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Food safety culture assessment using a comprehensive mixed-methods approach: A comparative study in dairy processing organisations in an emerging economy

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ABSTRACT

Food safety challenges are a global concern especially in emerging economies, which are in the midst of developmental changes. The challenges are directly or indirectly related to the behaviour and decision-making of personnel, and to an organisation's food safety culture. This study evaluated the prevailing food safety culture in three Zimbabwean dairy companies of different size (multinational, large and medium) using a comprehensive mixed-methods approach. Four key elements were assessed, namely enabling conditions, employee characteristics, actual behaviour and microbial safety performance. Card-aided interviews provided data on enabling conditions, and questionnaires and storytelling on employee characteristics. Observations and microbial analysis assessed actual behaviour and microbial safety performance, respectively. The multinational company demonstrated a more proactive food safety culture compared to the other companies, which operated at an active level as exhibited by multiple inconsistencies in the enabling conditions and compliance behaviour. The large company had a moderate microbial safety performance even though it operated in a potentially risky situation, which could have been mitigated by the food safety management system. The medium-sized company had a poor microbial safety performance likely related to noncompliance with sanitation requirements, negative attitudes towards personal hygiene and an ambivalent attitude towards sanitation. Our study demonstrated the ability of the mixed-methods approach to assess and distinguish an organisation's prevailing food safety culture into identified classification levels (reactive, active, proactive). Specifically, storytelling elicited respondents to share stories, which reflected the food safety and hygiene control attitudes.

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1. Introduction

Food safety is a global concern; the World Health Organisation (WHO) estimates that each year 600 million foodborne illness incidences occur worldwide (WHO., 2015). The highest burden of foodborne illnesses per population is in transitioning countries, particularly in Africa (WHO., 2015), as evidenced by inconsistent food safety (FAO, 2007; Kussaga, Jacxsens, Tiisekwa, & Luning, 2014). Kussaga et al. (2014) reported that 83% of the microbial cases, including dairy products, reported in African countries, exceed microbiological limits. This is worrisome since dairy products significantly contribute to the human diet and are consumed by all population groups (Chimboza & Mutandwa, 2007; Papademas & Bintsis, 2010). Additionally, dairy products are easily perishable (Demirbas, Cukur, Yildiz, & Gölge, 2009) and are highly vulnerable to contamination (Chimuti, Midzi, Njage, & Mugadza, 2016; Papademas & Bintsis, 2010). Therefore, the food industry and regulators are putting significant efforts on improving food safety management systems (FSMS) and food safety performance (Consumer Goods Forum (CGF) (2011); Kussaga et al., 2014) in the dairy industry. However, FSMS are not always effective, as demonstrated by recurring food safety problems (e.g. Chimuti et al.,

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2016).

In transitioning countries such as Zimbabwe, deficiencies in food safety performance of dairy processing organisations have been attributed to outdated and/or poorly designed equipment, inadequate sanitation programs, restricted personal hygiene, unskilled/semi-skilled employees, and contaminated packaging material (Chimuti et al., 2016; Kussaga et al., 2014; Macheka, Manditsera, Ngadze, Mubaiwa, & Nyanga, 2013; Zimbabwe Economic Policy And Research Unit, 2014). These deficiencies have been linked to an insufficient food safety culture (FS-culture) (Pennington, 2009) and are directly or indirectly related to decisions made by individuals in an organisation.

The role of individuals in food safety/FS-culture has been argued by various authors (e.g. De Boeck, Mortier, Jacxsens, Dequidt, & Vlerick, 2017; Griffith, 2006). Individual characteristics (Fatimah, Strohbehn, & Arendt, 2014b; Griffith, Livesey, & Clayton, 2010b; Nyarugwe, Linnemann, Hofstede, Fogliano, & Luning, 2016) influence decision-making behaviour and actual food safety practices (e.g. De Boeck et al., 2017; Pacholewicz et al., 2016; Sanny, Luning, Marcelis, Jinap, & Van Boekel, 2010). Human behaviour contributes to food safety (De Boeck, Jacxsens, Bollaerts, & Vlerick, 2015; Griffith, 2006; Griffith, Livesey, & Clayton, 2010a) and has warranted the use and application of psychological models, behavioural frameworks and systems approaches, to assess and improve food safety (e.g. De Boeck et al., 2017; Griffith, 2006; Jespersen, Griffiths, Maclaurin, Chapman, & Wallace, 2016; Luning & Marcelis, 2006,2009; Taylor, 2011).

Griffith et al. (2010a) defined FS-culture as “shared attitudes, values and beliefs towards food safety behaviours that are routinely demonstrated in food establishments”. FS-culture research, therefore, requires integrated analysis of personal/individual characteristics, organisational standards, practices/behaviour, FSMS and the context an organisation operates in (De Boeck, Jacxsens, Bollaerts, Uyttendaele, & Vlerick, 2016; Griffith, 2006; Luning et al., 2011; Nyarugwe et al., 2016; Powell, Jacob, & Chapman, 2011). Since several elements are interlinked, using multiple methods in FS-culture assessments could enhance research validity (Nyarugwe et al., 2016). This study aims to get an insight into the prevailing (FS-culture) of dairy organisations in an emerging economy in view of their context characteristics using a mixed-methods approach.

2. Material and methods

2.1. Elements used for assessing prevailing FS-culture

Four key elements (microbiological safety performance, actual behaviour, technological and organisational enabling conditions, and employee characteristics) were identified to systematically analyse an organisation's prevailing FS-culture. The elements were derived from previously validated organisational, safety and FS-culture studies (e.g. De Boeck et al., 2015; Fatimah et al., 2014b; Fleming, 2000; Glendon & Stanton, 2000; Griffith et al., 2010b) based on a review done by Nyarugwe et al. (2016), and have been pretested in dairy companies in an explorative study (Nyarugwe, 2013).

The techno-managerial approach, i.e. concurrent analysis of technological and managerial factors (Luning & Marcelis, 2006,2009), was used as a principal research approach. De Boeck et al. (2015) also distinguished two routes; the techno-managerial route (FSMS and organisation's context) and the human route (i.e. employees' shared perception of leadership, commitment, communication, resources and risk awareness). These routes provide a basis for FS-culture assessment and are considered to influence food safety behaviour and the microbial output (De Boeck et al., 2017).

Microbiological safety performance reflects the actual food safety performance as previously described by Jacxsens et al. (2010) and could be influenced by an organisation's FS-culture as demonstrated by De Boeck et al. (2016). *Actual behaviour* defines the actual execution of work practices (Van den Berg & Wilderom, 2004) and is an outcome and reflection of the prevailing FS-culture. *Enabling conditions* are situational aspects of the system's environment aimed at supporting (when appropriate) personnel to appropriately execute work tasks. Both organisational and technological enabling conditions are interrelated and can be positive (support) or negative (hinder) employees to appropriately execute food safety or hygiene control tasks (Clayton, Griffith, Price, & Peters, 2002; Luning & Marcelis, 2006). The underlying assumption is that supportive conditions will enable more consistent compliance behaviour (Luning et al., 2011; Pacholewicz et al., 2016; Sanny et al., 2010).

Employee characteristics describe an individual's attitudes, knowledge and perceptions of food safety and hygiene control (Nyarugwe et al., 2016). Individuals with the right attitude will seek to do things right especially when they perceive the organisation supports food safety (Griffith et al., 2010a; Pacholewicz et al., 2016; Yiannas, 2009). Moreover, employees' characteristics (e.g. perceptions, attitudes) are assumed to affect compliance behaviour (Chen, Flint, Perry, Perry, & Lau, 2015; Luning & Marcelis, 2006; Nyarugwe et al., 2016).

To operationalise the elements and assess the prevailing FS-culture, 25 indicators (i.e. crucial aspects) were defined for the four elements. Indicators give a measure of the actual situation (Kirezieva, Jacxsens, Uyttendaele, Van Boekel, & Luning, 2013) and define the extent to which FS-culture is prioritised, embedded, practiced and shared among staff (Griffith, 2013). The indicators enabled data to be collected and assessed with the mixed-methods approach (section 2.3).

Indicators for microbiological safety performance measure actual food safety (e.g. De Boeck et al., 2015; Powell et al., 2011), while behaviour indicators measure actual practices displayed at critical steps and/or processes (Luning & Marcelis, 2009). For organisational conditions, the indicators leadership, communication, commitment, procedures, training and time were selected based on a review by Nyarugwe et al. (2016) and their potential contribution to food safety performance (De Boeck et al., 2015; Griffith et al., 2010a). For technological conditions, sanitation, protective clothing, handwashing facilities, zoning, hygiene design, and equipment maintenance were selected (Nyarugwe, 2013; Nyarugwe et al., 2016) as they are requisites for food safety and hygiene (Arendt, Ellis, Strohbehn, & Paez, 2011; De Boeck et al., 2015; Wright, Leach, & Palmer, 2012). For employee characteristics, knowledge, attitudes and perceptions were selected based on a pre-test and on previous studies (Nyarugwe et al., 2016; Powell et al., 2011; Van den Berg & Wilderom, 2004).

2.2. Description of the comparative study

2.2.1. Characteristics of selected companies

A comparative study was executed in three Zimbabwean dairy companies. The companies were selected based on size, level of implemented FSMS, variety of dairy products and willingness to participate in the research. The companies represent medium (company A), large (company B) and multinational (company C) companies. Company A (CA) employs an average of 120 employees, is currently working towards HACCP certification, and mainly produces a range of ice cream and yoghurts. Company B (CB) has about 400 employees, a Standards Association of Zimbabwe certified HACCP-based FSMS, and produces a wide variety of milk, ice cream and yoghurts. Company C (CC) has approximately 300

employees, a SGS (Société Générale de Surveillance) certified HACCP-based FSMS, and mainly produces a variety of milk.

2.2.2. Characteristics of respondents

Respondents were selected from the operations department, i.e. food handlers (machine operators, production attendants/packers and supervisors) and management (production controllers/managers, quality controllers/managers and food safety officers). This is because FS-culture research should recognise the hierarchical level of assessment as different levels are confronted with different responsibilities and decisions (Nyarugwe et al., 2016). Table 1 shows the respondents' profiles. Respondents were approached based on willingness to take part in the study. Respondents were locals and the local language (Shona) was used to explain or translate questionnaires, where necessary.

2.3. Mixed-method data collection approach

A mixed-methods approach was used to collect data since it provides a systematic and rigorous way to understand concepts (Creswell, Klassen, Plano Clark, & Smith, 2011, pp. 2094–2103). Six methods were applied, i.e. microbial analysis, observations, card-aided interviews, questionnaires, storytelling and document analysis to collect information on the four key elements (section 2.1). Microbial analysis provided insight into the microbial safety of the dairy products as outsourced or analysed by the companies. Observations were used to assess actual behaviour and card-aided interviews to assess enabling conditions. Questionnaires and storytelling were used to collect data on employee characteristics, and document analysis to assess microbial safety performance records and actual behaviour.

2.3.1. Microbial analysis for food safety performance assessment

Salmonella sp. was selected as a food safety indicator and *Staphylococcus aureus,* coliforms/*Escherichia coli* as hygiene indicators based on Jacxsens et al. (2009). Researchers only collected samples from CA and CB because CC products were tested according to the company's protocols. Samples were collected at critical sampling locations (CSL's) (Table 2) over a period of 2 weeks. CSL's are “locations where microbial sampling provides information about the performance of core control strategies and loss of control at these locations could lead to food safety problems” (Jacxsens et al., 2009). For CA and CB, 15 and 17 samples were collected, respectively and kept in either chilled (4–6 °C) or frozen (−18 °C) storage before analysis at the Government Analyst of Zimbabwe (CA samples), or at the Central Veterinary Laboratory (CB samples). For CC, samples were taken by employees at the filling and sealing CSL's, and analysed at the central laboratory daily. All laboratories are ISO17025 accredited.

A modified two class attribute sampling plan was used for *Salmonella* sp. and a three class attribute sampling plan for *Salmonella* sp. (Codex Alimentarius, 2004). The microbial analyses were according to the Official Microbiological Methods (FDA., 1998). Records for *E. coli* and coliforms, and customer complaints were analysed over a similar 3 month period to provide a uniform basis for comparing the three companies. Score zero was given when there was no indication of the specified food safety output, and scores 1, 2 and 3 for a poor, moderate and good safety output, respectively, using the criteria of Jacxsens et al. (2010). Data was analysed using Microsoft Office Excel. Percentage non-conformance of products was calculated based on documents analysed.

Table 1
Characteristics of respondents from the 3 Zimbabwean dairy companies.

Characteristics of respondents	CA	CB	CC
Gender			
Male	14	40	26
Female	10	3	2
Position			
Managers	3	3	4
Food handlers	21	40	24
Years in employment			
0–5	12	39	13
6–10	7	4	10
11–15	5		
15 and above			5
Type of employment			
Contract		33	9
Permanent	24	10	19
Educational level			
Tertiary	7	21	9
Secondary	17	22	19

2.3.2. Participatory observation to assess actual food handler behaviour, facility layout and equipment

Participatory observation, which entails the researcher being part of the group without informing group members that they are being observed, was done as it reduces the bias of the participants (Kumar, 2011; Zahle, 2012). Observations were randomly done by 2 researchers for 3 weeks in each company. For each observation period, the length and total people observed depended upon the activities. A checklist was developed as a guideline to evaluate the actual execution of food safety and hygiene tasks, and the organisation's facility layout and equipment, based on Codex Alimentarius (2003) and Lelieveld, Holah, and Napper (2014). Assessment criteria and the observation scoring system were modified from criteria developed by Nyarugwe (2013) and Pacholewicz et al. (2016). Where food safety and hygiene activities were not executed, incompletely executed or properly executed $\geq$80% of the time (Table 3), scores 1, 2 or 3 were given, respectively. Where the facility layout or equipment did not comply, partially or fully complied with at least 80% of the stated requirements, scores 1, 2 or 3 were given, respectively. To get an overall impression of actual employees' behaviour, the predominant behaviour observed was scored. For facility layout/equipment, the predominant observation was scored. Data was analysed using Microsoft Office Excel.

2.3.3. Card-aided interviews to assess enabling conditions

For each of the 11 enabling condition indicators, 3 cards were developed. Each card described a situation (Table 3) that corresponded with a concealed proactive (score 3), active (score 2) or reactive (score 1) food safety situation. To reduce bias, the cards were randomly arranged and given to the respondent. The interviewer guided each interviewee through each set of cards to ensure the interviewee understood each description, and selected a choice that reflected the company situation. The respondent was asked to justify the selection to verify that they clearly understood the questions. Responses were individually scored. Statistical analysis was performed using IBM SPSS version 22 for Windows to check the frequency and mode scores for each enabling condition.

2.3.4. Questionnaires to assess employees' knowledge and perceptions

To assess knowledge, a closed-ended questionnaire with 15 questions on food safety and hygiene was directed to food handlers. Both positive and negative questions were included to avoid bias (Kumar, 2011). Respondents could answer true, false or do not know. A correct answer scored 2 and an incorrect answer or do not know scored zero. The percentage of correct answers was calculated to obtain each respondent's percentage knowledge score. An

Table 2
Microbiological sampling locations in companies A and B.

Company	CSL	Reasoning
A	[a] Cutting	Product handling involved therefore personal hygiene is crucial to prevent cross-contamination.
	[a, b] Cold room storage	Food handlers manually transfer unpackaged product to cold rooms using bare hands. Moreover, products are left on wooden shelves (poor hygienic design) risking cross-contamination.
	[a, b] Vacuum packaging	Products are manually packaged and left unsealed for long periods of time. There is no further intervention step before sealing
	[c] Filling and sealing (before sealing)	Food handlers manually position packaging containers and seals increasing product contamination risk.
	[c] Filling and sealing (after sealing)	Packing material is improperly stored and could be a source for contamination. There is no further intervention step.
B	[d] Before sealing	Product coating is manually prepared and could result in cross-contamination.
	[d] Sealing/packaging	Some areas of the sealing machine are not easily cleanable increasing contamination risk. Packing material is not properly stored and could be a contamination source.
	[e, f] Filling and sealing	Pasteurized product is manually inoculated potentially resulting in contamination. Improper cleaning of the filling machine could result in cross-contamination Packaging material is manually positioned and that requires proper hygiene practices

The table shows samples taken by the researchers. *CSL refers to critical sampling location. a, b, c, d, e, f refers to product type from the companies. For CA, 5 samples were collected for product a, 5 samples for product b and 5 samples for product c. For CB, 7 samples were collected for product d, and 5 samples each for products e and f.

arbitrary scale used by Pacholewicz et al. (2016) was used to interpret the overall scores. If ≥ 80% of the questions were correctly answered, score 3 (good) was given, between 51 and 79% score 2 (moderate) and ≤50%, score 1 (poor).

For perceptions, a questionnaire with 6 open-ended questions on food safety and hygiene practices was used. Each response was evaluated to check the degree of alignment of food handlers' perceptions with company requirements. An arbitrary but explicitly defined scoring system was used. Scores 1, 2 or 3 were given, respectively, when food handler perceptions were aligned, partially/incompletely aligned or not aligned for at least 80% of the time with company requirements as defined in previous research (Nyarugwe, 2013). The frequency of responses with similar scores and the mode scores for both knowledge and perceptions were calculated using Microsoft Office Excel.

2.3.5. Storytelling to assess employees' attitudes

Employee attitudes were assessed using storytelling as this

Table 3
Key aspects of a reactive, active and proactive FS-culture.

Component	Key aspects		
	Score 1 (reactive FS-culture)	Score 2 (active FS-culture)	Score 3 (proactive FS-culture)
[a]Microbiological safety performance	Poor performance (noncompliance/ conformance) -minimal criteria used for microbial safety performance evaluation, and having various food safety problems due to different problems in the FSMS.	Moderate performance (restricted compliance/conformance) - several criteria used for microbial safety performance evaluation and food safety problems restricted to one type of problem in the FSMS.	Good performance (full compliance/ conformance) - systematic evaluation of microbial safety performance using specific criteria and having no food safety problems.
Actual food safety and hygiene control behaviour	High-risk behaviour due to noncompliance with food safety and hygiene control requirements. Food safety and hygiene practices are not executed ≥80% of the time. Risk of cross-contamination is highly likely to occur.	Moderate-risk behaviour due to partial compliance with food safety and hygiene control requirements. Food safety and hygiene control practices are executed wrongly/incompletely ≥80% of the time. Risk of cross-contamination likely to occur.	Low-risk behaviour due to full compliance with food safety and hygiene control requirements. Food safety and hygiene control practices correctly and completely executed ≥80% of the time. Risk of cross-contamination highly unlikely to occur.
Enabling conditions	Reactive (lack of support/conditions are not enabling) - acting only when there is a situation that needs to be controlled. Routine response to inspection findings, problems/incidents. Control is mainly problem driven.	Active (restricted support/conditions are enabling only to a certain extent) - systems are in place to manage the likelihood of (cross) contamination and to support food handlers' food safety/hygiene control decisions	Proactive (full support/conditions are enabling) - thinking and acting in advance of anticipated problems. Focus is on prevention of (cross) contamination
Knowledge	Inadequate knowledge- complete lack of knowledge in majority of food safety issues and unable to explain the reasoning behind majority of food safety requirements.	Moderate knowledge- incomplete knowledge in food safety issues and inability to explain the reasoning behind certain food safety requirements.	Good knowledge- ample knowledge in food safety issues required of them and capable of explaining the reasoning behind each food safety requirement.
Perceptions	Non-aligned- employee perceptions incorrect and not aligned with the company's food safety and hygiene control requirements	Partially aligned- employee perceptions partially/incompletely aligned with the company's food safety and hygiene control requirements	Fully aligned- employees have appropriate perceptions aligned with the company's food safety and hygiene control requirements
Attitude	Weak and negative attitude-negative predisposition toward compliance with food safety/hygiene requirements. Employees have no regard for food safety/ hygiene issues unless compelled to	Ambivalent attitude- uncertain predisposition to comply with food safety/ hygiene requirements. Employees perform adequately only when circumstances are appropriate	Strong and positive attitudes- positive predisposition to comply with food safety/ hygiene requirements under all circumstances. Employees always maintain adequate performance
Prevailing FS-culture	Reactive (negative FS-culture)- low support and little or no regard towards the importance of food safety	Active (intermediate FS-culture)- incomplete regard and restricted support towards food safety	Proactive (positive FS-culture)- high regard and complete support towards food safety

[a] For microbiological safety performance, a score zero (absence) was given and refers to a situation were no food safety performance evaluation is carried out, and/or that the specific food safety performance information is not known.

method enhances understanding of specific contexts, ensures active participation and encourages researcher/participant interaction (Banks, 2012). Moreover, storytelling could give an indication of employees' predisposition to respond in a positive or negative way to food safety and hygiene control. Eight stories on food safety and hygiene were formulated. These stories were hypothetical scenarios formulated to probe and stimulate respondents to identify situations and to tell versions of their own stories, as seen and/or experienced from the organisation, that could give an indication of the attitude of the organisation's personnel. The stories were developed based on Adamson, Pine, Van Steenhoven, and Kroupa (2006), who indicated that a good story should " inspire and combine conflict, suspense, symbols, characters to capture one's imagination and provide meaning". At the end of each story, questions were posed to check food handlers' opinion on the attitude displayed; whether they could identify with the attitude in their organisation and whether they had similar stories and/or experiences.

The stories were written on a card and read out to a small group of (at the most 8) employees. Since a group of respondents was required each time, they were asked to come outside working hours and were given US$ 5 each to cater for transport and food. The common interpretation of the attitude by the group on the story told and stories that the respondents shared were scored by 2 researchers. If for at least 80% of the responses, a negative, ambivalent/uncertain or positive predisposition towards compliance with personal hygiene, sanitation and crucial process parameters was evident, scores 1, 2 or 3 were given, respectively (Table 3). The frequency and mode scores were calculated using Microsoft Office Excel.

2.3.6. Document analysis to assess actual food safety and hygiene practices, microbiological safety performance and equipment maintenance

A checklist was developed to analyse records/documents for equipment maintenance, sanitation activities, control of crucial process parameters and microbial analysis. Records spanning 12 months were analysed to get an overview of the organisation's activities over a period of time. Information obtained was used to verify and explain the patterns observed for specific elements. Scores 1, 2 or 3 were given for non- (absence), partial (available but with gaps), and full compliance with the set criteria.

2.3.7. Characteristics of prevailing FS-culture

Table 3 shows scores used to assess the companies' prevailing FS-culture. Three classification levels, i.e. proactive, active and reactive levels (modified from Parker, Lawrie, & Hudson, 2006), were distinguished. For microbial safety performance, four stereotype situations that reflect no indication of, poor, moderate and good food safety performance were defined (Jacxsens et al., 2010).

3. Results and discussion

3.1. Prevailing FS-culture

Fig. 1 shows scores used to determine the companies' FS-culture; the greater the surface area, the more proactive the FS-culture. Score 2 predominated in CA and CB for employee characteristics and enabling conditions indicating that both companies demonstrated an active prevailing FS-culture. For CC score 3 predominated indicating a proactive prevailing FS-culture. This implies that food safety and hygiene control was not always regarded as important in CA and CB, whereas in CC food safety was consistently regarded as highly important i.e. food safety and hygiene control were prioritised. Our findings are consistent with De Boeck et al. (2016) who found that food safety climate scored higher for larger, centrally managed organisations.

3.2. Microbiological safety performance

Products in all 3 companies tested negative for *Salmonella*. *S. aureus* was also absent in CB and CC but was present in CA at 5 (2 cold room storage and 2 vacuum packaging points, and 1 filling and sealing step) of the 7 CSL's (Table 2). Document analysis showed that coliforms and *E. coli* were present in CA (Fig. 2), which is consistent with actual product testing on hygiene performance. For CB, compliance to criteria for coliforms was at least 93% and for CC compliance to *E. coli* criteria was 100%. Customer complaint records revealed that complaints for CA and CB were restricted to quality problems and for CC there were no complaints. In overall, the microbial safety performance for CC was good (score 3) compared to CA (score 1) and CB (score 2). CC's good performance could be because of the organisation's low product riskiness and the well-elaborated certified FSMS as also established by De Boeck et al. (2016) and Kussaga, Luning, Tiisekwa, and Jacxsens (2015). Moreover, the company had a comprehensive complaints system and a crisis management protocol in place, in case of food safety incidences. De Boeck et al. (2016), also found that companies with a high food safety climate score and a well elaborated FSMS had a better microbial safety performance. Analysis of data on actual behaviour, enabling conditions and employee characteristics could provide further explanations of the food safety performance differences.

3.3. Actual food safety and hygiene behaviour

Table 4 shows that CA partially complied (score 2; moderate-risk) with most behaviour parameters with an exception of health status, which scored 3 (low-risk) and sanitation practices, which scored 1 (high-risk) as food handlers did not execute sanitation activities at least 80% of the time. CB shows a more diverse pattern as some activities were well performed (score 3), i.e. correct cleaning compounds used and efficacy checked, whereas handwashing and corrective actions scored 1 as a majority of employees did not wash their hands or follow the whole handwashing procedure and adjusted process parameters without reporting the corrective action taken. Furthermore, in CB, most personal hygiene activities scored 2, as employees predominantly exhibited moderate-risk behaviour. Although no major microbial safety problems were observed, the multiple inconsistencies in compliance behaviour could imply potential risks in the organisation's microbial safety performance. CC showed a homogenous pattern as score 3 was consistently obtained since personnel strictly adhered to all food safety and hygiene control requirements (e.g. *"handwashing is a culture in this company"*). If employees perceive that their organisations treat them well and provide the enabling climate, they are more inclined to respond with positive work attitude and behaviour (Lee, Almanza, Jang, Nelson, & Ghiselli, 2013). Likewise, Pacholewicz et al. (2016) found that consistent food safety and hygiene compliance behaviour was reflected in better product safety performance.

3.4. Supportiveness of enabling conditions

Data for enabling conditions (Table 5) for CA and CB show a diverse pattern because there was no clear consensus amongst the food handlers on how the current enabling conditions supported them in executing their tasks, whereas data for CC show a homogenous pattern (score 3). In both CA and CB, technological conditions such as hygienic design and zoning, and a majority of the

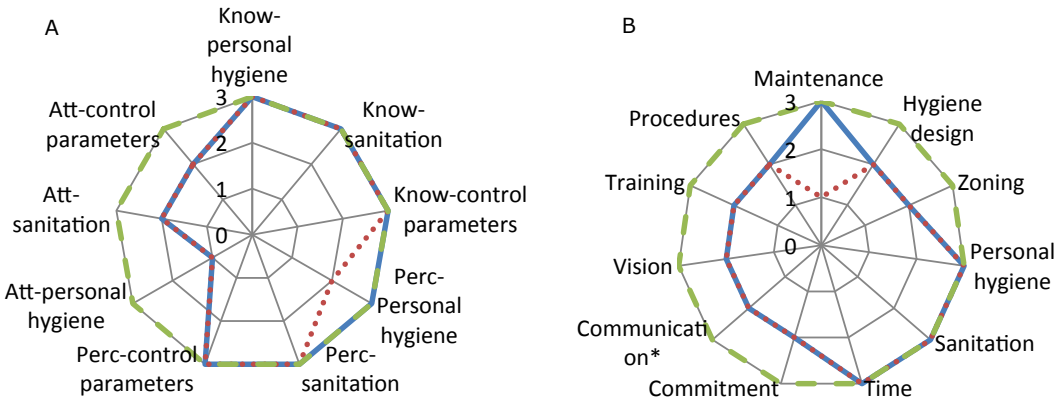

Fig. 1. Web diagrams showing an overview of overall scores for enabling conditions and employee characteristics for CA, CB and CC used to give an indication of the organisation's prevailing FS-culture. Interpretation of scores for each key element is given in Table 3. Know = knowledge, Perc = perceptions, Att = attitudes. A: Personal characteristics; B: Enabling conditions ——— ····· – – – .

organisational conditions (commitment, vision, training and procedures) scored 2 (restricted support) as compared to CC, where all enabling conditions were considered to be supportive (score 3).

Both CA and CB had similar overall mode scores for the provided enabling conditions with the exception of maintenance, which was more supportive in CA compared to CB where it was reactive and not supportive (score 1) as it was frequently triggered by breakdowns ("*maintenance is carried out when machines are down completely*"). Likewise, previous studies in dairy companies of transitioning countries found equipment maintenance to be reactive (Kussaga et al., 2015). For CC, equipment maintenance was proactive as the organisation had a structured, preventive program

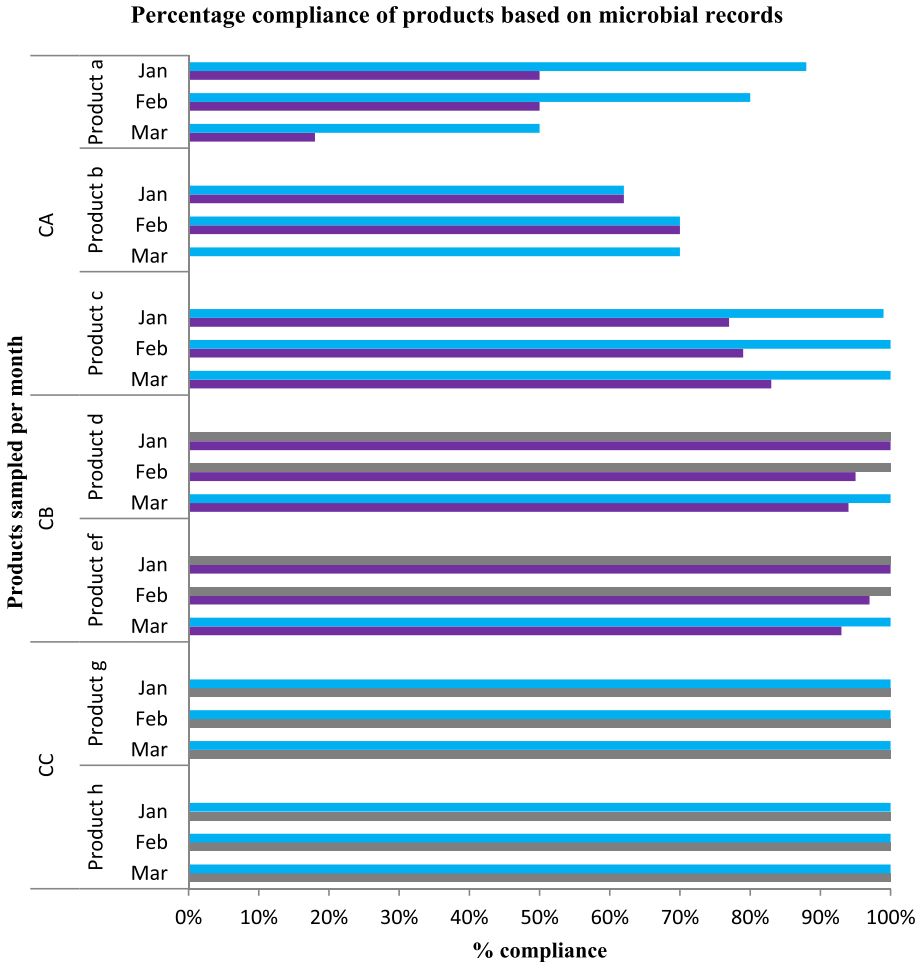

Fig. 2. Compliance of products with microbiological criteria in companies A, B and C based on analysis of company records on hygiene performance. Blue: *E. coli*, Purple: Coliforms, Grey: Analysis not done. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 4
Mode scores for employees' actual behaviour for executing different food safety and hygiene tasks.

Indicator	CA n = 24 Mode	CB n = 38 Mode	CC n = 10 Mode
Actual personal hygiene behaviour			
• Protective wear			
Maintenance of high degree of personal cleanliness (protective clothing, hair covers, footwear, hand gloves)	2	2	3
• Handwashing practices			
Handwashing behaviour before and after crucial activities, e.g. high risk areas, before starting work, after blowing nose, visiting the toilet and handling waste	2	1	3
• Handwashing steps			
Following handwashing steps	2	1	3
• Personal habits			
Personal hygiene habits e.g. (wearing jewellery, chewing gum, use of mobile phones or blowing nose during processing)	2	2	3
• Health status			
Handling of health issues i.e. coughing/sneezing, illness, exclusion of those sick and with open lesions/wounds in food processing areas	3	2	3
Overall score personal hygiene practices	**2**	**2**	**3**
Actual execution of sanitation activities			
• Following cleaning and disinfection procedures	1	2	3
• Correct cleaning compounds	1	3	3
• Correct cleaning tools	1	2	3
• Sanitation activities and/or efficacy monitored	2	3	3
Overall score sanitation activities	**1**	**2**[a]	**3**
Actual control of process parameters			
• Appropriateness of monitoring of crucial parameters	2	2	3
• Corrective actions taken when crucial parameters deviate from required levels	2	1	3
Overall score control of process parameters	**2**	**2**[a]	**3**

[a] Overall score obtained from further checklist sub-parameters in the event that checklist criteria have an equal scoring. Score 1 = noncompliance (food safety and hygiene practices are not executed ≥80% of the time), 2 = partial compliance (incomplete execution ≥80% of the time), 3 = full compliance (correct and complete execution ≥80% of the time).

regularly monitored by experts and maintenance was periodically done ("*we don't mind shutting down the plant to carry out maintenance*").

Closer inspection of the frequency scores shows that for various enabling conditions e.g. personal hygiene and training (Table 5), there was no clear distinction on the extent of supportiveness of the provided conditions. For example, the diverse assignment of scores for training in CA could be attributed to the company's initiative towards HACCP training at the time of assessment. This prompted some respondents to have a positive bias towards training whereas others stated unstructured training to be the norm. In CB, some respondents also had a positive bias because of the current occupational safety training, whereas others highlighted training was unstructured. However, in CC training was tailored to individual needs as there was a competence and development matrix to identify training needs.

For communication, a clearly divided opinion (equal scores assigned) on its supportiveness was evident (Table 5). Some respondents in CA considered communication lines to be open, whereas others cited lack of communication tools, e.g. infosheets. In CB, some respondents considered the communication system to be advanced because of the existing information sharing software, whereas others cited limited opportunities for feedback and channels to reach supervisors. A study by Fatimah, Arendt, and Strohbehn (2014a) also showed a divided opinion on communication with some respondents appreciating the communication style and others pointing at its inconsistencies. The varied responses could be because the enabling conditions are as perceived by employees and individuals could over- or underestimate the supportiveness of the conditions due to i.e. job stress and conscientiousness (De Boeck et al., 2015). For CC, additional communication tools were clearly visible in all locations, which might have reinforced the good food safety practices. Chapman, Eversley, Fillion, MacLaurin, and Powell (2010) also found that infosheets positively influence hygiene behaviour, which underpins the importance of food safety communication strategies for compliance behaviour.

The inconsistencies in perceived supportiveness of enabling conditions in CA could have hindered compliance to food safety and hygiene control. For example, respondents indicated personal hygiene requirements were not always available and adequate. Moreover, equipment was difficult to clean, which confirms findings by the Zimbabwe Economic Policy And Research Unit (2014), who found that hybrid and self-fabricated equipment is sometimes used in Zimbabwe and could be a hindrance to effective sanitation. Furthermore, some respondents perceived management commitment as less supportive since according to them, some managers openly violated hygiene requirements. Chen et al. (2015) and Lee et al. (2013) suggested managers commitment as an important driver to food safety as it motivates employees to appropriately execute their tasks. Moreover, Arendt et al. (2011) posited that willingness of employees to follow safe food behaviour is shown when employees observe superiors following safe food practices.

Also for CB, lack of consensus, as not all food handlers perceived the enabling conditions to be supportive, could have resulted in the moderate-risk behaviour. Remarks such as "*some machines are difficult to clean*", "*it has been 3 years since I joined the company and have not seen any training*", "*handwashing facilities are crowded*" and "*it can take two days to replace sanitisers*" suggest a potentially risky situation. Fatimah et al. (2014a) indicated that supportive environmental conditions, i.e. resources, enable and prompt food safety practices and that if not functioning properly or inadequate, do not support safe food practices. Moreover, De Boeck et al. (2017) established that food safety behaviour could be influenced by FS-culture elements and could shape the organisation's FS-culture.

In CA, some food handlers scored different from the managers

Table 5
Frequency of individual scores and mode scores for the enabling conditions.

Indicator	Respondents	Frequencies of scores from respondents									Mode[a]		
		CA (n = 24)			CB (n = 43)			CC (n = 28)			CA	CB	CC
		1	2	3	1	2	3	1	2	3			
Technological enabling conditions													
Maintenance	Managers		3		1	3	2			4	2	2	3
	Food handlers	4	6	11	24	10	3			24	3	1	3
	Overall score										**3**[b]	**1**	**3**
Hygiene design	Managers		2	1	1	4	1			4	2	2	3
	Food handlers	1	15	5	3	23	11		2	22	2	2	3
	Overall score										**2**	**2**	**3**
Zoning	Managers	1	2			4	2			4	2	2	3
	Food handlers		16	5	1	32	4			24	2	2	3
	Overall score										**2**	**2**	**3**
Personal hygiene	Managers		2	1		3	3			4	2	2/3[c]	3
	Food handlers	1	8	12	4	14	19		1	23	3	3	3
	Overall score										**3**[b]	**3**[b]	**3**
Sanitation	Managers		2	1	1	1	4			4	2	3	3
	Food handlers	2	5	14	3	14	20			24	3	3	3
	Overall score										**3**	**3**	**3**
Organisational enabling conditions													
Time	Managers		1	2	1	1	4			4	3	3	3
	Food handlers		5	16	4	13	20			24	3	3	3
	Overall score										**3**	**3**	**3**
Commitment	Managers		2	1		5	1			4	2	2	3
	Food handlers	2	10	9	6	26	5		2	22	2	2	3
	Overall score										**2**[b]	**2**	**3**
Communication	Managers		2	1		3	3			4	2	2/3[c]	3
	Food handlers		10	11	5	16	16		1	23	3	2/3[c]	3
	Overall score										**2/3**[c]	**2/3**[c]	**3**
Vision	Managers		3		1	2	3			4	2	3	3
	Food handlers		10	11		29	8		1	23	3	2	3
	Overall score										**2**[b]	**2**	**3**
Training	Managers		3		1	5				4	2	2	3
	Food handlers	1	9	11	19	18				24	3	1	3
	Overall score										**2**[b]	**2**[b]	**3**
Procedures	Managers		3			3	3			4	2	2/3[c]	3
	Food handlers	1	12	8	6	21	10		2	22	2	2	3
	Overall score										**2**	**2**	**3**

Scores 1, 2, 3 correspond with lack of, restricted and full support. Overall scores are in bold.
[a] Mode scores derived from total scores of respondents.
[b] Overall score not clearly distinctive (differences between scores ≤ 5).
[c] Equal scores assigned.

e.g. for maintenance food handlers scored 3 as they were inclined towards proactive maintenance whereas managers scored 2 as they perceived it as active, but the number of managers is comparatively small. For CB, managers scored 2 or 3 for maintenance whereas food handlers mainly scored 1. Findings are consistent with De Boeck et al. (2015) who observed that mangers and food handlers were not always on the same wavelength. The discrepancies could affect trust and loyalty, which in turn could influence attitudes and actual behaviour (Cogliser, Schriesheim, Scandura, & Gardner, 2009; De Boeck et al., 2016). In comparison, both managers and food handlers in CC similarly perceived the enabling conditions and unanimously agreed that the organisation was focused on preventing food safety problems.

3.5. Employee characteristics: knowledge, perceptions and attitude

The mode scores show that respondents in all three companies scored 3 (Table 6) on all indicators related to knowledge of food safety and hygiene control. However, sufficient knowledge of respondents in both CA and CB did not always translate into good behaviour, which is consistent with findings by Arendt et al. (2011), Fatimah et al. (2014b) and Jianu and Chiş (2012). There is need to understand what motivates personnel to correctly execute food handling practices. Ko (2013) established that attitudes mediate the relationship between actual practices and knowledge. Moreover, optimistic bias, where personnel know the correct procedure but consider or perceive the inherent risk to less likely occur to them, could explain the discrepancy between knowledge and behaviour (da Cunha, Stedefeldt, & de Rosso, 2014). Interestingly, this is not the case for CC employees as quizzes to assess knowledge were periodically held and winners were awarded, all in the effort to make sure employees had good knowledge.

All three companies mainly scored 3 (mode score) for indicators on perceptions towards food safety and hygiene practices (Table 6) as respondents' perceptions completely aligned with organisational requirements. Findings are consistent with Fatimah et al. (2014b) where employees largely perceived food safety as being practiced within the organisation. An exception was perceptions on personal hygiene requirements in CB where respondents' perceptions did not always align with organisational requirements (score 2). This was mainly because of the handwashing procedure, e.g. the time for rubbing hands after applying soap varied from 15 s to 5 min. This result corroborates findings by Jianu and Chiş (2012), where food handlers did not know all the appropriate handwashing steps, which could explain the observed handwashing behaviour (Table 4).

Except for CC and for personal hygiene in CB, perceptions did not translate to actual behaviour. This discrepancy might be related to respondents' characteristics, perceived supportiveness of enabling conditions, and individual preferences, beliefs, attitudes and values.

Table 6
Frequency of individual scores and mode scores for knowledge, perceptions and attitude.

Indicator	Frequencies of scores from respondents									Mode		
	CA			CB			CC			CA	CB	CC
	1	2	3	1	2	3	1	2	3			
Knowledge of food safety and hygiene control												
• Personal hygiene requirements (protective clothing, hand gloves, hair covers, face masks, fingernails, handwashing, illness)	1	2	18			40		3	25	**3**	**3**	**3**
• Sanitation activities (sanitation procedures, cleaning methods, cleaning efficacy, cleaning tools, order of cleaning)	3	4	14	2	6	32			28	**3**	**3**	**3**
• Control of crucial process parameters (temperature, time, calibration, post pasteurisation)		4	17	3	9	28	2	3	23	**3**	**3**	**3**
Perceptions towards food safety practices												
• Personal hygiene practices (appropriate handwashing, personal cleanliness, use of protective wear, reporting of health issues)			10		6	4			7	**3**	**2**	**3**
• Sanitation activities (appropriate removal of soil)			10		1	8[a]			7	**3**	**3**	**3**
• Control of crucial process parameters (appropriate time and temperature control practices, and corrective actions)			10		1	5[a]			6[a]	**3**	**3**	**3**
Attitude towards compliance to procedures												
Personal hygiene practices		3	21			43			15	**3(1)**[b]	**3(1)**[b]	**3(3)**[b]
Sanitation activities			24			43			15	**3(2)**[b]	**3(2)**[b]	**3(3)**[b]
Control of crucial process parameters			24			43			8[a]	**3(2)**[b]	**3(2)**[b]	**3(3)**[b]

Scores 1, 2, 3 for (1) knowledge correspond with inadequate (complete lack of), moderate (incomplete) and good (ample) knowledge on food safety and hygiene issues, (2) perceptions with non-, partial and full alignment, at least 80% of the time, with company requirements, (3) attitudes with negative, ambivalent and positive attitude. For knowledge n = 21 for CA, n = 40 for CB and n = 28 for CC. For perceptions n = 10 for CA, n = 10 for CB and n = 7 for CC. For attitude n = 24 for CA, n = 43 for CB an n = 15 for CC.
[a] Respondents less than **n** as they indicated that questions were not applicable to them.
[b] Mode scores given are those for the common interpretation of stories told by the researchers and in brackets the predominant attitude scored for the stories shared by food handlers.

Taylor (2011) acknowledged that a person's family/social background (e.g. societal norms) can influence how someone perceives and responds to organisational food safety requirements, as expressed in work practices, and can be encouraged or discouraged by an organisation's values. The limited number of respondents on perceptions limits us in drawing strong conclusions, since respondents not involved in the work activities declined to answer.

Mode scores for attitudes towards food safety and hygiene control (Table 6) differed between the respondents' interpretation of the attitude in the stories told by the researchers and the actual (as shown in brackets) attitude judged from stories told by respondents of actual situations typical to their organisation. In CA and CB, all scores were lower (score 1 for personal hygiene practices, and score 2 for sanitation activities and control of crucial process parameters when they were assigned based on the actual attitude). On the contrary, CC consistently scored 3 for both mode scores. Food handlers' negative attitudes towards compliance with personal hygiene practices for CA and CB (Table 6) were reflected in stories such as "*some people are negligent because they are in a hurry to close from work*", "*changing rooms are not safe, so we carry our valuables e.g. phones, jewellery with us into the production area*" and "*sometimes people clean without detergents*". Some respondents attributed the negative attitude to unclear personal hygiene requirements. Moreover, financial constraints were frequently mentioned as a driver for risky decisions and risk-taking behaviour such as cutting corners, which is corroborated by Fatimah et al. (2014a). The negative personal hygiene attitude could also explain the handwashing behaviour in CB since attitude has been identified as a predictor of hand hygiene behaviour (Clayton & Griffith, 2008). Ambivalent attitudes towards sanitation activities and control of crucial process parameters could have triggered the insufficient adoption of food safety practices as also found in studies by da Cunha et al. (2014) and Ko (2013). In CC, respondents' attitudes were demonstrated by clear ownership of the products and attachment to the organisation. This was corroborated by common responses such as "… *because we want the job, we keep the rules*", "*it won't happen here*", "*it is better to do the right things*" and "*it is better to miss an appointment than shortcut the process*".

3.6. Mixed-methodology approach

The card-aided interview approach guided respondents to select the situation that best reflected the organisation and was useful to get in-depth understanding behind the choices. However, terms used were sometimes perceived to be too technical resulting in more time (i.e. 30 min to 1 h) spent with the respondent. It could be advantageous to translate the cards into the local language and add pictures (Chapman et al., 2010) to help understand some parameters, i.e. zoning, thus limiting the influence of the researcher. Storytelling was able to elicit food handlers to share more stories, which helped to understand the attitudes. Stories offer researchers an entry point to getting insights in an organisation's culture (Boyce, 1996). Chapman et al. (2010) used storytelling to generate dialogue and the method was effective as an intervention tool to positively influence food safety practices. A downside to storytelling could be the social desirability bias. Respondents could therefore put their thoughts on paper rather than airing them out in the group. A timestamp is also required since some stories could have happened years back and the situation could have improved over time, thus not reflecting current trends.

Observations provided information on the actual behaviour and status of equipment/facilities, and have been advocated as a reliable measure of FS-culture as they capture actual practices in their actual context (Chapman et al., 2010) and are not dependent on self-reported practices but can be independently and objectively assessed (Powell et al., 2011). Organisations were observed as units. It is recommended to observe an individual's behaviour in a next study as compared to organisational behaviour to get a more accurate insight of actual behaviour. Questionnaires have been successfully used in existing FS-culture research (e.g. De Boeck et al., 2016; Fatimah et al., 2014b). Document analysis gave a clearer picture of what had been on the ground for a longer period of time, which is consistent with Powell et al. (2011). All companies had samples analysed at accredited laboratories, which is consistent with the assessment done by Kussaga et al. (2015). The microbial results should be interpreted with caution due to the sample size and limitations placed by the organisations on actual microbial

analysis.

Overall, the mixed-methods approach was suitable to get an in-depth understanding of FS-culture. The approach encourages multi-level analysis, enables one to take a multi-faceted view of FS-culture, and to establish relationships between the context, behaviour and individual characteristics (Cooper, 2000). Moreover, the methodology enables assessment of the external validity of the FS-culture construct through a "within-methods triangulation approach" and "between-method validation process". Within-methods involves crosschecking each method used for consistency and reliability (Cooper, 2000). Between-method validation involved comparisons between the different constructs, i.e. prevailing FS-culture, actual behaviour and performance. However, the approach was quite elaborate but time consuming. To get a quick overview of the FS-culture with a less demanding process, an organisation can use a self-assessment tool.

4. Conclusions and suggestions for future research

Comparison of the results obtained from the microbiological safety performance of the three dairy companies in this study are in agreement with the outcomes of the data on actual food handler behaviour, enabling conditions and employee characteristics. Firstly, this clearly supports the suitability and validity of the proposed mixed-methods approach used to assess FS-culture in the present study. Secondly, it enables an organisation to have an understanding of its prevailing FS-culture, which provides guidelines on measures to improve performance. The identified levels (reactive, active and proactive) were able to distinguish the prevailing FS-culture. To reach a proactive level, appropriate roadmaps for tackling the identified bottlenecks (scores 1, 2 or where respondents lacked consensus) are needed. Such roadmaps should elaborate FS-culture specific interventions, point the where, what and how to improve the FS-culture (Hudson, 2007) and be assessed over time to assure their effectiveness to FS-culture improvement. Though having a proactive FS-culture is sufficient, an enlightened (well-advanced) FS-culture would be ideal. However, the paradigm stating that the more enlightened the FS-culture, the better the performance, could be over-the-top and FS-culture paranoia will make operations time consuming and rigid, and workers could lose motivation resulting in performance losses. Pidgeon (1998) acknowledged the paradox of safety culture, where it could both act as a "precondition to safe operations (illuminating hazards) and for oversight of incubating (deflecting attention) hazards." As such, risk-based auditing for management of key food safety risks could be a tool useful in FS-culture as it allows spot checks and focuses on areas of risk (Albersmeier, Schulze, Jahn, & Spiller, 2009).

Future studies need to add weight factors to the FS-culture indicators as the indicators could have differently contributed to food safety performance. This is because some indicators could be more detrimental and could accumulate or gradually worsen leading to major consequences in food safety (Nayak and Waterson (2016)). Future studies should also consider chemical safety as existing studies primarily focus on microbiological safety.

The study was done in 3 dairy companies of 1 country and since FS-culture is context specific (Fatimah et al., 2014a; Nyarugwe et al., 2016), generalisations cannot be inferred across food establishments and countries as sector specific characteristics and national culture can influence the FS-culture. Future research needs to study the national culture influence, and research in food establishments in several countries is required.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.foodcont.2017.07.038.

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