The role of information technology in recall cases: a systematic literature review

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Abstract

Transparency in communication and the exchange of information is a challenge for the management of supply chains, which have become more complex and, consequently, more vulnerable to recall incidents. Therefore, this research aims to analyze information technology (IT) and its different roles in the mitigation process and information sharing between different Stakeholders in recalls. For this, a systematic literature review with content analysis was carried out. Our results identify the IT and how it can contribute to each stage of the recall, relating it to the Stakeholders involved.

Keywords: Information Technologies, Recall, Stakeholders.

Introduction

Modern supply chains are intrinsically complex, as they comprise geographically disconnected entities and subject to greater competition to meet customer requirements (Lambert and Enz, 2017; Urciuoli and Hintsa, 2018). In this environment, disruptions can occur suddenly, bringing increasingly significant impacts to companies (Kamilaris et al.,2019). Among such disruptions, recalls are highlighted, which pose risks to consumer safety. Bernon et al. (2018) define recall as the act of requesting the return of a batch or the entire production of a product that could negatively affect consumer health or violate current government regulations (Kong, Shi and Yang, 2019).

In this sense, in the search for mitigating the causes of recalls and better coordination between different links in a chain, information technology (IT) stands out to make supply chains more efficient and improve compliance with customer requirements (Dimakopoulou, Pramatari and Tsekrekos, 2014; Yan et al., 2016). IT can help in traceability and in improving the flow of information. Through traceability, IT can contribute to the prevention of fraud throughout the chain (Biswas et al., 2017). Accurate tracking of products can help reduce rework and recalls (Saberi et al., 2019). Regarding the flow of information, IT is a key facilitator, supporting coordinated decision-making between Stakeholders concerning disruptions management (Dimakopoulou et al., 2014). Engelseth and Wang (2018) state that information is a central component in managing risks and possible disruptions. This statement is even more relevant in food chains, in which the complexity and risks involved require a faster response to disruptions (Rogerson, Parry and Glenn, 2020) under the risk of causing damage to the health of the population. Thus, in dealing with such risks, chains can adopt both a more reactive stance and a proactive stance. To better understand this process of responding to disruptions, Scholten, Scott and Fynes (2014) classify it in four phases: preparation, immediate response, recovery, and mitigation. While mitigation is the application of measures that will prevent the onset of a disaster or reduce the impact if it occurs, the preparation includes activities that prepare the chain for an effective response, both proactive (Altay and Green, 2006; Tomlin, 2006). Opposed to this are the reactive phases, an immediate response initiated after an interruption and actions taken to eliminate the impacts caused, aiming at recovery (Bischof, 2019). To effectively manage disruptions, chain Stakeholders must share a common understanding and awareness of the risks that may occur throughout their operations (Scholten et al., 2019).

Freeman (1984) defines a Stakeholder as any group or individual that can affect or be affected by implementing an organization’s objectives. The Stakeholder theory seeks to understand the relationship management between the different actors, seeking to integrate their interests and avoid conflicts (Miles, 2012). Given this need for integration between the different Stakeholders, IT can provide a collaboration platform (Hall et al., 2012) and, spread digitalization along the supply chain. (Abeyratne e Monfared, 2016; Rogerson, Parry and Glenn, 2020). In this way, there is an opportunity to identify the IT and analyze how IT help in the conduct of recalls and the coordination between the different chain Stakeholders.

There is extensive literature related to role of IT in supply chain risk management including investigations on the development of ITs that support product traceability along the supply chain (Ringsberg, 2014; Vukatana et al., 2016; Giagnocavo et al., 2017; Astill et al., 2019; Wallave and Manning, 2020). However, many of the relevant publications on the role of IT in supply chain management did not directly involve the issue of recalls (Crumbly and Carter; 2015). Thus, to fill this gap, this article aims to analyze the main ITs and their different roles in the recall mitigation process and information sharing between different Stakeholders.

The article is organized as follows: the introduction is in the following section. The third section presents the methodological procedures used to conduct the research. In the fourth section, the main findings are presented, and, finally, the conclusions and suggestions for future studies.

Research method

This systematic literature review follows the steps defined by Tranfield, Denyer and Smart (2003). Initially, a protocol was established (Table 1), which aims to guide the research execution (Denyer; Tranfield, 2009). The interest of this research is in the convergence between the four main points: IT, recall, supply chains and Stakeholder (see the research questions in Table 2).

Table 1 - Systematic Review Protocol

Phase	Stage	Details	Description
Phase 1	**Planning**	Search the main journals in Operations and SCM for articles that discuss IT, Recall, supply chains and Stakeholders.	• Define research problem; • Identify constructs; • Find keywords; • Definition of Strings (Table 2).
Phase 2	**Conduction**	Database search (Web of Science, Scopus, Scielo and EBSCO)	1st Filter: reading the title, abstract; 2nd Filter: reading the introduction and the conclusion and analysis of inclusion and exclusion criteria (Table 3); 3rd Filter / Classification: reading and critical evaluation of the complete articles.
	Analysis of articles	Reading of selected articles	• Read selected material; • Content analysis of articles selected for using QDA Miner software.
Phase 3	**Results**		• Discussion and presentation of results.

Source: Elaborated by the authors

Table 2 - Questions, Keywords and Strings

Question	Keywords	String
Which IT can contribute along the supply chains to recalls events?	Information Technology; Supply Chains; Recall.	(("technolog*" OR "information technolog*" OR "communication technolog*" OR "digital technolog*") AND ("supply chain*" OR "supply net*" OR "value chain*" OR "net* chain" OR "net* value") AND ("recall*"))
How can IT contribute to recall events (before, during and after their occurrence)?	Information Technology; *Recall*.	(("technolog*" OR "information technolog*" OR "communication technolog*" OR "digital technolog*") AND ("risk" NEAR/5 ("mitigat" OR "management*" OR "reduc" OR "diminish" OR "minimiz" OR "practic")) AND ("supply chain*" OR "supply net*" OR "value chain*" OR "net* chain" OR "net* value"))
How do key Stakeholders use IT to reduce recall in food chains?	Stakeholders; Information Technology; Recall; Supply Chains.	((stakeholder* OR "interested part*" OR "related part*" OR "actor*" OR "agent*" OR "player*" OR "collaborator*" OR "partner*") AND ("technolog*" OR "information technolog*" OR "communication technolog*" OR "digital technolog*") AND (("supply chain*" OR "supply net*" OR "value chain*" OR "net* chain" OR "net* value") NEAR/5 "food*"))

Source: Elaborated by the authors

In the planning stage, we searched relevant studies related to the research questions initially formulated. Given this, we selected four databases: Scopus, Web of Science, EBSCO and Scielo. From the searches in the databases, 1,153 articles were obtained, which were subsequently submitted to the selection and evaluation filters.

In phase 2, which covers driving and analysis, in the first stage, the articles were read in order to rule out any studies that were not relevant. This was achieved by defining some inclusion and exclusion criteria identified in Table 3 (Denyer; Tranfield, 2009). After applying the inclusion and exclusion criteria, 116 articles were selected for content analysis, as shown in Figure 1. In the second stage of phase 2, each of the selected articles was reviewed and analyzed from a complete reading. This step was performed based on the content analysis method, according to Krippendorff (2013). To conduct this analysis, we used the co-occurrence analysis using the QDA Miner.

Table 3 - Inclusion and exclusion criteria

Criterion	Inclusion criteria	Exclusion criteria	Reading
Access	Access to the paper, be written in English or Portuguese.	Do not have access to the document. Not written in English or Portuguese.	Reading the title and abstract.
Focus	Recall and IT concepts in the context of operations management, supply chain management and quality management.	Refer to IT recall or application focusing on an area other than supply chain, operations and quality management.	
Recall	Handle recalls in the sense of removing products in the context of product problems.	Do not refer to the concept of removal.	Introduction Reading and conclusion
ITs	Treat directly about the application of IT.	Do not refer directly to IT applications and their benefits.	
Analysis Unit	Supply chains or organizations involved in recall events.	Address recalls or IT in communities, environments or individuals unrelated to the parties involved in a supply chain.	
Quality	Scientific journal with peer review.	Scientific periodical without peer review, business newspapers, current magazines, conferences, books and websites.	

Source: Elaborated by the authors

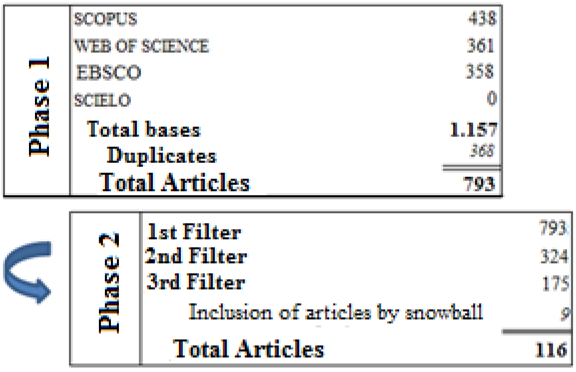

Figure 1 - Process of reading and applying filters
Source: Elaborated by the authors

In phase 3, analysis and discussion are presented regarding the main findings that meet the research questions initially raised. The results were obtained using the content analysis method conducted according to Krippendorff (2013). The QDA Miner was used to perform this analysis, which is a qualitative analysis tool, which makes it possible to extract information from documents (QDA, 2020). In this phase, an extraction form was also created using the Parsif.al software. This form was intended to explore the relevant details in each study and allow the researcher to be involved in the process (Denyer; Tranfield, 2009).

Findings

The results were organized according to topics related to the systematic review questions. The first section presents the main IT applied, according to the papers reviewed. The second section describes the contribution of the identified ITs in the different phases of the recall. The third section describes the role of Stakeholders in IT adoption and recall events.

Role of ITs to recall incidents

Table 4 presents each of the identified ITs.

Table 4- Tecnhology and its contributions for recalls

Technology	Contribution	Authors
Barcode/Q.R. Code	When added to the product labeling process, they allow, at a low cost, the feeding of traceability systems.	Dai et al. (2015); Vukatana, Sevrani and Hoxha, (2016); Bai et al. (2017); Gao et al. (2019); Bumblauskas et al. (2020).
Big Data	It allows the collection and treatment of large volumes of information, with high speed and high variety, to improve visibility and speed up decision making. It helps predict disruptions, in addition to providing more accurate data to build resilient chains.	Astill et al. (2019); Bischof and Wilfin-ger, (2019); Ivanov, Dolgui e Sokolov (2019); Protopop and Shanoyan (2019); Singh et al. (2019).
Blockchain	Digitally compacts information about each product, creating a digital record that provides transparency, compliance, authenticity and tamper-proof quality. Because it is decentralized and distributed, it is accessible to all Stakeholders.	Rejeb et al. (2018); Astill et al. (2019); Banerjee (2019); Jayaraman, Salah and King (2019); Rejeb e Rejeb (2019); Bumblauskas et al. (2020); Daun et al. (2020); Qian et al. (2020).
RFID (Radio-frequency Identification)	It guarantees the acquisition and storage of data that favors greater speed, accuracy, efficiency, and secu-rity in sharing information among all Stakeholders.	Kumar (2014); Vuktana, Serani and Hoxha (2016); Bai et al. (2017); Astill et al. (2019); Ivanov, Dolgui e Sokolov; 2019).
Sensors	They make it possible to automatically capture and track information and report it safely and reliably in real-time.	Vukatana, Sevrani and Hoxha (2016); Comes et al. (2018); Bischof and Wilfinger (2019); Srivastova (2019); Bumblauskas et al. (2020); Duan et al. (2020).
AI (Artificial intelligence)	It involves determining a specific information man-agement problem, introducing a computational for-mulation, and creating an algorithm to implement it.	Montecchi, Plangger and Etter (2019); Zimmermann (2019); Rodríguez-Espíndola et al., 2020.
CPS (Cyber-Physical Systems)	Provide more accurate and real-time data to enable less human interaction in decision-making.	Branke et al. (2016); Hofmann and Rüsch (2017).
Cloud Computing	Provides a channel to store and process many data sets.	Choi, Chan and Yue (2017); Li and Zhou (2020).
AM (Additive Manufacturing)	It leads to the possibility of producing modules, components and even final products anywhere in the supply chain.	Li et al., 2017; Ivanov, Dolgui and Sokolov (2019).

Source: Elaborated by the authors

As mentioned, IT allows collecting information throughout the entire chain, in an agile and precise manner. This manner allows companies to successfully manage a recall process and reestablish trust among consumers (Kumar, 2014). Besides, IT allows information to be distributed in a decentralized manner and can be accessed independently by the various Stakeholders, without compromising their security, favoring the transparency and visibility of the entire process that the product goes through the chain. In recall incidents, this makes it possible to address the visibility and traceability challenges present in the chain (Kshetri; Loukoianova, 2019) to increase the authenticity of information and speed up recall (Qian et al., 2020).

The contribution of ITs in the different phases of the recall

Then, it was possible to report the different phases of the recall with the phases of the management of disruptions, as shown in Figure 2, where the main actions carried out in each of these phases are pointed out. Mitigation and Preparation actions have a proactive character; that is, they are measures to prevent failures from occurring. Therefore, they are congruent with the actions taken before a recall, when mitigation processes are also used and proactive measures. Hora, Bapuji and Roth (2011) state that these proactive actions imply that a company conducts quality checks and inspections and can discover defects in the product that poses a security risk (Schniederjans and Khalajhedayati, 2020). Regarding Immediate Response actions, the main actions are to collect the harmful product and communicate with all Stakeholders involved. In this phase, transparency and traceability of information in all links in the chain are the main actions to successfully manage the recall effects (Kumar, 2014) ensure that the actions taken are coordinated through timely and accurate information.

Finally, in the management of disruptions are the actions for the Recovery phase, which aim to reestablish order, which is congruent with the actions of the phase after the recall, when the information captured during this procedure will serve as support to prevent future incidents. Kumar (2014) emphasizes that after the conclusion of the recall, it is essential that companies work to have fail-proof processes based on what has been observed. In Table 5, the main contributions of each of the main IT found are summarized.

Disruption Management Phases	Recall Phases	Actions	Authors
Mitigation	Before	Quality checking and inspection	Bumblauskas et al., (2020)
		Control of suppliers	Fu and Zhu (2019)
		Storage control	Astill, et al., (2019)
		Transport control	Banerjee (2019)
		Packing control	Kumar (2014)
Preparation		Sanitary control	Allata, Valero and Benhadja (2017)
		Thermal control	Kumar, Singh and Modgil (2020)
		Composition control	Kumar and Budin (2006)
		Control in the phases of the harvest	Banerjee (2019)
Immediate Response	During	Communication with Stakeholders involved	Chammen et al., (2018)
		Identification of harmful items	Kumar (2014)
		Return of harmful items	Bamgboje-Ayodele et al., (2016)
		Identify causes	Kumar (2014)
Recovery	After	Evaluate effects	Singh and Singh (2019)
		Search for solutions	Singh and Singh (2019)
		Define mitigation opportunities	Lohmer, Bugert and Lasch (2020)
		Continuous improvement plans	Kumar (2014)
		Employee training	Crumbly and Carter (2015)

Figure 2 - Phases of the recall and main actions
Source: Elaborated by the authors

Table 5 - Contribution of ITs to the recall phases

Technology	Mitigation/Preparation	Immediate response	Recovery	Authors
	BEFORE	**DURING**	**AFTER**	
Bar-code/Q.R. Code	It stores the data, providing accurate information, collaborating with the prior identification of potential failures	Location, identification and monitoring of products	Improvement identification based on observed failures	Bai et al., (2017); Gao et al., (2019); Bumblauskas et al., (2020).
Big Data	Transparency and authenticity of data for all Stakeholders	Improvements to the process of identifying items to be collected in a recall	Perception of the failures already faced in the practice of risk mitigation	Astill et al., (2019); Bischof and Wilfinger, (2019); Singh et al., (2019).
Blockchain	Transparency needed to help solve food security problems	Accurate product tracking, which can speed up product recall	Access to information seeking to avoid the occurrence of failures already witnessed.	Banerjee (2019); Jayaraman, Salah and King (2019); Daun et al., (2020);
IOT	Accurate information and efficient monitoring and information capture	Accurate product tracking	It assists to develop continuous improvement	Banerjee (2019); Birkel and Hartmann (2020); Duan et al., (2020).
RFID	Reliable and efficient traceability. Information about the entire production process	Product traceability for proactive actions, as well as to successfully manage a recall process	Assistance in restoring consumer confidence after recalls through quick and accurate actions	Kumar (2014); Astill et al., (2019); Ivanov, Dolgui and Sokolov; 2019).
Sensors	Streamlines data collection, reducing the risk of input errors, reporting data safely and reliably	They combine motion, location, environmental and physiological sensors that allow advanced location and tracking.	Efficiently identifying the failures that occurred, providing information for establishing future mitigation plans.	Comes et al., (2018); Bischof and Wilfinger (2019); Bumblauskas et al., (2020)
AI.	Authentication of products through decentralized verification	It assists quality through traceability together with post-harvest management.	Avoid the occurrence of failures already witnessed through computational formulations.	Montecchi, Plangger and Etter (2019); Zimmermann (2019); Rodríguez-Espíndola et al., 2020
CPS	Less human interaction in decision making and automatic reporting of variations in indicators	They provide a high level of connection and traceability, favoring the location of items	Through more accurate data, it favors better adaptation and flexibility	Branke et al., (2016); Hofmann and Rüsch (2017); Ding (2018); Ivanov, Dolgui and-Sokolov (2019).
Cloud Computing	Transparency and security through the provision of a high volume of information in real-time	A high volume of data that supports product traceability	Storage and processing of many data sets, providing insights for improvement	Choi, Chan and Yue (2017); Zimmermann (2019); Li and Zhou (2020); Saurabh and Dey (2020)
AM	Production with less human interaction reducing production failures	It increases manufacturing flexibility, making it easier to replace defective items	It contributes to a faster, more efficient and resilient chain	Li et al. (2017); Ivanov, Dolgui and Sokolov (2019).

Source: Elaborated by the authors

Main Stakeholders and ITs used in food chains

As seen, each IT has a unique contribution; however, the Stakeholders also have a significant influence for the actions carried out in recall events and the adoption of such technologies. Given this, Table 6 presents the role of Stakeholders both for the actions of a recall and the adoption of ITs throughout the chain.

Table 6 - Role of Stakeholders

Stakeholder	**The role on the actions of *Recall***	**The role of IT adoption**	**Authors**
Consumers	Do not consume and return (when possible) the well treated in the recall.	Seek to know the origin and quality of the product. Pressure to adopt traceability.	Montecchi, Plangger and Etter (2019); Demestichas et al., (2020).
Retailers / Distributors	Store and receive recall products warnings, as well as demand quality.	Feed the distribution logistics data in the chain.	Vlachos (2013); Prashar et al., (2020); Demestichas et al., (2020).
Focal Company	Ensure food security.	Facilitator for strategic IT adoption decision	Min (2019); Prashar et al. (2020).
Employees	Follow the manufacturing and distribution procedures and protocols.	Development and implementation of all security and traceability systems	Wynn et al. (2011); Vishnubhotla et al. (2020)
Providers	Guarantee the quality of the raw material.	Share product information with the focal company to help define quality.	Bamgboje-Ayodelea, Ellisa and Turnera (2016); Fu and Zhu (2019); Lui et al. (2019)
Media	Communicate to the consumer the decision of a focal or supervisory company.	Persuade and make consumers aware of the transparency of information and product quality.	Wynn et al. (2011); Kumar (2014); Astill et al. (2019).
NGOs	Provide independent technical support to provide transparency.	Press for transparency and quality of products, based on decisions with technical data.	Qi Tang et al. (2015); Kumar et al. (2020).
Government agencies	Prevent dangerous outbreaks. Establish guidelines, laws and regulations.	Demand transparency, based on new laws created. Encourage investment in technologies.	Crumbly and Lemuria (2015); Protopop and Shanoyan (2016); Demestichas et al. (2020)
Carriers / Operators Logistics	Ensure the safe transportation of products. Manage product returns.	Monitor products in real-time to improve chain performance.	Yang, Yang and Plotnick (2013); Banerjee (2019);
Producers	Monitor and supervise all stages of the harvest in the food sector.	Inform the data for traceability.	Aung and Chang (2014); Salah et al. (2019); Bumblauskas et al. (2020).
IT vendors	Develop improved systems for quality and food safety tracking.	Initiate the effort to provide technology knowledge to organizations. Develop systems that communicate IT.	Bosona and Girma (2013); Astill et al. (2019); Ahmad Tarmizi et al. (2020)

Source: Elaborated by the authors

Conclusion and Suggestions for future research

This article reviewed the existing literature on the interrelationships between ITs, recalls and supply chains. After conducting the review, the main ITs that have applications in each of the three phases of the recall were identified and the main actions carried out in each phase, also relating them to the Stakeholders involved, as shown in Figure 3.

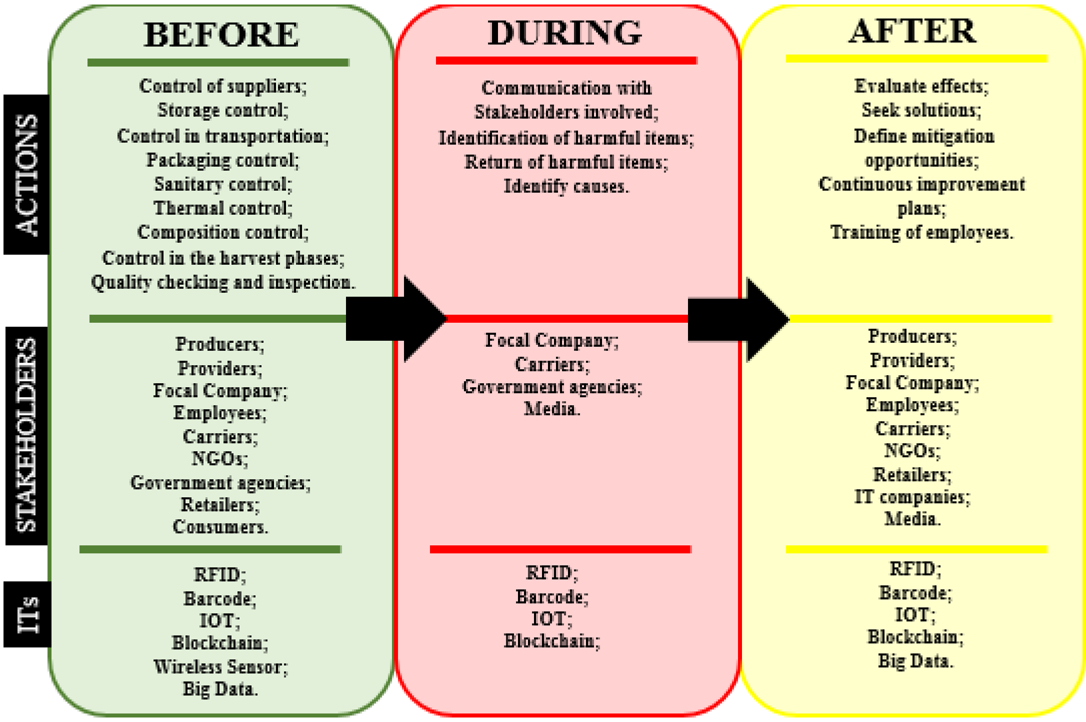

Figure 3 - Actions, Stakeholders and ITs of the recall phases
Source: Elaborated by the authors

This article contributes to identifying the relationship between the different phases of the recall, the IT and Stakeholders involved. It also helps to identify the role of the Stakeholders in the actions to mitigate the recall and their contribution to the IT adoption. In terms of managerial contributions, we highlight some ITs to establish transparency and traceability along the chain to reduce and/or eliminate the causes of the occurrence of recall.

Some research gaps have been observed, and some possibilities for future research are suggested. The first suggestion is about studies analyzing the theory of Stakeholders with the cases of recalls. Despite the relevance of the theory concerning this theme, in the analyzed articles, no authors were found that addressed the recall events from the perspective of Stakeholders' theory. Another point is the application of ITs for recall cases, many articles address the issue of risk management, but few articles have explored the recall and its phases. Finally, the last gap and suggestion for future study are empirical studies to analyze the emerging IT from I4.0, so that its effects have not been so well explored in the context of supply chains and recalls.

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