of the loop with respect to such food supply chain information. This vast difference in the amount of food supply chain information known to the sellers vis-à-vis their customers creates a high degree of information asymmetry between these two parties in the retail context.

However, the recent increase in consumers' desire for food-safety related information resulting from their food-safety concerns has forced retailers<sup>1</sup> to share more information with consumers to reduce information asymmetry between the two parties and thereby alleviate consumers' food-safety concerns. Prior research has shown that some types of information systems

\* Corresponding author at: 325N Jacobs Management Center, Buffalo, NY 14260-4000, USA. Tel.: +1 716 645 3507.

E-mail addresses: [yoo@fau.edu](mailto:yoo@fau.edu) (C.W. Yoo), [sparames@buffalo.edu](mailto:sparames@buffalo.edu) (S. Parameswaran), [rkishore@buffalo.edu](mailto:rkishore@buffalo.edu) (R. Kishore).

<sup>1</sup> We use the terms retailer and vendor interchangeably and synonymously in this paper.

(ISs) can play an important role in reducing information asymmetry between vendors and consumers [136]. In the retail context, ISs provided by the retailers to consumers can play an important role in resolving this information asymmetry by providing consumers with more information regarding the food products they want to buy. These systems not only support customers' decision making; they also motivate sellers to charge fair prices for their products, thereby resulting in customer purchases with high satisfaction [26]. For this reason, the packaged food and grocery industry is adopting a variety of ISs for use by consumers in the retail context [50]. Examples of such ISs include Product Search Systems, which provide customers with information about grocery products' location and stock, and food traceability systems (FTSs), which provide customers with information about the production region, producer, timing, and other details of the production and distribution process. Ultimately, retailers' objective is to be successful in selling their food products, and hence, they are adopting and providing such systems for consumer use in the retail context to give consumers information that can help them in their purchasing decisions.

There are several attributes specific to these ISs – particularly the FTSs – that have not been addressed in the literature in a comprehensive way. Moreover, FTSs have started making their foray in the retail packaged food industry only recently, as a result of which there is a paucity of studies about the acceptance and use of these types of systems. The unique combination of attributes FTSs possess and the nascent state of knowledge about their acceptance and usage in the retail packaged food industry provide us with the motivation for this study. We discuss FTSs and the state of knowledge about their acceptance in more detail later. Briefly stated, however, these systems belong to a specific class of systems – voluntary, direct consumer-use, decision support systems – that not only reduce information asymmetry between the seller and the consumer in the retail packaged food products industry but also have the potential to reduce consumer health risk. First, the consumers' usage of FTSs is *voluntary*. A consumer is free to buy a product without using the information benefits provided by these systems. Second, as opposed to transaction processing systems such as retail checkout systems, FTSs are *decision support systems* that are *directly* used by the consumer in a retail context. The consumers themselves directly use these systems to help them support their purchase decision. Third, these systems aim to reduce information asymmetry between the seller and the buyer about the food supply chain by providing consumers with detailed information about when, where, and how the various food products were produced. Fourth, these systems also have the potential to mitigate consumers' health risks from poor-quality or contaminated food products that can sometimes have serious, life-threatening consequences, as opposed to other types of ISs that aim to mitigate strategic, operational, or information assurance risks.

The goal of this study is to shed light on consumers' acceptance and usage of FTSs in a retail packaged food purchasing context and their purchasing behavior in that context with or without the use of FTSs. A key goal of retailers in providing these systems for consumers is to empower them by reducing information asymmetry between the retailer and the consumer; therefore, we use the principal agent (PA) theory and the technology acceptance model [83] as the underlying theories for this study. Furthermore, because collecting and providing detailed food supply chain information to consumers would require additional investments on the part of the various supply chain actors, food products supported by FTSs are likely to be more expensive than food products about which detailed supply chain information is not collected and not provided to consumers. Therefore, we ask: What factors drive consumers' purchase of a food product that may

pose health risks in conjunction with their use of an FTS to reduce information asymmetry in the context of this purchase decision? We develop a research model to address this research question and test it using data collected from a survey administered to users of a beef traceability system (BTS), which is a type of FTS that provides consumers with information about the production, processing, and delivery of the beef that consumers are considering purchasing from a retail store.

This study makes two main contributions. First, to our knowledge, this is the first study to investigate the acceptance and use of FTSs in retail settings. As a voluntary, direct consumer-use decision support systems that reduce information asymmetry between buyers and sellers in a retail context, FTSs unique types of information systems whose acceptance and usage have not been studied in previous IT acceptance literature. This paper developed and tested a parsimonious theoretical model that combined the most relevant variables from the two underlying theories – perceived regulatory effectiveness, perceived purchase risk, trust in the seller, and the willingness to pay a price premium, from the principal agent theory, and the perceived usefulness and ease of use, from the technology acceptance literature – providing evidence of the importance of these variables in the context of FTS acceptance and usage in retail settings. Second, this paper advances the theory of technology acceptance by adding the notion of consumers' willingness to pay a price premium as a mediator of the relationship between trust in the seller and intention to use an FTS and between trust in the seller and purchase intention. This is an important construct in the context of ISs that reduce information asymmetry between consumers and sellers in retail contexts because food products that are produced and sold with more supply chain information to consumers cost more to produce. As discussed before, resolving information asymmetry in a retail packaged food industry context is important to mitigate consumers' food safety concerns, which have increased due to an increasing number of occurrences of tainted food products, which can cause diseases, such as mad cow disease [159]. Together, the above two contributions allow us to advance the theory of technology acceptance in the context of the acceptance and use of voluntary, direct consumer-use decision support FTSs in retail contexts.

The rest of the paper is organized as follows: First, we discuss the theoretical foundations of this study, starting our discussion with food traceability systems (FTSs) and beef traceability systems (BTSs), which are a specific type of FTS, and their importance in the context of consumer concerns about food safety. This is followed by a review of the two umbrella theories – technology acceptance and principal agent theories – because they provide the underpinnings for the research model developed in this study. Next, we develop and discuss the research model and hypotheses to address the research questions posed in this study. We then discuss the methods used in this study, including the measurement instrument, data collection, and analysis methods. Next, we report the structural equation model results and conclude with a discussion of our results, theoretical contributions, practical implications, limitations, and future research directions.

## 2. Theory

### 2.1. Theoretical foundations

#### 2.1.1. Food traceability and beef traceability systems

The goal of this study is to understand consumers' usage of a beef traceability system (BTS), a specific type of FTS that is a voluntary, direct use decision support system, for food purchase transactions in a retail context where food-safety concerns are prevalent. Consumers started paying more attention to food safety

and quality with the occurrence of major food safety-related issues, such as mad cow disease [48]. In Europe, many countries showed a reduction in the sales of beef (e.g., Italy 42%, Germany 60%, and France 40%) after the mad cow disease incident [10]. Food-safety issues not only influence consumers' health; they also affect companies' sales [87] and may affect the food industry as a whole. Therefore, traceability of food has become an important issue in many countries. The General Food Law in the European Union (EU) defines traceability as "the ability to trace and follow a food, feed, food-producing animal, or substance through all stages of production and distribution" [104].

Many countries have introduced FTSS to reduce consumers' perceived purchase risk concerning food safety because these systems have been found to have a positive effect on customer purchases [39,90,169]. FTSS provide a large variety of pertinent information to support consumers' decision making about their food purchases. These systems present consumers with information about the food supply chain, which is entered by supply chain participants, including food producers, distributors, and retailers, at every stage of the food production process. Through these systems, consumers get information about how the food they want to purchase was produced, processed, and delivered. Consumers are also able to make decisions about food safety using the information that FTSS provides them. These systems allow greater control to consumers over the food they buy and more certainty in terms of the quality and the safety of their food. From the retailer's perspective, adopting FTSS allow them to gain a strategic advantage because these systems provide assurances to their customers about the safety of their products and help generate customer loyalty.

A beef traceability system (BTS) is one type of food traceability system. BTSs were originally developed to address consumers' concerns about the possible infection of beef with mad cow disease. A BTS provides detailed information about the birth, breeding, butchery, and processing of the beef. This information history is captured and tracked through a radio frequency identification (RFID) chip that is placed on a cow at the time of its birth. Consumers can check information about the beef that they wish to purchase through their cellular phones, through a personal computer at home or at a kiosk at the market. A distinction on the retail packaging of beef is made between ordinary beef and beef that is managed using a BTS; this readily helps customers gain all the necessary information on beef that is produced and delivered using a BTS. When suspicion of mad cow disease arises, beef from suspicious farms and lots can be accurately withdrawn from the market because even small-sized beef packages have information that can be used to trace farms and beef production lots. Consequently, BTSs elevate customers' sense of food safety toward beef that is managed using a BTS. However, beef managed through a BTS is priced almost twice the amount of ordinary beef, largely due to the costs associated with maintaining the system and capturing information at every stage of the supply

chain. However, consumers may nonetheless want to purchase beef produced and managed using a BTS because they can eliminate the chance that the beef is contaminated by mad cow disease.

To make vendors' investment in these FTSS successful and to reduce consumers' food safety concerns, it is important that consumers widely use these types of information systems. The motivation for this study stems from the fact that although this special type of information system is beneficial both for consumers, in terms of reducing their food safety risk, and for retailers, in terms of their ability to sell food products at premium prices, we know very little about the factors that shape consumers' behavior with respect to usage of these systems to make food-purchasing decisions at retail stores. Therefore, as mentioned, we develop a research model rooted in technology acceptance and principal agent theories to investigate the antecedents and moderators of consumers' intentions to use a BTS and to make purchasing decisions using a BTS. We next discuss the technology acceptance and principal agent theories.

### 2.1.2. Technology acceptance theory

Technology acceptance and use has been studied in multiple technology contexts, including spreadsheets, web sites, electronic payments systems, e-commerce, Internet banking, and electronic health records. In each context, researchers have found unique factors and relationships influencing technology acceptance and use. Given that our goal is to understand the factors that shape consumers' etc decision to use information systems that can help them reduce their health risks in a retail consumer context, we focus our review of technology acceptance and use studies based on two criteria. First, we examine technology acceptance and use studies with respect to ISs that reduce different types of risks because the aim of our research is to understand consumers' technology usage behavior with respect to BTSs that mitigate consumers' food safety and health risk in food purchasing contexts. Second, we examine prior technology acceptance and use studies that are focused on retail consumer contexts because the aim of our research is to understand consumers' BTS usage behavior in conjunction with their food purchase decision-making in a retail context.

Based on our first criteria, we classify risks into two types for the purposes of this review: strategic risk and operational risk. This risk categorization was developed based upon the research contexts of previous studies and the current study. In previous IS literature, strategic risk and operational risk were examined in depth because early ISs focused on strategic and operational advantages that IT adoption provides [99,138]. In Table 1, we therefore categorize research in the IS domain based on who is the buyer of the system (the entity that purchases the technology), what is the level of analysis for the usage of the system (individual or organization), whether usage is voluntary or mandatory, and whether the focal technology alleviates strategic or operational

**Table 1**  
Prior studies of technology acceptance and use focused on strategic and operational risk.

Buyer	Individual	Organization			
	Individual	Individual (outside organization)	Individual (within organization)	Organization	
Level of analysis for usage					
Usage type	Voluntary	Voluntary	Voluntary	Mandatory	
				N/A	
Risk type					
Strategic risk	[3,32,61,60,75,83,111,117,156,160,168]	[2,9,45,84,103,124,128,133,174]	[77,86,109,119]	[8,31,78,96,98,158,164,172]	[23,121,141,142,145,152,164] [107]
Operational risk		[35,76]	[29,41,95,110,162,163]	[127]	[21,30,46,51,52,57,63,85,105,108,116,118,122,126,139,151,176–178]

**Table 2**

Prior studies of technology acceptance and use focused on information assurance risk.

Buyer	Individual	Organization		
		Individual (outside organization)	Individual (within organization)	Organization
Level of analysis for usage	Individual			
Usage type	Voluntary	Voluntary	Voluntary	Mandatory
Information assurance (security and privacy) risk studies	[11,68,106]		[92]	[27,33,79,92,120,149]
				[40,92,107]

risk. However, risks associated with information security and privacy, i.e., information assurance, started receiving much attention from researchers and practitioners in the early 2000s as people's concerns and the consequences of information security and privacy breaches exacerbated after the 9/11 attacks [92,154]. Therefore, following the format of Table 1, in Table 2, we classify prior IS studies of technology acceptance and use that are focused on information assurance risk. We also included health risk in our review not only because it is the context of the present study but also because of the growing importance of IT in the healthcare and agribusiness industries and the increasing focus of research studies in those domains [5,13,48]. These studies of health risk are shown in Table 3, following the format of Table 1.

Early IS acceptance and use research investigated the factors relevant to technology that reduced strategic risk and operational risk. Technology alleviates these risks by increasing productivity, introducing strategic advantages, or reducing errors. For example, early studies focused on technologies related to strategic and operational benefits/risks, such as spreadsheets [29], consumer service systems [30], personal computers [32], electronic data exchange [51], websites [23], Internet banking [45], and online stock trading [84]. More recently, technology acceptance studies have considered information assurance risks, i.e., risks from an information security and privacy standpoint. A majority of these studies addressed behaviors related to a company's or a household's information security. Variables such as psychological ownership [11], response efficacy [92], mandatoriness [27], and punishment severity [79] were found to explain security-related behaviors in the household/workplace.

As IT began to play an increasingly important role in the healthcare arena, recent studies also began investigating technologies and factors relevant to healthcare services. Variables such as social norms [15] and privacy concerns [13] are being used in studies of technology acceptance in this arena. In this arena, we review studies of systems that address health risk, specifically those that reduce the risks that arise due to the lack of food safety. Health risk-alleviating systems have been studied under the context of food traceability systems [81,157], electronic health records [13,15], mobile healthcare systems [173], health information exchange [97], precision farming technology [16,22], and medication safety technology [69]. User-level variables, such as farmers' prior knowledge in technology, education, age [16] and anxiety about technology [157], organizational-level variables, such as farm size and resource availability [16], and other variables, such as social norms [15] and privacy concerns [13], are typically used in this stream of literature.

Research about food traceability systems can be divided into two streams: (i) users' usage behavior with respect to these systems and (ii) their intention to purchase food supported by these systems. Studies have linked perceived usefulness, perceived ease of use, mobile anxiety, perceived limitations, social influence, attitude [157], and voluntariness [81] as antecedents of usage behavior. Factors such as health consciousness, the need for learning, the food traceability label, the care of food value [169], perceived information asymmetry, fear of seller opportunism, perceived uncertainty [48,90], and customer involvement [90] have been linked to users' intention to purchase food supported by these systems.

As seen from the above tables, there is a paucity of studies about the acceptance and use of technologies that are purchased by an organization and used by individuals outside the organization (e.g., customers) and that are focused on reducing health risk for those users. Except for the study by Tsai et al. [157], none of the studies in the health risk mitigating systems category address the voluntary use of food traceability systems by individuals outside an organization. Tsai et al.'s study is, however, silent on the role of users' behavior of purchasing food supported by the system. Furthermore, this study also does not consider information asymmetry-related issues that are at the core of our theorizing. As a result, we conclude that research about the acceptance and use of health risk-alleviating systems, specifically about food traceability systems, is in its early stages. The present study fills this gap in the literature.

In addition, little is known about IT adoption or use in the retail consumer context. As mentioned, the second criterion for our review of technology acceptance and use studies was the retail consumer context. Table 4 categorizes prior studies on technology acceptance and use in retail consumer contexts. IT can be used in the retail context in two ways. A consumer can use the technology directly (direct use), or technology can be used by an employee of an organization to serve a consumer (proxy use). As seen in Table 4, although transaction processing systems (TPS) and management information systems (MIS) are well investigated for both direct and proxy use, little is known (except for Tsai et al. [157]) about the direct customer use of decision support systems (DSS). The present study fills this gap as we strive to foster a new understanding of IT acceptance and use behavior with respect to the direct use of DSSs in the retail consumer context.

### 2.1.3. Principal agent theory

The principal agent theory explains the agency relationship between a principal and an agent under a condition of information

**Table 3**

Prior Studies of technology acceptance and use focused on health risk.

Buyer	Individual	Organization		
		Individual (outside organization)	Individual (within organization)	Organization
Level of analysis for usage	Individual			
Usage type	Voluntary	Voluntary	Voluntary	Mandatory
Health risk studies		[157]	[13,15,16,22,42,81,173]	[69,80,97]

**Table 4**  
Prior studies of technology acceptance and use in retail consumer context.

Type of use	Type of system		
	Transaction processing systems (TPS)	Management information systems (MIS)	Decision support systems (DSS)
Direct use	Self-checkout system [35,76] Online shopping system [25,70,71,100,133,142]	Transaction information system [124]	<b>Food traceability system [157]</b>
Proxy use	Point of sale system [127,172]	Consumer service system [31,158]	Customer resource management system [8,78,96,98]

\*Boldface item is our research context.

asymmetry [64]. The agency situation arises when one party (principal) entrusts the other party (agent) with the authority to perform some task on behalf of the former [89]. However, both the principal and agent are self-interested entities with an interest in accomplishment of their respective goals. This lack of alignment of goals causes information asymmetry-related problems, including the problems of adverse selection (i.e., hiding of information by the agent for its own benefit before the transaction) and moral hazard (i.e., hiding of actions and related information by the agent after the transaction) [14].

Adverse selection occurs when the principal makes an incorrect choice because the agent hides information, which leads to information asymmetry between the principal and the agent [7]. This information asymmetry makes it difficult for the principal to differentiate between the “cherries” (i.e., what is good for the principal) and the “lemons” (i.e., what is bad for the principal) [171]. In our research context, a beef seller and an individual consumer face information asymmetry conditions. The beef seller, who is the agent in this context, has information about the origin, quality, and fair price of the product. The consumer, who is the principal, has to make a purchase decision based on his diagnosis of product and the information the seller provides. If the seller provides limited or inaccurate information on the origin of the beef or sells low-quality beef for the seller's benefit, the consumer, who wants good-quality beef, suffers an adverse selection problem due to the condition of information asymmetry in this context. This adverse selection could also even causes the consumer not to buy the product, which would reduce the overall economic welfare of both the consumer and the vendor. We posit that ISs such as a BTS could provide a remedy for this adverse selection problem by providing customers with accurate and comprehensive information about the beef being offered for sale and institutional-based trust [82,129], thereby resolving, to some extent, the information asymmetry condition.

Moral hazard occurs after the principal hires an agent who does not put in the promised effort or engages in hidden actions for profit, at the principal's expense [89]. Hidden action takes place because the principal cannot monitor the agent's behavior completely. As a remedy to the hidden action problem, signals, incentives, bonding, and behavior or performance monitoring are discussed in the extant literature. In our research context, hidden action and related problems of information asymmetry come into play when retailers who use a BTS do not follow the promised protocols and do not appropriately update information about the beef they are selling. It should be noted that in the context of the present study of BTS, although a government agency installs and supports BTS-related technology and devices, it is the participants in the BTS program, including the retailers, who are supposed to input and update information about the origin and production of their beef products at every stage of the production process. If retailers do not comply with their contract after they gain consumers' loyalty by signaling their use of the BTS system, they are deceiving the consumer because they are not putting in their promised effort and are not providing the consumer updated and

correct information. To mitigate the problem of moral hazard, customers can be charged an extra price premium for the products supported by a BTS to incentivize retailers and other participants not to engage in hidden actions and shirk their responsibility of updating and providing correct and comprehensive beef production information to consumers. Numerous disciplines, including information economics, management, strategy, and finance, have adopted the principal agent theory due to its large range of application in those disciplines. Of particular relevance to this study is a study by Pavlou et al. [136], who investigate each party's behavior in e-commerce using factors of trust and perceived purchase risk because the issues of information asymmetry also arise in that setting.

In addition to price premium, an effective and sustainable certification and monitoring effort on the part of regulatory agencies can also help prevent the hidden action and information phenomenon. The study of the role of government regulatory agencies typically falls under the theoretical lens of institutional theory; governmental regulation and enforcement often lead to the formation of an institutional field in an industry and its associated field with isomorphic (i.e., similar) strategies, processes, and practices in the institutional field [143]. In the IS literature, institutional theory-based research has focused primarily on this isomorphism perspective, whereby firms' technology adoption and usage decisions are explained by institutional factors such as the role of government regulations [101,125]. However, in this study, instead of focusing on the isomorphism perspective, we focus on consumers' perceptions of the effectiveness of government agencies in monitoring the food-supply chain and ensuring that information about the supply chain is comprehensively and accurately captured in BTS systems for later use. This is our focus because our goal in this study is to understand how these consumer perceptions of governmental regulatory effectiveness reduces their information asymmetry about the food product they are considering purchasing. Prior studies in the IS literature have indeed focused on governmental and institutional effectiveness. For example, individual perceptions of institutions have been studied with factors such as perceived monitoring, perceived accreditation, and perceived legal bonds for the purpose of resolving principal agent issues [93]. In a similar vein, other studies explain the role of institutions in reducing information asymmetry in diverse contexts, including information system consulting [62], institution-based remedies in e-retailing [55,150,153], information technology outsourcing [18], and consumer behavior in electronic commerce [12]. We draw from these studies in our theoretical development, which we discuss in the following paragraphs.

## 2.2. Theoretical development

We develop a research model for this study, shown in Fig. 1, rooted in the theoretical foundations reviewed above. Based on our discussions above, the key constructs in our research model include: perceived regulatory effectiveness, trust in the seller,

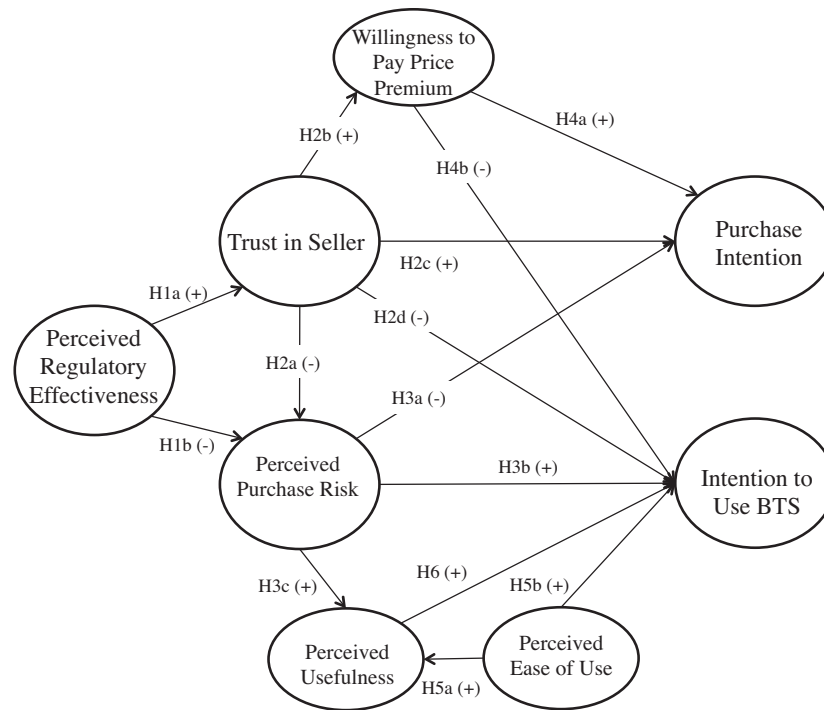


Fig. 1. Conceptual research model.

perceived purchase risk, willingness to pay a price premium, perceived ease of use, perceived usefulness, the intention to use BTS, and purchase intention. We next discuss the hypotheses that emanate from the nomological net of the proposed research model.

### 2.2.1. Perceived regulatory effectiveness

In this study, perceived regulatory effectiveness refers to the extent to which a consumer believes that the regulating agency effectively regulates and monitors the beef sellers and the beef they sell. The regulating agency performs three key functions. First, it is the responsibility of the regulating agency to efficiently enact and enforce regulations to ensure that the entire beef production process, from the farm to the table, is conducted according to promised protocols. In other words, the regulating agency should monitor the hidden actions of the participant in the BTS (i.e., producers, distributors, and sellers). Prior literature on institution theory illustrates the significant influence of institutional monitoring on consumer perception [131]. Because the consumer cannot monitor the hidden actions of every participant at every stage of the beef manufacturing process, she entrusts this role to the regulating agency. Second, the regulating agency establishes a code of conduct and certifies the beef sellers who follow this code. Third, the regulating agency resolves any conflicts that arise between the seller and the consumer.

Due to the way the BTS program is managed, consumers' trust in sellers in the context of this study may be greatly affected by the extent to which they perceive the regulatory authorities as effective in monitoring the retailers who are selling beef using a BTS. Information in a BTS is input by beef production supply chain participants who are part of the different steps of the beef manufacturing process. Participants' use of these systems is voluntary. Due to the voluntary nature of BTS use, it is likely that a participant may not provide complete information in the BTS. Furthermore, in the absence of external oversight, it is also likely that supply chain participants provide false information about their beef in the BTS to maximize their profits, knowing fully well that providing the right information about poor-quality beef

may make that beef go unsold. Consequently, a consumer who uses the BTS may be suspicious of the integrity of the information provided by the retailer with respect to BTS beef under the conditions that BTS usage by the supply chain participants is voluntary and that the regulatory oversight of those participants by appropriate governmental agencies is weak. Thus, consumers' perceived regulatory effectiveness may play a crucial role in strengthening the trust they have in the sellers.

When a consumer believes that the regulating agency (specifically, the Korean Ministry for Food, Agriculture, Forest, and Fisheries, in the context of this study) carries out this job appropriately, her perceptions of regulatory effectiveness increase. An increase in perceived regulatory effectiveness will help improve the consumer's trust in the seller because she feels that the conduct of the seller and the accuracy of information in their BTS is being monitored. Previous studies also demonstrate that a well-structured institution helps improve consumers' trust in sellers [134,135]. Therefore, consumers' trust in sellers is higher when consumers perceive a higher level of regulatory effectiveness in the market. We thus formally hypothesize:

**H1a.** Perceived regulatory effectiveness has a positive effect on trust in the seller.

Risk is a subjective concept that is tough to measure directly. Consequently, perceived risk has been used in the literature as a proxy for risk. Perceived risk is the subjective belief of an anticipated loss resulting from a future transaction [66]. The role of perceived risk in a transaction between a buyer and seller has been shown in the IS literature [100,166]. Perceived risk is inevitable under conditions of information asymmetry. Agency theory assumes that in a real-world economic exchange, an agent tends to show opportunistic behavior and hence hides product-related information from the consumer. The consumer is always at risk of making an adverse selection due to the lack of full and true information about the product [88]. In the context of e-commerce, if a consumer perceives risk in purchasing products from a

particular seller, he tends to avoid conducting purchase transactions with that seller. However, trust plays a role in mitigating perceived risk [134].

In this study, perceived purchase risk refers to a customer's perception of the risk involved in purchasing contaminated beef. In the BTS context, consumers' perceived risk in purchasing beef arises primarily from the negative, and even fatal, effects contaminated beef could pose for consumers and their families. This perceived purchase risk is even higher if the beef comes from an unknown region or from a region with a history of mad cow disease. However, perceived purchase risk is mitigated if consumers know that a government agency supervises and regulates the beef industry by ensuring BTS information's credibility and by enforcing quality control protocols. Bélanger and Cater [24] also argued that institutional safeguards reduce perceived risk. When consumers perceive high regulatory effectiveness in the market, they think that sellers' opportunistic behavior tends to be well controlled. Moreover, appropriate supervision over sellers provides consumers with a greater possibility of avoiding an adverse selection [167]. Previous studies in the retail context show that an effective institutional structure that prevents sellers' fraudulent behaviors mitigates consumers' perceived purchase risk [135]. Additionally, consumers' perceived risk in purchasing BTS beef may be further reduced due to the possibility of receiving compensation for an adverse selection, which may be higher because the regulating agencies also play an active role in resolving conflicts between sellers and buyers. Therefore, we posit a negative association between perceived regulatory effectiveness and perceived purchase risk, and we hypothesize:

**H1b.** Perceived regulatory effectiveness has a negative effect on perceived purchase risk.

### 2.2.2. Trust in seller

If consumers trust a seller who sells beef products managed by BTS, they would expect the seller not to sell poor-quality products or provide inaccurate information. That is, trust causes these consumers to be more assured about the safety of the products they are buying from sellers using BTS. Trust also causes consumers to have a positive expectation about transaction results [65], which, combined with the assurance about their food safety arising from their trust in the seller, also helps alleviate their perceived purchase risk. Previous studies have also shown the mitigating role of trust in consumers' perceived risk [53,100]. We thus suggest a negative relationship between trust and perceived purchase risk, and we hypothesize:

**H2a.** Trust in the seller has a negative effect on perceived purchase risk.

Price premium is generally defined as the monetary amount received by sellers above the average price of a certain matching product [12]. Aaker [1] describes the willingness to pay a price premium as consumers' willingness to pay more for one product than for other relevant products. The willingness to pay price premiums will be higher if the quality of a product is difficult to determine and the consumers are sensitive to the seller's reputation [148]. The difficulty in diagnosing actual product quality before making a purchase influences the willingness to pay a price premium for a product [4]. Consumers who are more concerned about product quality are willing to pay higher price premiums to assure the quality of the product they are buying [48]. Similarly, buyers tend to compensate reputable sellers with high price premiums because these sellers assure safe transactions with a high product quality [12].

In the BTS context, sellers charge a price premium to provide consumers with food safety assurance. However, consumers will not pay a price premium if they have less trust in the seller. Past research indicates that consumers who have high trust in a seller will be willing to pay that seller the additional price to ensure a safe transaction and buy a high-quality product [17,132]. Thus, we hypothesize:

**H2b.** Trust in the seller has a positive effect on the willingness to pay a price premium.

Beef products managed by the BTS are typically twice as expensive as other beef products because of the additional food-safety information provided by the BTS. Therefore, for the consumer to make a purchase decision regarding a BTS-managed product, she has to feel that the food-safety information is accurate enough to be worthy of the extra amount paid for that information. We posit that when a customer has high trust in a seller using BTS, she is less suspicious of the accuracy of the information provided by the seller about the beef she is considering buying. Previous studies also show that trust is the most important factor in deciding consumer purchasing behavior [113,137]. Thus, we posit a positive association between trust in the seller and purchase intention, and we hypothesize:

**H2c.** Trust in the seller has a positive effect on purchase intention.

We posit that in the context of BTS, trust in the seller will have a negative influence on the intention to use BTS. The key purpose of the BTS is to reduce information asymmetry between the buyer and the seller regarding BTS-supported food, particularly for those customers who have low trust in the seller. Therefore, consumers with low trust are more likely to use a BTS to gather more information about the beef that they are considering buying. However, consumers who have high trust in a seller using a BTS will be more likely to purchase beef products directly without checking beef production information using a BTS to reduce information asymmetry between the seller and the consumer. We posit that the BTS system plays the same role as trust in the seller because both of them help alleviate consumers' concerns about food safety issues that arise from the information asymmetry between consumers and sellers. Therefore, when the consumer trusts the seller, there is no need for him to use the BTS to help him in his beef purchase decision. Thus, we suggest a negative relationship between trust and the intention to use BTS, and we hypothesize:

**H2d.** Trust in the seller has a negative effect on the intention to use BTS.

### 2.2.3. Perceived purchase risk

The relationship between perceived purchase risk and purchase intention has been frequently addressed in the literature [56,134]. In this study, a consumer who perceives a higher degree of purchase risk will avoid buying beef products from a seller due to food-safety concerns, thereby showing a low purchase intention. In such cases, the consumer might purchase substitute products, such as chicken or pork, instead of buying beef from the seller. We thus formally hypothesize that:

**H3a.** Perceived purchase risk has a negative effect on purchase intention.

BTS helps consumers make better decisions by providing them with the necessary information to bridge their information asymmetry with the producers and retailers with respect to the beef they are considering buying. We can expect that a consumer who perceives more risk in purchasing a product will have a

greater need to use BTS to resolve the information asymmetry condition because the BTS system exists to provide food safety-related information to consumers. Therefore, we posit that the relationship between perceived purchase risk and the intention to use BTS will be positive. Accordingly, we hypothesize:

**H3b.** Perceived purchase risk has a positive effect on the intention to use BTS.

In the context of BTS, we posit that perceived purchase risk will have a positive effect on perceived usefulness, defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” [60]. BTS provides consumers buying BTS beef with information about the origin and the manufacturing details of the beef product. When consumers feel that buying beef is risky, i.e., their perceived purchase risk with respect to conducting a beef purchase transaction is higher, they will need information from a BTS to alleviate their food safety concerns. Venkatesh and Davis [161] argued that the perceived usefulness of the system increases when the system is applicable to users' needs. Because a BTS can provide requisite information with respect to the beef provenance, which consumers with high perceived purchase risk seek, consumers are likely to rate the BTS as more useful than those who have low perceived purchase risk. Thus, we hypothesize that:

**H3c.** Perceived purchase risk has a positive effect on perceived usefulness.

#### 2.2.4. Willingness to pay a price premium

Though a BTS provides consumers with the necessary information to reduce the information asymmetry problem and aids consumers in their beef purchase decisions, this information comes at a cost. These additional information costs are associated with the costs of installation and upkeep of the BTS and those associated with the continuous tracking, entry, and updating of the necessary information in the BTS throughout the beef production process. As a result, consumers are charged approximately twice the amount for BTS beef than they would be charged for normal beef. This price premium serves as an incentive for supply chain participants to provide accurate information and to not engage in hidden actions or provide false information about the beef to consumers. We posit that this price premium also plays a crucial role in enabling consumers' beef purchasing decision.

Research in the marketing area has shown that consumers perceive higher priced products to be of high quality [4,36,91,123,140]. Given the high cost of BTS beef, consumers considering buying BTS beef would perceive it to be of high quality. The marketing literature has also established that consumers feel that charging an additional price for a product is justified when they associate high product price with high product quality [36,112]. Research has also linked customers' concerns about product quality as a primary reason for their willingness to pay a price premium [38,59]. In other words, a consumer's willingness to pay a price premium acts as a proxy for his perceptions of the product quality. It is well established that perceived product quality is positively related to purchasing behavior, mediated either directly [28,37,175] or indirectly [58,155] by satisfaction.

As argued above, consumers' willingness to pay a price premium acts as a proxy for their perceived product quality. Therefore, in the context of this study, we posit that customers who are willing to pay more for beef products managed by the BTS consider those products to be of higher quality and do not cite cost as the crucial factor for making a purchase decision. Furthermore, based on prior findings in the marketing literature, we also posit

that customers' perceptions of higher beef quality lead to a higher purchase intention. Thus, we hypothesize that:

**H4a.** Willingness to pay a price premium has a positive effect on purchase intention.

Thus, we posit that consumers who have high willingness to pay a price premium are assured of the quality of BTS beef and are therefore less likely to use the BTS, which provides information about the quality of beef in terms of the production information from the farm to the store. Past research has also shown that when consumers are satisfied with product quality, they are less likely to use traceability systems [157]. Thus we hypothesize that:

**H4b.** Willingness to pay a price premium has a negative effect on the intention to use BTS.

#### 2.2.5. Perceived ease of use

Perceived ease of use is the extent to which a user believes that using a system does not require considerable effort [60]. Perceived ease of use herein refers to whether buyers believe that it is effortless for them to obtain information about BTS beef using a BTS. Based on previous research [61,164] about the relationships between perceived ease of use and perceived usefulness and between perceived ease of use and intention to use, we present the following two hypotheses:

**H5a.** Perceived ease of use has a positive effect on perceived usefulness.

**H5b.** Perceived ease of use has a positive effect on the intention to use BTS.

#### 2.2.6. Perceived usefulness

The purpose of the BTS is to alleviate consumers' food safety concerns by providing food safety-related information about beef sold using a BTS. Therefore, when consumers perceive that the BTS is useful for them in that regard, they will intend to use the BTS. Extant research in technology acceptance has shown that perceived usefulness is positively related to the intention to use ISs [61,164]. Thus, we hypothesize that:

**H6.** Perceived usefulness has a positive effect on the intention to use BTS.

#### 2.2.7. Control variables

We carefully chose three variables – experience (prior use of BTS), age, and gender – as control variables in our model because they have been mentioned in the technology-acceptance and marketing literature as important variables that potentially have effects on users' intentions. It has been suggested that knowledge gained from past behavior helps shape users' intention [67], partly because prior experience makes knowledge more accessible in memory and also because past experience may make low-probability events more salient, ensuring that they are accounted for in the formation of intentions [6]. Prior experience is also shown to have an effect on purchase intentions and actual purchases [43]. Furthermore, older people and people with different genders may also perceive and use information systems differently. All three of these variables were proposed as moderators in the UTAUT model [164], an extension of TAM, and some of them were found to have significant moderating effects on some of the relationships between different exogenous constructs and users' intentions. More recently, all three of these variables were proposed as moderators in the UTAUT2 model, a further extension of the UTAUT model in the consumer context



[165], and some of them were found to have significant moderating effects on some of the relationships between different exogenous constructs and users' intentions. Therefore, we included all three variables in our model to control for any direct effects that they may have on the intention to use BTS and purchase intention.

### 3. Research methodology

#### 3.1. Research context

This research was conducted with users of a beef traceability system (BTS) in Seoul, South Korea. A BTS is an easily accessible, direct consumer use, health risk-focused decision support system in the retail industry in Korea. It is installed in almost every beef retailer and grocery market in Seoul, Korea. BTS was chosen as the focal technology for this study because the aim of this study is to understand the consumers' use behavior in the retail context with decision support systems that are designed to alleviate consumers' food safety concerns. Moreover, the beef managed through BTS is priced 2–3 times higher than ordinary beef and beef imported from the US, allowing us to study the effects of consumers' willingness to pay a price premium on their purchasing decisions.

#### 3.2. Measurement development

The measurement items for this study's main constructs were derived from existing validated measures and were adapted for the context of this study. Table 5 shows the main constructs of this study, their items, and the original studies from which they were taken. The preliminary instrument was first pre-tested for content validation, comprehensiveness, and clarity in meaning by panels from both academia and the Korea consumer association. The panel was encouraged to give feedback about the comprehensiveness and clarity of the instruments. The measurement instrument was shortened and refined based on this pretest. The refined survey instrument was then pilot tested with 20 graduate students to check the psychometric properties of the measurement scales.

The refined scale was validated for its statistical properties, and further refinements were made. Once a consensus was reached regarding the clarity and validity of the measurement instruments, the paper-based survey was prepared for the data collection for the main study.

#### 3.3. Survey administration

Questionnaires were distributed to consumers in consumer conventions in Seoul, Korea. We requested one consumer association in one section of the convention to distribute our paper-based questionnaires during the course of a lecture on learning knowhow about food purchasing. Over 500 consumers attended the lecture, and of these consumers, 316 participated in our survey. The respondents were asked to answer all questions based on their experience using a five-point Likert-type scale with an anchor of 1 for "strongly disagree" and 5 for "strongly agree" for all constructs except for buyers' experience, for which the anchors were 1 for "none" and 5 for "over 20 times," and for the willingness to pay a price premium, for which the anchors were 1 for "none" and 5 for "over 200%." Respondents who completed the survey each received \$10 gift certificate. We carefully checked the collected survey responses, and we dropped 71 responses due to the high number of missing values. As a result, the sample used in all further analyses in this study consists of the 245 usable responses that were retained after our initial data review. The profile of the respondents in our sample is provided in Table 6. Although female respondents constitute a larger proportion of our sample than male respondents, our sample may be considered to reflect the population well [44] because 68% of grocery shopping is done by women, according to a report by Chong [49].

### 4. Analysis and results

We used partial least square (PLS) as a measurement validation and to test the structural model in this study. PLS employs a component-based approach for estimation, and it places minimal

**Table 5**  
Measurement items for study constructs.

Perceived regulatory effectiveness	1. I believe that Mifaff <sup>a</sup> is an effective authority that assures all products are in accordance with the posted information. 2. I believe that Mifaff is an effective third-party authority that helps resolve conflicts. 3. I believe that Mifaff is an effective third-party authority that certifies the appropriate conduct of retail beef sellers.	[72]
Trust in seller	1. Sellers who sell products managed by BTS <sup>b</sup> are generally reliable. 2. Sellers who sell products managed by BTS are generally honest. 3. Sellers who sell products managed by BTS are generally trustworthy.	[134]
Perceived purchase risk	1. There is considerable risk involved in purchasing BTS beef in the market. 2. There is a high potential for loss involved in purchasing BTS beef in the market. 3. My decision to purchase BTS beef in the market is risky.	[134]
Intention to use BTS	1. I intend to use BTS in the market in the near future. 2. I predict I will use BTS in the market in the near future. 3. I plan to use BTS in the market in the near future.	[60]
Purchase intention	1. Given the opportunity, I plan to purchase products supported by BTS. 2. It is likely that I will actually purchase product supported by BTS in the near future. 3. I intend to purchase products supported by BTS in the near future.	[134]
Willingness to pay price premium	How much more are you willing to pay for products supported by BTS?	
Perceived usefulness	1. I can obtain useful information about products through BTS. 2. Using BTS enables me to be efficient in searching information about a product. 3. It is important to me to get valuable information about a product.	[60]
Perceived ease of use	1. It would be easy for me to become skillful at using BTS. 2. I can easily obtain information about product through BTS. 3. Using BTS easily is important to me.	[60]

<sup>a</sup> Mifaff represents Ministry for Food, Agriculture, Forest and Fisheries.

<sup>b</sup> BTS represents beef traceability system.

**Table 6**  
Profile of respondents.

Variable	Value	Frequency	Variable	Value	Frequency
Gender	Male	41	Education	High school	12
	Female	204		Undergraduate	73
Age	21–30	13		Graduate	15
	31–40	106	Prior use of BTS	Never	13
	41–50	114		1–2 Times	23
	51–60	12		3–5 Times	96
Occupation	Clerical	43		6–10 Times	79
	Homemaker	179		10+ Times	34
	Student	8			
	Other	15			
N = 245					

restrictions on sample size and residual distributions. PLS is best suited for testing complex relationships by avoiding inadmissible solutions and factor indeterminacy. Hence, we chose PLS to accommodate the presence of a large number of variables, relationships, and mediating effects. PLS Graph was utilized as the software for our analysis.

#### 4.1. Measurement model assessment

PLS analysis involves two stages: (1) the assessment of the measurement model, including the assessment of the reliability and discriminant validity of the measures, and (2) the assessment of the structural model. Individual item loadings and internal consistency were examined as a test of reliability. An individual item loading that is greater than 0.70 is considered adequate [94]. As shown in Table 7, the loadings for all measurement items were above the threshold of 0.70, indicating that our measures exhibit sound internal reliability. In addition, all the loadings were statistically significant at  $p < 0.01$ . The almost uniformly distributed loadings also indicate that each item contributes to each construct equivalently. In addition, we investigated the Cronbach's alpha for internal consistency (see Table 7). The results show that the Cronbach's alpha values for all constructs were greater than 0.70. The average variance extracted (AVE) was also calculated (see Table 7). AVE is a measure of the variance that a construct captures from its indicators relative to the variance

contained in measurement error. Statistically, it is generally interpreted as a measure of reliability for the construct and as a means of evaluating discriminant validity [20]. All AVEs for the constructs in our study were greater than 0.70, indicating that 70% of the variance of the indicators could be accounted for by latent variables. Additionally, if all composite reliability values are higher than 0.70, it can be concluded that the measurement has both internal consistency and convergent validity [170]. All composite reliability values in this study were higher than 0.80 (see Table 7). Together, these statistics provide evidence that the measurement model of this study exhibited suitable reliability, internal consistency, and convergent validity.

AVE is also used to assess discriminant validity [73]. The square root of AVE should be greater than the correlations among the constructs to show discriminant validity. In other words, the amount of variance shared between a latent variable and its indicators should be greater than the shared variance between the latent variables. Table 8 shows the inter-correlations among study constructs and the variance shared between latent variables and their indicators. The diagonal elements of Table 8 are the square root of the AVE. As seen, the square roots of all AVE values are greater than the off-diagonal elements.

To assess discriminant validity further, we also conducted a cross-loading analysis [73]. As seen in the cross-loading table (Table 9), all items of each construct have self-loadings over 0.70, which are significant at a confidence level of 0.01. Furthermore, the loadings of items from other constructs on a particular construct, i.e., cross-loadings, are below 0.70. There is only one item, PEOU1, that has a self-loading of 0.691, which is less than but very close to the cutoff value of 0.70. However, this self-loading value is still higher than all the cross-loadings for the PEOU scale, providing further evidence of discriminant validity in our measurement model. Finally, to further ensure that our model did not suffer from multicollinearity issues, we calculated variance inflation factors (VIFs), adopting as a DV both intention to use BTS (VIF1) and purchase intention (VIF2; Table 8). As seen, all VIF values are much lower than the recommended threshold of 10 [19,34]. Put together, these results indicate that the measurement model of this study exhibits strong discriminant validity and does not suffer from multicollinearity issues.

#### 4.2. Structural model assessment

With an adequate measurement model, we tested the hypotheses proposed above by examining the structural equation model, and our results are shown in Fig. 2. After computing the path estimates in the structural model, the PLS software was used to perform bootstrap analyses to obtain the corresponding  $t$ -values for all path coefficients. Support for the hypothesis can be determined by examining the sign (positive or negative) and the statistical significance based on the  $t$ -value for its corresponding path.

**Table 7**  
Descriptive statistics and construct reliability.

Items	Loadings	Mean	S.D.	Alpha	C.R.	AVE
PRE1	0.91	3.80	0.75	0.86	0.92	0.78
PRE2	0.86	3.98	0.82			
PRE3	0.88	3.90	0.75			
Trust1	0.84	3.74	0.74	0.87	0.92	0.79
Trust2	0.92	3.70	0.80			
Trust3	0.91	3.75	0.81			
Risk1	0.98	3.80	0.75	0.97	0.98	0.93
Risk2	0.95	3.98	0.82			
Risk3	0.97	3.90	0.75			
PP	n/a	3.18	1.02	n/a	n/a	n/a
PU1	0.88	3.80	0.68	0.8	0.89	0.73
PU2	0.94	3.95	0.71			
PU3	0.72	3.99	0.86			
PEOU1	0.69	3.82	0.73	0.84	0.87	0.69
PEOU2	0.90	4.03	0.76			
PEOU3	0.88	3.93	0.71			
PI1	0.82	3.62	0.72	0.82	0.89	0.74
PI2	0.87	3.50	0.72			
PI3	0.88	3.54	0.75			
ITU1	0.86	2.72	0.68	0.84	0.9	0.76
ITU2	0.85	2.70	0.78			
ITU3	0.90	2.71	0.74			

Note: PRE, perceived regulatory effectiveness; Trust, trust in seller; Risk, perceived purchase risk; PP, willingness to pay price premium; PU, perceived usefulness; PEOU, perceived ease of use; PI, purchase intention; ITU, intention to use.

**Table 8**

Correlations of the latent variables and the square root of AVE.

Variables	VIF1	VIF2	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) PRE	n/a	n/a	0.88											
(2) Trust	1.84	2.06	0.66	0.89										
(3) Risk	1.47	1.47	-0.60	-0.55	0.96									
(4) PP	1.45	1.46	0.38	0.50	-0.26	n/a								
(5) PU	1.02	1.03	0.04	-0.01	-0.04	-0.06	0.85							
(6) PEOU	1.02	1.06	0.01	-0.05	0.09	-0.03	0.66	0.83						
(7) PI	1.05	n/a	0.57	0.69	-0.49	0.57	0.03	0.00	0.86					
(8) ITU	n/a	1.53	-0.44	-0.52	0.38	-0.36	0.07	0.05	-0.45	0.87				
(9) Age	1.08	1.07	0.07	0.21	-0.11	0.05	0.04	-0.07	0.08	-0.09	n/a			
(10) PUB	1.15	1.17	0.26	0.21	-0.20	0.32	0.08	0.01	0.46	-0.25	0.01	n/a		
(11) Gen	1.06	1.05	-0.01	0.03	-0.06	-0.03	-0.06	-0.12	0.07	0.06	0.13	0.01	n/a	
(12) Mark	n/a	n/a	0.03	0.09	-0.05	-0.07	0.04	-0.06	0.02	-0.03	0.05	-0.02	-0.01	n/a

Notes: (1) Diagonal elements represent square root of AVE. Variable names are: PRE, perceived regulatory effectiveness; Trust, trust in seller; Risk, perceived purchase risk; PP, willingness to pay price premium; PU, perceived usefulness; PEOU, perceived ease of use; PI, purchase intention; ITU, intention to use; PUB, prior use of BTS; Gen, gender; and Mark, marker variable. (2) Price premium, PUB, Age, Gender and Marker are single-item variables. (3) VIF1 was calculated by adopting ITU as a dependent variable. (4) VIF2 was calculated by adopting TI as a dependent variable.

The  $R^2$  value was used to assess the proportion of variance in the endogenous constructs that could be explained by the antecedent constructs. Trust in the seller, perceived purchase risk, the willingness to pay a price premium, perceived usefulness, perceived ease of use, and the three demographic variables (buyer's prior use of BTS, age, and gender) explain approximately 32.9% of the variance in the intention to use BTS. Based on this  $R^2$  value of 0.329 for the intention to use BTS considering all predictors, the Cohen's  $f^2$  effect size is 0.491. The  $R^2$  value for the intention to use BTS considering only the three control variables is 0.081, based on which the incremental Cohen's  $f^2$  for the intention to use BTS (considering only the five hypothesized predictors) is 0.369. This incremental Cohen's  $f^2$  is greater than the cutoff value of 0.35, denoting a large effect size for the intention to use BTS [54,144].

Trust in the seller, the willingness to pay a price premium, perceived purchase risk, and the three demographic variables explain 63.3% of the variance in purchase intention, the other dependent variable in this study. Based on this  $R^2$  value of 0.633 for purchase intention, considering all predictors, the Cohen's  $f^2$  effect size is 1.724. The  $R^2$  value for purchase intention considering only

the three control variables is 0.218, based on which the incremental Cohen's  $f^2$  for purchase intention to use BTS (considering only the three hypothesized predictors) is 1.131. This incremental Cohen's  $f^2$  is greater than the cutoff value of 0.35, denoting a large effect size for purchase intention [54,144]. Furthermore, a high degree of explained variance for the other endogenous constructs in the model, including the willingness to pay a price premium ( $R^2 = 0.253$ ), trust in the seller ( $R^2 = 0.435$ ), perceived purchase risk ( $R^2 = 0.397$ ), and perceived usefulness ( $R^2 = 0.570$ ), make the interpretation of path coefficients meaningful.

An assessment of the path coefficients in our structural model results, shown in Fig. 2 in terms standardized regression coefficients, indicates that trust in the seller is a more influential factor ( $b = 0.467, p < 0.01$ ) that affects purchase intention than the willingness to pay a price premium ( $b = 0.226, p < 0.01$ ) and perceived purchase risk ( $b = -0.124, p < 0.01$ ). Trust in the seller ( $b = -0.379, p < 0.01$ ) is also found to have more influence on the intention to use BTS than the willingness to pay a price premium ( $b = -0.084, p < 0.10$ ) and perceived purchase risk ( $b = 0.149, p < 0.01$ ). Consistent with the extant results in the literature, our

**Table 9**

Item loadings and cross-loadings.

	PRE	TRUST	Risk	PP	PU	PEOU	PI	ITU
PRE1	0.908	0.631	-0.562	0.389	-0.025	-0.032	0.552	-0.416
PRE2	0.861	0.533	-0.449	0.318	0.010	0.006	0.446	-0.365
PRE3	0.884	0.579	-0.562	0.309	0.048	-0.022	0.514	-0.389
Trust1	0.405	0.842	-0.422	0.394	0.004	-0.020	0.423	-0.453
Trust2	0.413	0.917	-0.499	0.459	-0.032	-0.040	0.436	-0.441
Trust3	0.347	0.912	-0.533	0.488	0.016	-0.037	0.374	-0.505
Risk1	-0.327	-0.558	0.985	-0.266	-0.010	0.110	-0.242	0.396
Risk2	-0.285	-0.529	0.949	-0.259	-0.006	0.078	-0.218	0.360
Risk3	-0.279	-0.492	0.967	-0.230	-0.018	0.103	-0.200	0.347
PP	0.235	0.503	-0.261	1.000	-0.076	-0.048	0.376	-0.360
PU1	-0.039	-0.052	0.015	-0.089	0.875	0.519	-0.045	0.049
PU2	0.045	0.012	-0.050	-0.062	0.943	0.565	0.012	0.080
PU3	0.045	0.008	-0.073	0.026	0.723	0.681	0.069	0.039
PEOU1	-0.039	-0.036	0.070	-0.023	0.665	0.691	-0.024	-0.006
PEOU2	0.021	-0.063	0.113	-0.017	0.570	0.900	-0.005	0.045
PEOU3	-0.022	-0.021	0.049	-0.028	0.640	0.880	0.002	0.042
PI1	0.443	0.527	-0.362	0.613	-0.005	-0.021	0.824	-0.412
PI2	0.500	0.627	-0.392	0.400	0.044	0.037	0.868	-0.368
PI3	0.529	0.630	-0.497	0.465	0.044	0.017	0.880	-0.389
ITU1	-0.234	-0.468	0.339	-0.311	0.015	0.002	-0.181	0.900
ITU2	-0.224	-0.476	0.276	-0.335	0.053	0.054	-0.254	0.865
ITU3	-0.131	-0.427	0.387	-0.295	0.046	0.015	-0.172	0.854

Note: PRE, perceived regulatory effectiveness; Trust, trust in seller; Risk, perceived purchase risk; PP, willingness to pay price premium; PU, perceived usefulness; PEOU, perceived ease of use; PI, purchase intention; ITU, intention to use.

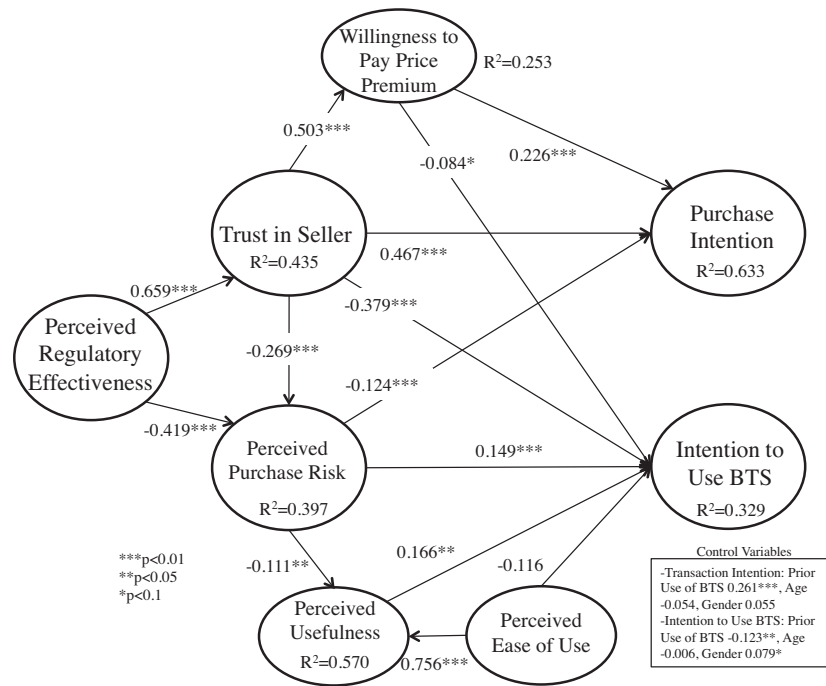


Fig. 2. Results from the structural equation model.

analysis also confirms that perceived ease of use has a significant influence on perceived usefulness and that perceived usefulness has a significant effect on the intention to use BTS. Furthermore, as control variables, prior use of BTS and gender were found to have statistically significant effects on the intention to use BTS, with prior use of BTS exhibiting a stronger and statistically significant influence at the 0.05 level, whereas gender exhibited a weak influence at the marginal 0.10 level of significance. The results were similar for the effect of the control variables on purchase intention, with prior use of BTS exhibiting a stronger and statistically significant influence at the 0.01 level, whereas gender and age did not exhibit an influence.

As shown in Table 10, 12 of the 14 proposed hypotheses were supported by the results of this study; 11 of them found support at 0.05 or better significance levels, and one of them found marginal support at the 0.10 level. The two hypotheses that were not

supported are H3C and H5B. First, H3c proposed a positive effect of perceived purchase risk on perceived usefulness, but our results found this coefficient to be negative and contrary to the hypothesized direction. This finding may partly be explained by the wording of our items for the perceived purchase risk construct. Because the items measured the perceived purchase risk of buying BTS beef, a user who found buying BTS beef to be risky might not have found the BTS to be useful. Setbon et al. [146] show consumers' beef consumption decreases significantly when they are concerned about mad cow disease. It is therefore possible that consumers' negative attitude toward purchasing beef, arising from their perceptions of a higher degree of purchase risk, can affect their perceived utility of related ISs. Shedding further light on this relationship is an area of future research, and we accordingly include this as a future research direction later in the paper. Second, H5b proposed a positive effect of perceived ease of use on

Table 10 Hypothesis testing results.

	Hypothesis	Direction	Path coefficient	t-Value	Support
PRE → Trust	H1a	+	0.659***	14.640	Supported
PRE → Risk	H1b	–	–0.419***	5.459	Supported
Trust → Risk	H2a	–	–0.269***	3.841	Supported
Trust → PP	H2b	+	0.503***	12.505	Supported
Trust → PI	H2c	+	0.467***	8.891	Supported
Trust → ITU	H2d	–	–0.379***	4.664	Supported
Risk → PI	H3a	–	–0.124***	2.895	Supported
Risk → ITU	H3b	+	0.149***	2.612	Supported
Risk → PU	H3c	+	–0.111**	2.515	Not supported – sign in opposite direction
PP → PI	H4a	+	0.226***	5.352	Supported
PP → ITU	H4b	–	–0.084*	1.503	Supported
PEOU → PU	H5a	+	0.756***	21.833	Supported
PEOU → ITU	H5b	+	–0.116	1.301	Not supported – coefficient not significant; sign in opposite direction
PU → ITU	H6	+	0.166**	2.054	Supported

Notes: (1) PRE, perceived regulatory effectiveness; Trust, trust in seller; Risk, perceived purchase risk; PP, willingness to pay price premium; PU, perceived usefulness; PEOU, perceived ease of use; PI, purchase intention; ITU, intention to use. (2) One-tailed tests due to directional hypotheses.

\* p < 0.10.  
 \*\* p < 0.05.  
 \*\*\* p < 0.01.

the intention to use BTS, but our results found this coefficient to be negative. Contrary to the hypothesized direction, the results show this coefficient to be statistically not significant. We conjecture that this negative coefficient on the path from PEOU to ITU may be due to a suppression effect.<sup>2</sup> This is because as the marginal effect of PEOU on ITU (after controlling for the effects of the three demographic variables and four other predictors on ITU) is positive, the bivariate zero-order correlation between PEOU and ITU is positive, as seen in Table 8 above. This finding about a potential suppression effect may in fact be insightful and may help further develop the technology acceptance literature. We therefore discuss it further in the directions for future research section.

Overall, our results show that perceived regulatory effectiveness plays an important role in building trust in the seller and reducing perceived purchase risk. The significant result of the relationship between trust in the seller and perceived purchase risk shows that trust in the seller mitigates the perceived purchase risk of the consumer. Significant relationships between the willingness to pay a price premium and purchase intention and between the willingness to pay a price premium and the intention to use BTS illustrate that the willingness to pay a price premium is an important factor that not only motivates consumers to conduct retail transactions but also reduces their likelihood of using a BTS to get detailed information on the beef they are considering buying. Moreover, our results demonstrate that trust in the seller is a prime determinant of consumers' intentions to purchase beef and of their intentions to use a BTS to obtain information on the beef they are considering buying. Lastly, the significant relationship between perceived purchase risk and intention to use BTS supports the notion that the information asymmetry condition often increases customers' perceived purchase risks, as a result of which they are more likely to use BTS types of systems to reduce information asymmetry and make meaningful purchase decisions.

#### 4.3. Common method bias test

We investigated the presence of common method bias because both the dependent and the independent variables came from the same survey. The partial correlation technique was adopted using a marker variable to control for the common method bias [114,115]. A variable that is theoretically not related to the main dependent variables of a study can be used as a marker variable [115], and a significant association between the marker and the dependent variables in the study can be assumed to be due to common methods bias. The question "Do you agree with the opinion that the price of 500 ml bottled water will increase in the future?" was used as a marker variable in this study because it is theoretically not related to any of the principal constructs of the present study.

First, we computed the correlation coefficient between the marker and other variables in the study (see Table 8). Then, we tested the significance of the relationships among our core variables after partialling out the effect of the marker variable from all our study correlations following the procedure in [114,115]. The size and the significance of the proposed relationships did not change after conducting this procedure. As a result, we conclude that common methods bias is not a significant threat to this study.

<sup>2</sup> A suppression effect is said to have occurred if the absolute beta weight of a predictor is greater than the predictor's zero-order correlation with its outcome variable, or if the beta weights and the zero-order correlations are of a different sign [102]. The suppression effect we encounter in our study is negative suppression, a case where the beta weights and the zero-order correlations are of a different sign [130].

#### 4.4. Mediation tests

In the current study, trust in the seller, perceived purchase risk, and the willingness to pay a price premium act as the mediators for the effects of perceived regulatory effectiveness on purchase intention, one of the two dependent variables in this study. Furthermore, trust in the seller, perceived purchase risk, the willingness to pay a price premium, and perceived usefulness act as mediators for the effects of perceived regulatory effectiveness on the intention to use BTS, the other dependent variable in this study. These factors not only mediate the relationship between perceived regulatory effectiveness and purchase intention and between perceived regulatory effectiveness and the intention to use BTS but also mediate the relationships between mediators. Because this study adopts multiple mediators, we tested the mediation effects using Preacher and Hayes's multiple mediator model # 6 with a bootstrap resampling size of 1000 to calculate the significance of the indirect, mediated effects [147]. The results of our mediation analyses<sup>3</sup> are shown in Table 11.

Our mediation analyses illustrate the important roles of three of the four mediators considered in our study: trust in the seller, the willingness to pay a price premium, and perceived purchase risk. First, our results show that the total and direct effects in both mediation models – one for purchase intention as a dependent variable and the other for the intention to use BTS as a dependent variable – are significant, suggesting partial mediation. Furthermore, all paths that include trust in the seller as a mediator are highly significant, except for the one path that contains PU as a mediator. This confirms that trust in the seller partially mediates the relationship between perceived regulatory effectiveness and the intention to use BTS and the relationship between perceived regulatory effectiveness and purchase intention. These results are not found in previous studies and implicate that trust is a key bridge that can increase purchase intention and reduce the intention to use the system.

Second, our analyses also show that the two mediating relationships that include the willingness to pay a price premium as a mediator are highly significant. These results also confirm the significant mediating role of the willingness to pay a price premium,<sup>4</sup> which partially mediates the effect of perceived regulatory effectiveness on both the intention to use BTS and purchase intention. These findings indicate that perceived regulatory effectiveness builds consumer trust in the seller and her willingness to pay a price premium, which in turn reduces her intention to use BTS and improves her purchase intention. The mediating role of the willingness to pay a price premium is also a novel finding of this paper.

Finally, we also find perceived purchase risk to be a significant mediator in our model because all paths in which this construct is

<sup>3</sup> The indirect effects calculated by the Preacher and Hayes model #6, shown in table 11, may be slightly different from the results calculated using path estimates from the PLS model. This is because the Preacher and Hayes model includes all paths between constructs while estimating the indirect effects estimates considering the sequence of mediators in the model. However, we do not hypothesize all paths between the IV, the various mediators, and the DV; accordingly, we run our PLS model with only the paths that we hypothesize in our study. Therefore, the path coefficient estimates calculated by our PLS model, shown in Fig. 2, would be different from the path coefficients for individual paths calculated using Preacher and Hayes's PROCESS multiple Mediator model #6. As a result, the calculation of indirect effect estimates would also be different. Furthermore, our model consists of multiple mediators, and the total effect from an IV to a DV would be the sum of all the indirect effects and the direct effect, not just the indirect effects of the hypothesized mediated paths.

<sup>4</sup> We are very thankful to an anonymous reviewer for suggesting the inclusion of the willingness to pay a price premium as a mediator of the relationship between trust and purchase intention, instead of as a moderator of that relationship. The results indeed provide strong evidence for the willingness to pay a price a premium as a mediator rather than a moderator.

**Table 11**  
Mediating effects analysis.

Effects of PRE on PI					
Direct effect			Total effect		
Estimate	S.E.	t Value	Estimate	S.E.	t Value
0.092 <sup>***</sup>	0.052	3.539	0.448 <sup>***</sup>	0.046	9.748
Indirect effect (Bootstrap)		LLCI	ULCI	Mediation supported?	
PRE → Trust → PI	0.254 (0.043) <sup>***</sup>	0.296	0.465	Partial mediation	
PRE → Trust → Risk → PI	0.016 (0.010) <sup>***</sup>	0.002	0.036	Partial mediation	
PRE → Trust → PP → PI	0.060 (0.016) <sup>***</sup>	0.035	0.087	Partial mediation	
PRE → Risk → PI	0.032 (0.016) <sup>***</sup>	0.003	0.064	Partial mediation	
Effects of PRE on ITU					
Direct effect			Total effect		
Estimate	S.E.	t Value	Estimate	S.E.	t Value
−0.067 <sup>**</sup>	0.070	−1.916	−0.348 <sup>***</sup>	0.056	−12.489
Indirect effect (Bootstrap)		LLCI	ULCI	Mediation supported?	
PRE → Trust → ITU	−0.209 (0.057) <sup>***</sup>	−0.302	−0.110	Partial mediation	
PRE → Trust → Risk → ITU	−0.021 (0.015) <sup>***</sup>	−0.054	−0.002	Partial mediation	
PRE → Trust → PP → ITU	−0.024 (0.016) <sup>***</sup>	−0.050	−0.001	Partial mediation	
PRE → Risk → ITU	−0.036 (0.021) <sup>***</sup>	−0.071	−0.003	Partial mediation	
PRE → Trust → Risk → PU → ITU	0.001 (0.002) <sup>ns</sup>	−0.001	0.004	Not supported	
PRE → Risk → PU → ITU	0.001 (0.003) <sup>ns</sup>	−0.002	0.006	Not supported	

1. <sup>ns</sup>not significant (one-tailed tests due to directional hypotheses).

2. Level of confidence for all confidence intervals in output: 90.00%.

3. PRE, perceived regulatory effectiveness; Trust, trust in seller; Risk, perceived purchase risk; PP, willingness to pay price premium; PU, perceived usefulness; PI, purchase intention; ITU, intention to use.

4. Covariates (i.e., Prior Use of BTS, Gender, and Age) in models of PI and ITU only.

\* $p < 0.10$ .

\*\* $p < 0.05$ .

\*\*\* $p < 0.01$ .

included as a mediator have significant mediating effects, except for those that contain perceived usefulness. However, perceived purchase risk has lower estimates and weaker significance levels ( $t$  values) for indirect effects than the willingness to pay a price premium, indicating that the willingness to pay a price premium is a stronger mediator of the relationship between trust and transaction intention.

## 5. Discussion

### 5.1. Limitations

Before we discuss our findings and the theoretical contributions of our study, we would like to note three key limitations of our study. First, because this study was conducted in Korea, we cannot generalize the results of this study for consumers across different cultures. This limitation calls for future related work in which data are collected from consumers from several cultures. Second, because our sample consists of 83% female respondents, the results of the study should be interpreted with caution, particularly with regard to their generalizability for the larger grocery-shopping population. However, as noted above, 68% of grocery shopping is done by women, according to a report by Chong [49], and our sample reflects this population generally well. Nonetheless, future studies should attempt to recruit more representative grocery-buying samples to improve the generalizability of the findings of this study. Third, because this study used cross-sectional data, there could be ambiguity surrounding the causal relationships it proposed and tested. However, our research model and hypotheses were rooted in extant theory, and the theoretical logic underpinned the causal direction of the proposed relationships. Nonetheless, future studies should collect multi-wave data to establish causality empirically.

### 5.2. Summary of findings

Our results shows several key findings specific to the IS of our interest: voluntary, direct-use, decision support systems provided in the retail context to mitigate the consumer's food-safety risk. First, this study introduced the concept of perceived regulatory effectiveness in addressing the hidden action problem that arises in a retail context because sellers have more information about products they are selling than the buyers. In such an environment of information asymmetry, the role of monitoring is important to prevent any hidden action problems. Monitoring ensures that the information provided by the system is not false or inaccurate. As our results show, high perceived regulatory effectiveness significantly increases a consumer's trust and significantly reduces her perceived purchase risk. This in turn increases her purchase intention and decreases her intention to use BTS. Our results regarding the relationship between trust in the seller and perceived purchase risk are consistent with previous literature [134]. However, our mediation analyses indicate that trust in the seller plays the important role of a mediator in the relationships between perceived regulatory effectiveness and perceived purchase risk and between perceived regulatory effectiveness and the willingness to pay a price premium. That is, monitoring effort increases the customer's trust in the seller, and trust in the seller in turn alleviates the customer's perceived purchase risk and boosts up her willingness to pay a price premium. Unlike traditional risk-mitigation systems, perceived regulatory effectiveness plays a key role in the use of these types of systems because the concern here is food-safety risk. Because food-safety risk is a key concern here, the usage behavior of this special class of ISs are contingent upon how much a central agency regulates the information provided by this system.

Two, our results show that as a consumer's trust in the seller who provides these types of ISs increases, so does the likelihood

that the customer will conduct a purchase transaction with that seller. Previous studies also report that trust in the vendor is the most important factor in customers' decision making in purchasing a product [17,47,74]. However, as hypothesized, our results also show that trust in the seller is negatively related to the system use. This shows that when the customer has greater degree of trust in the seller, i.e., the provider of the system, she buys the risky food product without necessarily using the system that provides her with the food-risk related information. This shows that vendors should install decision support systems for risky food products to encourage more purchases. However, vendors should not necessarily expect consumers to use these IS because their presence in itself acts as an assuring mechanism for making a purchasing decision.

Finally, for a product that typically requires paying twice the original price, the consumer's willingness to pay price premium plays an important role. The results confirmed that the willingness to pay a price premium causes a customer to engage in a purchase intention. In addition, the mediating effect of the willingness to pay a price premium provides further insights about the influence of trust in the seller on purchase intention and intention to use BTS. The results of the partial mediating effect show that when a customer has high trust in a seller, it increases his purchase intention and reduces his intention to use BTS indirectly through the willingness to pay a price premium.

### 5.3. Theoretical contributions

This study makes two main contributions. First, to our knowledge, this is the first study to investigate the acceptance and use of FTSs in retail settings. As a voluntary, direct consumer-use decision support systems that reduce the information asymmetry between the buyer and the seller in a retail context, FTSs are unique types of information system whose acceptance and usage have not been studied in previous IT acceptance literature. This paper developed and tested a parsimonious theoretical model that combined the most relevant variables from the two underlying theories – information asymmetry-mitigating factors of perceived regulatory effectiveness, perceived purchase risk, and trust in the seller, from the principal agent theory, and technology acceptance-related factors of perceived usefulness and ease of use, from the technology acceptance literature – providing evidence of the importance of these variables in the context of FTS acceptance and usage in retail settings. By juxtaposing these factors with the outcomes in a single model, this paper bridges the principal agent theory and the technology acceptance model and builds a parsimonious, novel model of user behavior for systems that support the purchasing of safer food products in the retail context.

Second, this paper advances the latest stream of research in the theory of technology acceptance, which has focused on consumers' acceptance of technology [1,165]. It does so by adding the notion of consumers' willingness to pay a price premium as a mediator of the relationships between trust in the seller and purchase intention and between trust in the seller and the intention to use BTS. This is an important construct in the context of ISs that reduces information asymmetry between consumers and sellers in retail contexts such as FTSs because the price premium is for health risk-related information, to which a consumer might attach a higher price, and food products that are produced and sold with more supply chain information for consumers cost more to produce. Recent research on technology acceptance has focused on the context of consumer technologies, where factors such as price value [165] have been identified as crucial in driving the acceptance of consumer technologies, which are primarily voluntarily used. We add to this body of research by analyzing the role of the willingness to pay a price premium on purchase intention and acceptance of consumer technologies in the food-safety context.

As discussed before, resolving information asymmetry in a retail packaged food industry context is important to mitigate consumers' food safety concerns, which have increased due to the increasing number of occurrences of tainted food products, which can cause diseases such as mad cow disease [159]. Together, these two contributions allow us to advance the theory of technology acceptance in the context of the acceptance and use of voluntary, direct consumer-use decision support FTSs in retail contexts.

### 5.4. Implication for practice

This study provides two practical implications. First, it shows that high-risk food products may be marketed more successfully through the use of voluntary, direct-use decision support systems. The more the consumers notice the support of FTSs in providing information about risky food products, the more likely they will be to conduct purchase transactions for products supported by those FTSs. Second, it is also important to let the customers know that the information provided by these FTSs is assured to be accurate due to the oversight of a regulating agency. Perceived regulatory effectiveness has a significant effect on building trust in the seller and reducing perceived purchase risk. Therefore, positive consumer perceptions concerning FTS regulation and oversight will help spur consumers to purchase food products even without using the FTS for their food purchases.

### 5.5. Directions for future research

We would also like to propose future research directions for extensions of this study. First, contrary to our hypothesis, we found that perceived purchase risk has a negative effect on perceived usefulness. We argued that customers who perceive a higher level of purchase risk are more likely to find a BTS useful because they would like to reduce their information asymmetry by gaining information through the use of the BTS. What we found is that customers who perceived a higher level of purchase risk considered the BTS not to be useful to them. This may partly be because of the wording of our items for the perceived purchase risk construct. Because the items measured the perceived purchase risk of buying BTS beef, a user who considered buying BTS beef to be risky might also not have found the BTS to be useful. Nonetheless, future research should attempt to shed more light on this surprising contrary finding.

Second, also contrary to our hypothesis, we found that perceived ease of use has a negative effect on the intention to use BTS, and we conjectured in the structural model assessment section that this negative relationship may perhaps be due to a suppression effect. As noted in the positioning of our paper, the current paper is the first study about the use of a particular class of decision support systems that are directly used by consumers in a retail context to reduce information asymmetry while making purchase decisions. Is it possible that PEOU has a negative direct effect on ITU in the context of such a special class of information asymmetry-reducing information systems in the retail context? Given the nascent stage of the research about these types of information systems, we cannot clearly answer this question or pinpoint the theoretical underpinnings for this negative effect. Rather, we leave the study of a potential suppression situation arising in the case of the effect of PEOU on ITU in the context of specific types of information systems as an avenue for future research.

Finally, we included experience, age, and gender as control variables. We did not include them as research variables in our model because they have been recently proposed as moderators in the UTAUT and the UTAUT2 models [164,165], and we wish to control for any direct effects that these variables may have on the intention to use BTS and purchase intention, our focal dependent

variables. Our goal in this paper was to develop a parsimonious model of technology acceptance for FTSs rooted in the two foundational theories – the technology acceptance model and the principal agent theory – that are directly pertinent to our paper. Adding these variables, which may have some effects on the intention to use BTS or purchase intention as research variables but are not established as key antecedents in these two foundational theories, would only further complicate our research model, which already contains a number of important constructs as exogenous antecedents and mediators. However, future studies should consider including these variables as moderators of the key relationships in the proposed model to further extend our understanding of consumer acceptance and the use of FTS technology.

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**Chul Woo Yoo** is an assistant professor in the Department of Information Technology and Operations Management in the College of Business at the Florida Atlantic University. He holds a PhD degree in MIS from the State University of New York at Buffalo. His research interests include information security, human factor in e-business, information privacy, software piracy, and agricultural information system. His works have been published in *Decision Support Systems*, *Information Development*, *Information and Management*, and *International Conference on Information Systems*.



**Srikanth Parameswaran** is a PhD candidate of Management Science and Systems at the University at Buffalo (UB). His research interests include information technology adoption and diffusion, with system design and social networks as a key theme. His publications have appeared in *Information and Management* and *Journal of Information Privacy and Security*. He has presented his research at major conferences on information systems, including AMCIS, WITS, WeB, and ASIA-SKM. Srikanth is a recipient of the Dean's PhD Rising Star Award, which honors the first- or second-year doctoral student who has most exhibited exceptional early overall performance in the PhD program. He is also a recipient of the Berner Award for

research excellence. In addition, he has been a reviewer for the *Journal of Strategic Information Systems* and *Information Systems Frontiers*, and for conferences such as AMCIS, PACIS, and AOM Annual Meeting. Srikanth received his MS in Management Information Systems from the University at Buffalo, and Bachelor's degree in Computer Science and Engineering from Anna University. He has industry experience in healthcare social media and internal communications, and international education research. He can be reached at, [sparames@buffalo.edu](mailto:sparames@buffalo.edu).



**Rajiv Kishore** is currently an associate professor in the School of Management at the State University of New York at Buffalo. His interests are in IT outsourcing, IT innovation, and knowledge management. Rajiv's research was funded by the National Science Foundation, and he published papers in premier journals including *MIS Quarterly*, *Journal of Management Information Systems*, *Information & Management*, *Decision Support Systems*, and *IEEE Transactions on Engineering Management*. He served as a guest editor for *Journal of the Association for Information Systems* and currently serves as an Associate Editor for *Information & Management*, both premier journals in the IS field.