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Perspectives on Effectiveness of Food Safety Management Systems During Pandemic

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Abstract

Food safety management systems (FSMSs) are available to support manufacturers and their supply chains in protecting consumers and maintaining desirable business reputations. FSMS implementation can be challenging and so also is ensuring system effectiveness. Several effectiveness factors of FSMS have been reported in the literature and FSMS effectiveness is an important consideration during challenging periods, such as the Pandemic. Since the outbreak of COVID-19, a possible spread through the food supply chain has been a concern, especially regarding food safety. Discussions of the role of FSMSs in addressing those concerns are a developing topic. The research objective of this paper is to determine if COVID-19 changed the focus of food safety practitioners on different FSMS effectiveness factors. A case study approach is adopted to accomplish the research objective, using a focus group in the glass container manufacturing industry. The focus group involved seven stakeholders of a container glass organization in the US. An open-ended question exercise regarding critical effectiveness factors was the central methodology of the focus group discussions. The focus group was asked to give their perspective on the possible impacts of COVID-19 on a set of crucial effectiveness factors of FSMS. The research concluded that the COVID-19 Pandemic shifted practitioners' emphasis from fostering the employees' pro-social behaviour to procedures and processes.

Keywords: FSSC 22000, FSMSs, focus group, COVID-19, FSMS effectiveness

1. Introduction

Food manufacturing continues to grow worldwide and represents one of the important sectors relied upon during the Pandemic. Food manufacturing and its supply chains covers a variety of sectors that acknowledges the importance of food safety i.e., routines in the preparation, handling and storage of food, important for preventing foodborne illness

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and injury. To support food manufacturers and their supply chains, numerous internationally recognized Food Safety Management Systems (FSMSs) exist, and they include the BRC, HACCP, IFS, ISO22000 and QS, providing support for minimizing risks, amongst others [1]. Firms implement FSMSs primarily either voluntarily due to perceived benefits over costs or they are forced to do so by stakeholders including regulatory bodies [2, 3]. Generally, FSMSs are necessary to protect consumers and business reputations [4].

The Global Food Safety Initiative (GFSI) has identified several FSMSs. The identified systems apply a robust hazard analysis and risk management methodology based on the Hazard Analysis Critical Control Point (HACCP) principles [1]. Not all of these systems apply to every industry. A special case of interest in this paper is the packaging industry wherein only a few of the identified FSMSs systems are applicable. This is very much so because, for example, the U.S. Food and Drug Administration (FDA) does not monitor packaging manufacturers but instead charges food manufacturers to ensure the hygiene of their suppliers. Section 415 of the Federal Food, Drug and Cosmetic Act explains that food processing facilities are required to register with the FDA; however, this requirement does not extend to packaging manufacturers uninvolved with food processing [5]. The US federal regulatory agencies, FDA and Food Safety and Inspection Service (FSIS) initiate food recalls if they become aware of a food safety issue [6]. According to Potter [7], 4.6% of all food recalls in the USA are driven by glass contamination. Moreover, many authors calculate the food companies' direct cost at $10 million for each recall [8,9,10]. Carlson and Fallaw [11] elaborate on the unique divergences of different FSMS schemes and acknowledge that there is no single approach covering all requirements. Among the GFSI recognized standards is FSSC 22000, which encompasses packaging and food manufacturers [12] and is often utilized in several industries including the container glass industry which offers a range of packing products for the food and beverages industry, amongst others.

Successful implementation of FSMS is dependent upon several factors that include organizational-specific aspects such as company size, type of linkages such as suppliers and customers, the adoption of automation, type of product, requirements for quality assurance and extent of top management support. These factors also carry through to post-implementation and can impact the effectiveness of FSMS in a firm. In addition, a key consideration is resilience i.e., the capacity to recover quickly from challenges, such as those arising from the COVID-19 Pandemic. Studies have reported the challenges and responses of companies in the context of FSMSs during COVID-19 [13]. There are also some indications of the effectiveness of FSMS in supporting companies through the pandemic [13]. Companies with FSMSs are reported to differ from those without in their approach to tackling COVID-19 [13]. The research objective is to determine if COVID-19 changed the focus of food safety practitioners' on different FSMS effectiveness factors. This is done by exploring practitioners' perceptions of the effectiveness of FSMS during the COVID-19 Pandemic.

Consequently, this paper's research questions are:

- What are the effectiveness factors of FSMSs in the container glass industry?
- What is the impact of COVID-19 on the effectiveness factors discussed?

The remainder of the paper is structured as follows. Section 2 reflects on related work regarding COVID-19 and food safety and highlights the effectiveness factors of FSMS. Section 3 describes the research methodology and elaborates on the required preparation for focus group research and how such research is conducted. Section 4 represents the case study, which illustrates the glass container manufacturing process, the role of glass containers in the supply chain, the food safety risk associated with glass containers, and the case study results, followed by a discussion of the findings. Finally, Section 5 ends the paper with conclusions and suggestions for future work.

2. Background and Related Work

This section contains background on COVID-19 and food safety. Also covered in this section is an overview of related work on the effectiveness of FSMSs.

2.1. COVID-19 and Food Safety

Since the pandemic's beginning, a possible spread of COVID-19 through the food supply chain was a concern of scientists. In addition, discussions of the role of FSMSs in addressing those concerns are a developing topic in the research community. Hence, numerous works can be found reflecting on the status of knowledge regarding these

matters. Therefore, the papers highlighted below illustrate related work on responses to the hazards of COVID-19 in the food supply chain and the role of FSMSs to minimise potential risks.

Djekic et al. [13] conducted a survey in 16 countries to provide comprehension regarding the response of companies in the context of food safety systems during the initial months of the COVID-19 Pandemic. The study concluded that companies with FSMSs commonly apply a more rigorous approach to tackling COVID-19 than those without. The two most important factors impacting food safety resulting from the COVID-19 pandemic are identified as hygiene and staff awareness. In addition, the study illustrates the increased purchase of personal protective equipment (PPE) and the implementation of more rigid hygiene procedures. The study found that only 50% of surveyed companies have plans for Pandemics and health issues. However, the study showed that food safety hazards were not accepted at any point.

Olaimat et al. [14] discussed the potential transmission of COVID-19 through food products. They illustrated the survival of viruses on packaging materials such as glass and plastic and food such as lettuce and therefore elaborated on the need for active antiviral packaging to eliminate the risk of potential COVID-19 transmission through food products. Based on their findings, they concluded that players in the food supply chain should strictly follow the protocols of FSMSs and following the HACCP principles to re-evaluate potential hazards based on new evidence for COVID-19 spread risks continuously.

The WHO [15] discussed at the beginning of the COVID-19 pandemic in the spring of 2020 the influence of COVID-19 on food safety. They pointed out that although remote working from home is a regular practice during the pandemic, it is not always possible for food industry employees to work remotely. Therefore, their guidance document indicated the importance of keeping employees in the food supply chain safe and healthy as a critical requirement during the pandemic to maintain trust and consumer confidence in the safety of accessible food. Though they elaborated on the research assessing the endurance of the COVID-19 virus on different surfaces for up to 72 hours, it was also stated that evidence of transmission through food and food packaging is limited. Based on the above, the focus of the issued guidance document was the protection of the working employees in the food supply chain and avoidance of COVID-19 spread in the work environment. The recommended measures to address these issues are laid out: 1) ensuring awareness of COVID-19 symptoms in the workforce; 2) reinforcing and modifying prerequisite programmes; and 3) social distancing.

Dinçoğlu and Rugji [16] reinforced the scientific evidence that human-to-human interaction is the predominant route of COVID-19 transmission. However, they also discussed that droplets from infected persons may come down on surfaces where the virus could remain a hazard. Therefore, the immediate environment can also be a viable source of spread. To prevent potential transmission of COVID-19 through the food supply chain they recommend the applications of 1) FSMSs, especially in the elements of HACCP and GMP; 2) enhanced cleaning and sanitising; 3) increased hand hygiene; 4) physical distancing; 5) monitoring of typical COVID-19 symptoms; and 6) other measurements such as hand washing after touching raw material in production and cooking at high temperatures in the food manufacturing process. They concluded that the focus of ensuring food safety during the pandemic is the implementation of adequate training and education regarding hygiene in the working environment.

The BRCGS [17] issued a guidance document to address the new challenges of managing an FSMS presented by the COVID-19 pandemic. Similar to other does the paper vindicated that COVID-19 is not transmittable through food products. The document profoundly elaborates on the challenges caused by the potential disruption of the supply chain, labour shortage and onboarding of untrained temporary employees. Therefore, they recommend implementing a special team addressing issues emerging from the pandemic and reporting solutions to the plant management. As possible challenges, the paper elaborates on the shortage of cleaning supplies jeopardising adherence to standard prerequisite programmes. Other recommendations contain a rigid emergency approval process for new suppliers and restricted access to food production sides—a further focus of the suggestions aims to enhance social distancing and hygiene.

Rizou et al. [18] explored the risk of COVID-19 transmission through the food supply chain and concluded that a possible spread through the food sector must be considered negligible. However, they also discussed that the focus moving forward must be bioanalytical detection tools monitoring foods, surfaces, and adjacent environments to ensure safe food production, processing, and delivery. They elaborated that the major challenge regarding these detections is the low viral load, diverse viral particles, and non-optimal tedious isolation.

2.2. Effectiveness of FSMS

The FAO [19] describes the purpose of the Codex Alimentarius as being to safeguard consumers' health and protect fair habits in the food sourcing chain. In the same vein, the General Food Law aims to protect social health and consumers' interests, and it pertains to all stages of food and feed processing, manufacturing, and distribution (with some exceptions) [20]. The Codex Alimentarius led to food laws and eventually to the ISO 22000 and GFSI-recognised schemes [21]. Thus, all FSMSs signify a Food Business Owners (FBO's) compliance with Codex Alimentarius, HACCP principles, the corresponding prerequisite programmes (PRPs) and legal requirements, and the adoption of an FSMS is a strategic choice for an organisation that can advance its food safety output [22].

The common understanding of food safety is the absence of food-borne threats at the point of consumption [23]. The Cambridge Dictionary describes 'effectiveness' as the ability to be successful and produce the intended results. A management system is an organisation's approach to controlling the corresponding parts of its business. This approach is commonly linked to specific objectives [24]. Hence, FSMS effectiveness is the capacity of an organisation to execute a set of defined policies, processes, and procedures so that food-borne threats at the point of consumption are eliminated. Therefore, an effective FSMS protects consumer health. There is no single approach to determine whether an FSMS is effective. Researchers, e.g., see Table 1, have assessed the effectiveness of FSMS or other management systems utilising two distinct approaches: 1) evaluation of the degree to which established objectives are achieved, and 2) evaluation of potential improvements in key performance indicators (KPI's).

Table 1. Approaches to establishing effectiveness

Evaluation if objectives are met	Evaluation of KPI
Ahmudi et al. [25]	Doménech et al. [29]
Psomas and Kafetzopoulus [26]	Purwanto et al. [30]
Sumaedi and Yarmen [27]	
Kafetzopoulus et a. [28]	

Ahmudi et al. [25] utilised a gab analysis to investigate disparities between the current state and objectives of an ISO 9001-certified manufacturer. They defined the objectives as the fulfilment of each ISO 9001 standard clause and assessed every clause by conducting a review of the stated work procedures and their corresponding execution. They concluded that although work procedures were effective, with clauses ranging between 82% - 94%, all of the ISO 9001 objectives had not been met due to incomplete execution.

Psomas and Kafetzopoulus [26] used a survey to compare ISO 22000 non-certified and certified milk businesses, enumerating the assessment, identification and management of food-borne safety hazards as objectives. They found that FSMS certification led to greater effectiveness in non-certified companies but elaborated that the effectiveness of HACCP relies on the level to which system objectives are met.

Sumaedi and Yarmen [27] addressed the lack of a rating instrument to evaluate the effectiveness of ISO 9001 application in food production. Based on a definition of effectiveness as the extent to which the expected results/objectives are achieved, they presented an instrument comprised of 12 dimensions: participation of people; system method to management; frequent improvement; process approach; fact-driven approach to decision making; customer focus; product performance; process performance; system; mutually beneficial supplier relationship; customer-based performance; and financial performance.

Kafetzopoulos et al. [28] researched the value of HACCP systems in Greek food companies and identified hazards' assessment, hazards' identification and hazards' control as system objectives. A measurement instrument in the form of a 15-item survey was used to evaluate the fulfilment of these three theoretical objectives. They found the HACCP objectives were largely met, thereby resulting in highly effective system implementation. Doménech et al. [29] analysed the microbiological quality (KPI) of 1054 dishes served at Spanish restaurants and hotels, and the results indicated an effective implementation of prerequisite programmes and HACCP objectives.

Purwanto et al. [30] researched the enactment of a quality management system that integrated ISO 9001 and ISO 22000 in the food packaging industry in Banten. Their survey of 144 employees measured customer satisfaction and complaints, defects, product returns and cost of quality as KPIs, and they concluded that the integrated system positively and significantly influenced the effectiveness of efforts to meet quality management criteria.

3. Research Methodology

A focus group was utilised in this paper to explore the effectiveness factors of FSMSs in the container glass industry during the COVID-19 pandemic. The focus group was comprised of stakeholders of a container glass organisation in the US. Focus group research is a valuable way to enhance understanding and gain deep knowledge of the topic being investigated. A focus group is essentially a moderated group session, and as Then et al. [31] explained, it is essential to establish a map for the group interview that clearly illustrates the path from the beginning to the end of the focus group session. Krueger [32] emphasise the importance of proper preparation for conducting focus group research, which entails planning the meeting start and end points, extending personal invitations and creating a detailed agenda to carry out the research. Moreover, all materials—such as flip boards, note cards, and markers—need to be prepared in advance. An open-ended question exercise regarding critical effectiveness factors was the main topic of this paper's focus group discussions. The focus group was asked to give their perspective on what the possible impacts of COVID-19 are on a set of key effectiveness factors of FSMS.

The focus group consisting of seven participants was selected based on the attributes of salience, FSMSs knowledge, and discussion skills, an overall good responsiveness to the question asked. The key effectiveness factors deliberated upon were: 1) FSMS knowledge; 2) rigorous prerequisite programmes; 3) FSMS verification and audit processes; 4); FSMS culture and 5) legal regulations.

4. The Case Study

4.1. Container Glass Manufacturing

The glass manufacturing process begins with the arrival and unloading of raw material at a glass plant. Various component materials are cleared into a delivery pit and sent through a conveying system to silos, where they are stored separately. After each component is separately weighted into a mixer, the materials are blended in the batch house and the blended materials batch, respectively, following which a conveyor system transports the batch to the melting furnaces day bin. The day bin batch is continuously fed into the melting furnace [33].

Kovačec et al. [34] explained that forming a glass container is a complex process. Glass flows from the furnace to the forming machine through channels called feeders. At an opening above the forming machine, shear blades cut the glass stream into evenly shaped glass gobs. The gobs are distributed to independent sections of the forming machine, which the glass-packaging industry refers to as an individual section machine (IS-machine), as each section operates independently as a standalone forming station.

The two steps at the IS-machine comprise forming a parison, which is a pre-shape of the final container, and the final formation of the container. The parison can be formed either by a) the blow and blow process, which entails utilising compressed air to shape the parison through the containers opening (B.B.; Figure 1), or b) the press and blow process, which involves applying mechanical force by employing a plunger movement into the glass through the resulting opening (P.B., Figure 2) [35]. Regardless of which approach is used, the parison is shaped to the final container by compressed air blown into the container's opening and optionally supported with vacuum assistance. Traditionally, the B.B. process was used for bottles and the P.B. process was used for jars; however, developments in forming technology eventually led to a P.B. technology for bottles called the narrow neck press and blow process (NNPB).

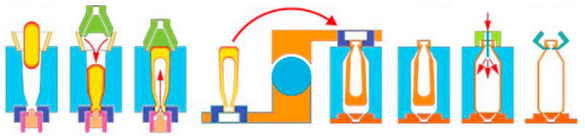

Fig. 1. Blow and blow (B.B.) process [35]

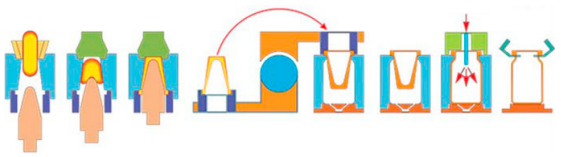

Fig. 2. Press and blow process [35]

The rapid cooldown of the glass during the forming process causes detrimental stress to the containers. To eliminate tensions, the containers are annealed in a lehr in a process entailing reheating and controlled cooling, following which

quality checks are performed in an online and offline manner whereby defective containers are rejected and returned to the melting furnace [36]. The final step of the process is packing and warehousing. Figure 3 illustrates the workflow in a container glass plant. Note that container glass plants typically use more than one furnace, each of which typically feeds more than one forming machine.

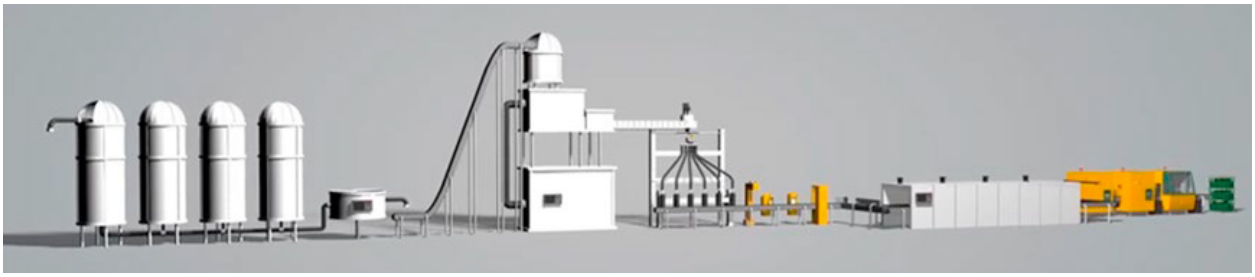

Fig. 3. Glass plant process [37]

Supply chain management (SCM) generally encompasses both packaging and transportation functions [38]. Primary packaging is commonly referred to as a consumer unit, which is grouped by secondary packaging into a stock-keeping unit (SKU). At the tertiary level is the transit or bulk packaging used to contain larger SKUs for shipping. Bottles and jars can be bundled in boxes or cartons and transported on pallets.

Packaging delivers food protection by preventing interaction between the product and possible contaminants. Van Eeden [39] presents six requirements of packaging in SCM: 1) protecting the contained good; 2) supporting product identification; 3) unitising the goods; 4) enabling product handling; 5) assisting with merchandise marketing; and 6) conveying information. Because primary food packaging occurs in direct contact with food, the first of these requirements is the most critical.

There are different packaging functions in the supply chain and commonly one out of four materials is used for primary packaging, namely plastic, metal, fibre, and glass [40]. Unlike most other packaging materials, glass containers have the ability to maintain a vacuum, which hinders deteriorative reactions and bacterial growth in the packed foods [41]. Moreover, glass provides a solid barrier to potential water vapour, and because it is inert, it does not transfer any toxins to food.

Glass is also considered extremely environmentally friendly, and it promotes a high-end marketing strategy [42]. To enhance merchandise and marketing, glass packaging can be formed into original and multifaceted shapes, and the production process may also include embossing or debossing or customised closure finishes [43].

Corso and Benassi [44] elaborated on the myriad options for attaching product identification and information labels on glass containers. Labels can easily be placed around the perimeter or on the container's front or back panel. A permanent label can be applied through printing, and codes can be lasered onto the glass. Clarke and Tanprasert [45] investigated the less commonly used approach of applying RFIDs (radio-frequency identification) to primary packaging containers and concluded that this is a viable option for all materials except metal.

The manifold array of food impurities can be categorised into chemical, physical, microbial and allergenic types, all of which can cause the end-user to experience injury, poisoning or infection [1]. Food safety concerns led to 462 recalls in the U.S. in 2020 [10], several of which were included by glass container-related issues. The FDA [46] maintains an Enforcement Report database of all monitored recalls. 78% of recalls related to the container glass industry were associated with physical contaminants such as glass particles and fragments, 11% were related to microbial contamination primarily caused by closure failures, and 8% were caused by chemical contamination by arsenic and heavy metals such as lead. Although the database only provides limited information regarding the root cause of contaminations, reasons mentioned in the report include several cases of production defects in the glass container plant, such as checks or insufficient wall thickness and finish defects. DeBello [47] identified 16 major defects in the container glass production that pose food safety risks. Disruptions in manufacturing, shipping, filling and warehousing can result in checks, chips, blisters and other issues that contribute to breakage or contamination with glass fragments and thereby endanger human life or health [48, 49].

4.2. Case Study Results

A substantial proportion of discussion can be classified under the effectiveness factor FSMS knowledge. The discussion of FSMS knowledge also extended to the importance of understanding FSMSs. It was also discussed that understanding the FSMSs impacts firm success and customer safety. A final knowledge discussion point concerned understanding faults in FSMS systems.

A considerable size of the discussion elaborated on topics correlated to rigid prerequisite programmes. A large proportion of representative responses addressed documentation. Pest control was another major topic of discussion. In addition, several participants discussed the importance of Good Manufacturing Practice (GMP). Finally, stakeholders also emphasised the critical importance of HACCP and food defence. FSMS verification and audit process was another prominent subject of discussion in the focus group. Participants' comments largely focused on external audits by third-party organisations or customers, internal audits and effects of audits such as drivers for continuous improvement, reality checks and the identification and closure of gaps. Statements regarding external audits emphasised the value of impartial reviews by independent organisations came up on regular basis. Comments concerning internal audits highlighted the reinforcement of compliance and the detection of shortfalls. Participants also more generally emphasised the role of both internal and external audits in addressing gaps and driving continuous improvement. Focus group participants also addressed behaviour and norms, which were considered part of the culture associated with FSMS. Participants described FSMS culture as a key element of program sustainability. They identified employee engagement and buy-in as critical elements of a positive and productive FSMS culture. However, the participants identified employee ownership as a key aspect of the engagement. Legal regulations were only brought up twice during the discussion (in the context of training, and regarding synchronizing FSMSs efforts throughout the supply chain).

Figure 4 summarises the most used keywords of the focus group during the discussion and the associated grouping. As noted above and shown in Figure 4, legal regulations were only mentioned on few occasions during the initial discussion. The group opined that the few mentions of legal regulations was due to the lack of direct interaction of the packaging industry with the major food safety regulatory agencies in the US where the company is located i.e., 1) the Food and Drug Administration (FDA); 2) the Food Safety and Inspection Service (FSIS); 3) the National Marine Fisheries Service (NMFS); and 4) the Environmental Protection Agency (EPA). The glass industry interacts with the EPA on a regular basis; however, these contacts do not occur in the context of food safety.

The focus group discussed the possible impact of COVID-19 on the effectiveness factors. In this context, it is vital to understand that glass packaging manufacturing was deemed an 'essential business' during the pandemic and continued to operate in its total capacity even during the period of the governmental stay-at-home orders. As consumers increasingly looked to obtain nutritious, shelf-stable glass packaged foods and beverages during the global pandemic, glass manufacturers' production increased to meet the demand. Hence, the container glass plants remained open and maintained appropriate functionality to supply the glass bottles and jars that filled grocery shelves during this time of high demand for packaged food and beverages. The U.S. Department of Homeland Security very specifically supported the designation of glass packaging manufacturing as an essential business in a memorandum on 19 March 2020, which detailed the 'essential critical infrastructure workers during a pandemic' and specifically named 'food manufacturer employees and their supplier employees', including 'beverage production facilities', to which the container glass industry supplies critical packaging. The WHO [15] also pointed out that although remote working from home is a regular practice during the Pandemic, it is not always possible for food industry employees to work remotely.

The group agreed with the reasoning behind a high focus on FSMS knowledge during the case study exercise based on the perspective that a lack of understanding and expertise led to irrational behaviour and a decline in training activities, and the lack of adequately trained employees caused by labour shortage also indicated the importance of this effectiveness factor. This is in line with Dinçoğlu and Rugji [16] who mentioned that the focus of ensuring food safety during the Pandemic is the implementation of adequate training and education regarding hygiene in the working environment. The following comments were made by participants.

> “Knowledge is important and was discussed more due to Covid-19 because I saw scarred and irrational people here at the beginning of the pandemic when information regarding the disease wasn’t fully available.”
> “At the beginning, we didn’t know if COVID-19 can spread through our product. That’s why knowledge seems for me very important.”

"After more knowledge regarding Covid-19 was researched and communicated it was clear to me that knowledge is very important in the context of FSMS. Knowledge is for me now the base for culture."
"I spoke more about knowledge due to Covid-19 because I saw a negative trend in training and a growing knowledge gap during the pandemic."
"Covid-19 limited the ability to train our project team effectively. Therefore, training is now very high up the ladder."
"Due to the staffing impact caused by Covid-19 either voluntarily or due actual illness I believe knowledge is very important because you potentially need more people qualified do various tasks".

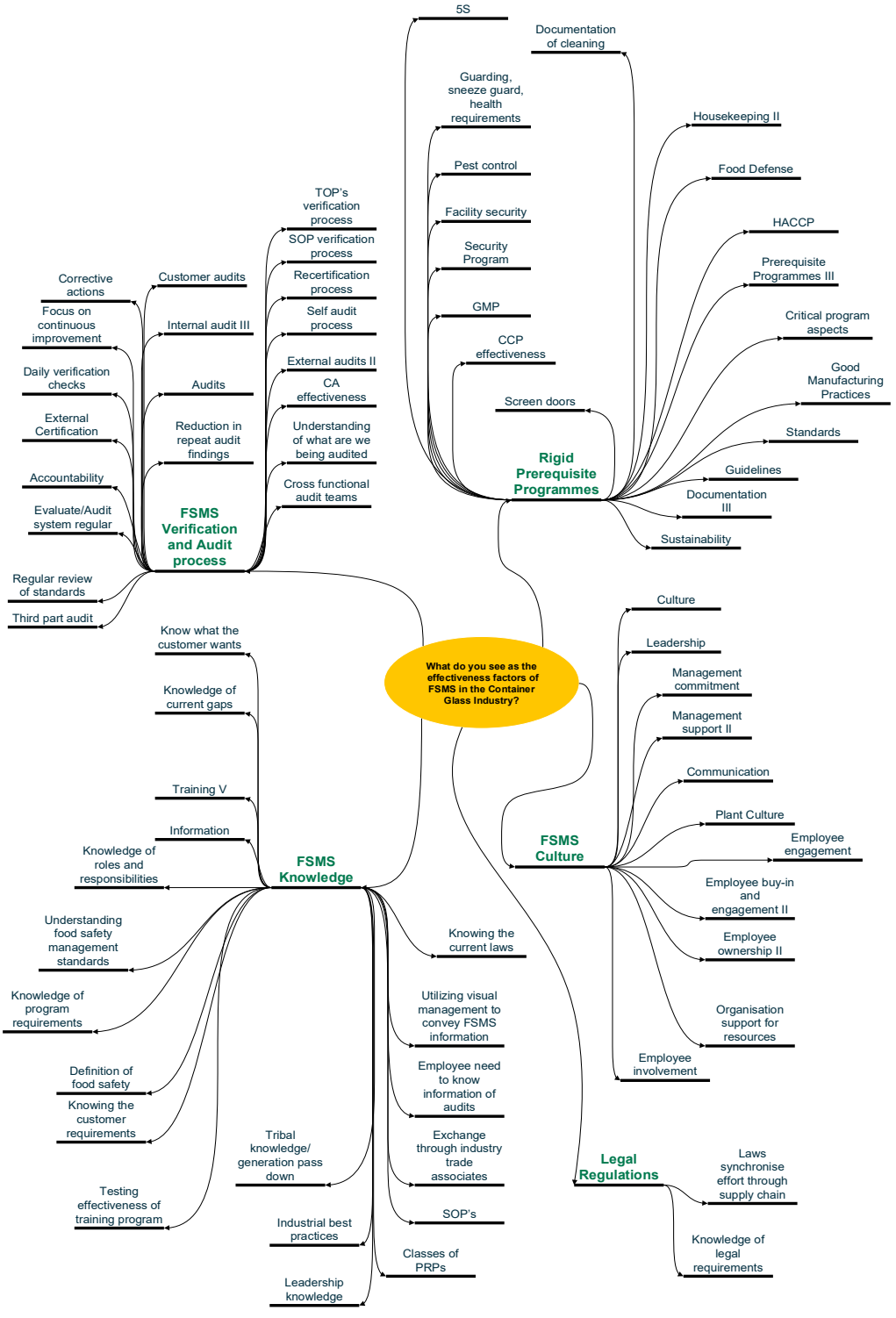

Fig. 4. keywords regarding FSMS Effectiveness Factors that came up in the Focus Group Discussion.

The focus group's comments regarding the strong focus on rigid prerequisite programmes were mostly related to the strong emphasis on PRPs during the pandemic—especially cleaning, disinfection, and personal protective equipment (PPE). Important is here also to mention the influence of the shortage of cleaning supply jeopardising adherence to standard prerequisite programmes as mentioned by the BRCGS [17].

> "I experienced more focus on cleaning and disinfection, therefore, I believe I spoke significant more about PRP's.
> "Covid-19 had a direct impact on our GMP focus due to the additional cleaning".
> "Covid-19 raised our awareness of how important the PRP's really are".
> "High Focus on PPE, like facemasks, made me think more about PRP's".
> "At the beginning of the pandemic, it was unclear if COVID-19 could be transmitted through our product. Hence therefore there was a high focus on PRP's (and verification and auditing). This was a clear indicator that those attributes are important."

The focus group discussed the strong focus on FSMS verification and audit process due to a lack of third-party audits and the additional burden of ensuring safety with only internal audits.

> "I mentioned audits/verifications often due to Covid-19 because I saw certain quality standards suffer to changing priorities/concerns from work performance to personal well-being".
> "Covid-19 changed the way we looked at the audit process and how important it is for food safety."
> "Covid-19 limited our ability to conduct effectively certification and customer audits for FSSC 22000. We clearly missed some of the feedback we got in the past".
> "At the beginning of the pandemic, it was unclear if Covid-19 could be transmitted through our product. Hence therefore there was a high focus on (PRP's and) verification and auditing. This was a clear indicator that those attributes are important".
> "Being in compliance the last 18 months (confirmed by the last customer audit) showed that verification and auditing (internal) is very important."

The focus group attributed the low FSMS culture discussion to the shifting of focus from fostering the social behaviour of employees to enforcing procedures and processes.

> "I believe culture would have been discussed more. However, Covid-19 brought us back to procedures and knowledge to create a new culture".
> "I properly would have brought up culture more often, but the new "Culture" did not exist but was now formed by new training and PRPs".
> "The focus on audits and PRPs to address the fear and uncertainty caused by COVID-19 created a strong "culture". It becomes very important to motivate and keep a cohesive team through the pandemic. However, at this point, the culture was the result but not the driver. The driver was education, PRPs, and our audit process."

As mentioned, legal regulations were not a significant topic in the focus group discussion. However, two significant opinions regarding legal regulations emerged in the focus group discussion. On the one hand, processes to enhance FSMS have been implemented even without explicit legal guidance; on the other hand, the legal classification of the industry as an essential business indicates the influence of regulatory authorities.

> "The Covid-19 pandemic confirmed my initial assessment for legal regulations because I saw many people doing the "right" things to protect their health and our product even with not being enforced. Carrot vs stick approach."
> "I consider during the discussion that the legal regulations deserved a higher focus since we were classified during the pandemic as essential workers, so we are all come to work during the COVID-19 outbreak. Hence legal regulations had an impact on us as an industry; therefore, I realized the impact as well to FSMSs."

4.3. Discussion

Section 4.2. above presented the results of the case study of effectiveness factors for FSMSs in the context of the glass packaging production industry. As elaborated, a focus group comprising FSSC 22000 stakeholders in the container glass industry was conducted to: 1) identify the critical effectiveness factors of FSSC 22000 in the container glass industry and 2) elaborating on the possible impact of COVID-19 on the discussion of the effectiveness factors.

Following Onwuegbuzie et al. [50], Table 2 presents a matrix used to reflect on the involvement of each focus group member by utilizing a matrix. The table indicates an overall high consensus regarding the discussion topics.

Table 2. Consensus assessment of the focus group

Focus Group Discussion	Quality Manager	Operations Manager	Plant Controller	Batch and Furnace Manager	Production Manager	Finish Goods Manager	EHS Manager
Discussion regarding the keywords that emerged.	A	A	SE	A	A	SE	SD
Possible impact of COVID-19 on the Prioritisation of the Effectiveness Factors.	SE	SE	SE	A	A	SE	SE

Key:

A = Indicated agreement (i.e., verbal or nonverbal)

D = Indicated dissent (i.e., verbal or nonverbal)

SE = Provided significant statement or example suggesting agreement

SD = Provided significant statement or example suggesting dissent

NR = Did not indicate agreement or dissent (i.e., nonresponse)

The focus group engaged well on the discussion regarding the possible impact of COVID-19 on effectiveness factors and there is a consensus that the pandemic has a significant influence. Factors identified as influencing the high FSMS knowledge discussion were the lack of sufficiently trained employees due to labour shortages during the pandemic and the negative impacts of irrational behaviour and declines in training activities on performance. The strong discussion of rigid prerequisite programmes was mostly related to the high focus on PRPs during the pandemic. The lack of third-party audits and the additional burden of being productively with internal audits were highlighted as the main drivers of the FSMS verification and audit process discussion. Participants attributed the low FSMSs culture discussion to a shift in focus from fostering pro-social behaviour to procedures and processes. Finally, the focus group noted that although FSMSs has been tightened ahead of legal guidance processes, the legal classification of the container glass industry as an essential business evinces the substantial impact of legal regulations on glass packaging manufacturing operations.

5. Conclusions and Future Work

The paper explored the perspectives of practitioners on the effectiveness factors of FSMSs during the Pandemic, using a focus group of participants in a container glass manufacturing business, The consensus of the focus group is that the five critical effectiveness factors presented to the group for discussion apply to the container glass industry, namely: 1) FSMS knowledge; 2) rigorous prerequisite programmes; 3) FSMS verification and audit processes; 4) FSMS culture and 5) legal regulations. In comparison to others, legal regulations were less mentioned by the focus group participants, and this was attributed to the lack of direct interactions regarding FSMS compliance with any of the major food safety regulatory agencies. However, parts of the research illustrated the linkages between FSSC 22000 and legal regulations. The focus group discussion also highlighted the role of the COVID-19 pandemic in the disparity, as organisational focus emphasised procedures and processes over fostering the employees' pro-social behaviour. In the focus group discussion, it was mentioned that many people were intrinsically motivated in doing the “right” things to protect their health and the company’s product, whilst recognizing the essence of food safety. Finally, it should be noted that the case study was limited to identifying and rating FSSC 22000-related effectiveness factors. Broader research could examine how the effectiveness factors can be reinforced post-Covid-19 to achieve improved FSSC 22000 performances.

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