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The impact of maturing food safety culture and a pathway to economic gain

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Abstract

Research into the connection between organizational effectiveness and culture has been documented since the early nineteen nineties. A connection between economic performance and organizational culture has been established directly linking strong cultural drivers to economic performance in both the finance and retail sectors. This research proposes a similar association between food safety culture, the measures of maturity and cost of poor quality. Through data collected at five multi-national food companies, this association is explored, and an improved food safety maturity model suggested. The authors also propose a dynamic model of food safety culture, segmenting it into 4 building blocks: I. Organizational effectiveness, II. Organizational culture norms, III. Working group learned and shared assumptions, and behaviours, and IV. Individual intent and behaviours; and discuss the crucial role of actions between building blocks as part of the pathway to realizing economic gain.

Highlights

1. Explores organizational culture, effectiveness, and performance in the food industry
2. Demonstrates theoretical economic gain from building food safety culture maturity
3. Refines and strengthens a food safety culture maturity model for practical application
4. Proposes a dynamic model of food safety culture building block and interactions
5. Empirical study of culture performance within five global food manufacturing companies

Keywords

Food safety culture, economic impact, food safety maturity model, cost of poor quality, food safety culture dynamic model.

1. Introduction

To solve the specific challenges related to food safety performance, e.g., consumer death, illness and injury (Maberry, 2016; World-Health-Organization, 2015), and impact on brand and economics (Hussain & Dawson, 2013; Ribera et al., 2012) throughout the food supply chain it is now widely recognized that food safety culture plays an integral role (Ball, Wilcock, & Aung, 2009; Griffith, 2010; Griffith & Jackson, 2017; Nayak & Waterson, 2017; Powell, Jacob, & Chapman, 2011; Taylor, 2011). It is also understood that to get to a stronger sub-culture (e.g., safety culture, food safety culture, innovation culture) one must consider the broader organizational culture and its effectiveness (Denison, Hooijberg, Lane, & Lief, 2012; Denison & Mishra, 1995; Schein & Schein, 2017). Quoting Harvard Professor Emeritus James L. Heskett, "Organization culture is not a soft concept, its impact on profit can be measured and quantified. And in organizations with large numbers of customer-facing employees, the sum of the effects of employee turnover, referrals of potential employees by existing ones, productivity, customer loyalty, and referrals of new customers attributable to culture can add up to half of the difference in operating income between organizations in the same business" (Kotter & Heskett, 1992). It is this contrast between perceived soft (e.g., principles of organizational and behavioural sciences) and hard (e.g., financial performance) concepts that makes organizational cultures and sub-cultures both intriguing and challenging for practitioners and scientists to understand and makes it important to conduct further work to elucidate how these concepts apply in different settings, e.g., food manufacturing, thus addressing the research gaps in these areas.

Crosby (1972) defines quality as ‘conformance to requirements’ and makes the claim that “management unintentionally cause an increased cost of quality for the organization by not understanding this simple definition.” Crosby also suggests, like Kotter and Heskett (1992), that a culture revolution through a planned strategy is the key to reducing cost of quality in any organization. Through the ‘Quality Management Maturity Grid’, Crosby defines six measurement categories by which an organization can evaluate its current stage of quality maturity. Using the grid, he demonstrates the connection between decreasing cost of quality and increasing quality culture maturity; thereby directly linking the culture of an organization to organizational financial performance. Crosby shows how as much as 20% of sales can be lost as cost of poor quality (COPQ) in contrast to losses in a high-level maturity culture of 2.5%. The American Society of Quality (ASQ) builds on the work by Crosby and divides COPQ into four activities: prevention costs, appraisal costs, and internal and external failure costs (Duffy, 2017). Through these activities, costs related to e.g., systems maintenance and training, conformance to specification, verification activities, waste and scrap, and complaints, are tracked to quantify the percentage of sales due to poor quality. Schiffauerova and Thomson, (2006) report that each industrial sector has unique quality cost elements but that there is no set structure or accounting standard for quality costing (Schiffauerova & Thomson, 2006). Thus, the decision on the cost structure of the COPQ model is generally left to the judgment of quality managers and may differ considerably between companies. Nevertheless, since prevention, appraisal, and review of internal and external failures have been related to food safety management effectiveness in food manufacturing companies (Hutton, 2001; Surak & Wilson, 2007; Wallace, Sperber, &

Mortimore, 2010), it is logical to surmise that costs of these activities will form quality cost elements for calculating COPQ in food manufacturing. Thus, the authors of this research suggest that COPQ, as defined by Crosby and ASQ and applied to food companies, includes specific food safety metrics (Table 1) and is therefore a relevant measure for estimation of economic impact of a company's food safety culture maturity, although this has not yet been tested by empirical research.

(Table 1)

In order to further explore the potential impact of food safety culture maturity on economic indicators such as COPQ, it is necessary to establish the relevant theoretical background in organisational and food safety culture. This now follows along with a delineation of the aims of this research.

2. Theoretical background and research aims

2.1 Organizational culture, effectiveness and impact on financial gains

Principles from organizational culture have been incorporated into research on food safety culture by most of the researchers in the field. As such, the authors seek to provide a review of research that specifically focused on showing the connection between organizational culture, organizational effectiveness and the impact of both on economic performance.

Kotter and Heskett (1992) studied culture in 207 U.S. firms through surveys and detailed interviews and found a direct connection between organizational culture and financial performance. While the authors clearly stated that many confounding variables impact an organization's financial performance, they also discovered a substantial difference in financial performance between performance-enhancing cultures and non-performance enhancing cultures within two groups of 12 companies (Table 2). In the group that invested in a performance-enhancing culture, the increase across the financial indicators ranged from more than 200% to more than 900% for specific indicators. Kotter and Heskett (1992) described 'performance-enhancing cultures' as those which have organizational values that include managers deeply caring about customers, and strongly value people and processes that create useful change. Conversely values in non-performance enhancing cultures are described as managers mostly caring about themselves and their immediate work group and emphasising consistent management processes that reduce risks within their immediate area of responsibility.

(Table 2)

Similar to Kotter and Heskett (1992) Denison (1997) explored the connection between organizational culture and effectiveness. Denison's research sought to answer the question "what can the cultural characteristics of an organization tell us about effectiveness?" and demonstrates the connection between four organizational traits: Involvement, Consistency, Adaptability, and Mission and organizational effectiveness. Denison measured organizational effectiveness through behavioural performance using the established scale 'Survey of Organizations (SOO)' and financial performance through income/sales ratio and income/investment ratio. Denison found a valid connection between these cultural traits to both behavioural performance and financial effectiveness (Denison, 1997; Denison & Mishra, 1995). Graham *et al.* (2017) defined an effective culture as “one that promotes the behaviours needed to successfully execute the firm’s strategies and achieve its goals”. Data were gathered from 1,348 North American firms through surveys and interviews with senior executives. The authors found that organizational effectiveness is the result of interaction between an organizations values, norms, and formal systems (Graham *et al*. (2017). In this context, values are defined as the aspirations of the organization, norms as the day-to-day practices that live out the values, and formal systems as their written policies and procedures. Human behaviours are conditioned through the integration and adaptation of organizational norms, and norms are, in turn, an interpretation and adaptation to the organization’s values and formal systems. Graham *et al*. (2017) demonstrates that norms enhance business outcomes, but values do not. Their research also suggests that the marketplace influences executives’ investment in culture as well as the organizational values they promote (Graham *et al.* 2017). This external adaption is also captured in Schein’s updated (2017) definition of organizational culture as “... the accumulated shared learning of the group as it solves its problems of external adaptation and internal integration…” (Schein & Schein, 2017). Schein thereby integrates external and internal triggers of change as confirmed by the findings of Graham *et al.* (2017).

The ‘Great Place to Work® Institute’ is a global organization dedicated to providing knowledge on how to build and sustain high performing work place culture. Its database contains data from more than 5,500 companies operating in 45 countries collected through annual assessment surveys and is used for the ‘Great Place to Work® Institute’ own publications on workplace culture as well as being made available for academic study (Great-Place-to-Work, 2017). Through analysis of the survey data, researchers found that proclaimed values appeared irrelevant to an organization’s effectiveness (Guiso, Sapienza, & Zingales, 2014). This supports the findings of Graham *et al.* (2017) that values alone do not drive business outcomes, but norms do. The research also shows that if executives are perceived as trustworthy and ethical the company’s performance will be stronger. In analysing S&P 500 companies the researchers found that 80% of the companies mention ‘innovation’ followed by ‘integrity and respect’ in their corporate values. A culture of integrity was found to add value and positively correlated with financial performance and attractiveness of job offerings and negatively correlated with the degree to which the company’s workforce was unionized or not (Guiso *et al.* 2014).

Causality between culture and organizational effectiveness measured through performance, was proven in a six-year longitudinal study with car dealers. The study proved that ‘culture does come first’ and performance will follow. Further, the positive effect of culture on vehicle sales was fully mediated by customer satisfaction ratings (Boyce, Nieminen, Gillespie, Ryan, & Denison, 2015).

2.2 Measuring food safety culture maturity

An extensive list of researchers (Ball et al., 2009; Boeck, Jacxsens, Bollaerts, & Vlerick, 2015; Griffith, 2014; Hinsz & Nickell, 2015; Jespersen, Griffiths, & Wallace, 2017; Nayak & Waterson, 2017; Nickell & Hinsz, 2011; Nyarugwe, Linnemann, Hofstede, Fogliano, & Luning, 2016; Powell et al., 2011; Taylor, Garat, Simreen, & Sarieddine, 2015; Yiannas, 2009) have built the current knowledge base of food safety culture and its assessment and improvement, which the authors seek to further through this research.

Focussing on food safety culture maturity, Jespersen et al completed five studies aimed at measuring this construct (Jespersen & Edwards, Submitted; Jespersen, Griffiths, Maclaurin, Chapman, & Wallace, 2016; Jespersen, Griffiths, et al., 2017; Jespersen, MacLaurin, & Vlerick, 2017; Jespersen & Wallace, 2017). The initial study (Jespersen et al., 2016) suggested that by applying a mixed method approach using quantitative (questionnaire) and qualitative (interviews and document coding) elements, a comprehensive insight could be gained through profiling using a maturity model. The initial model was built on principles from organizational culture, specifically Schein's five dimensions (Schein, 2004) as well as learnings from maturity models in other domains: quality management (Crosby, 1972), health care (Goonan, Muzikowski, & Stoltz, 2009), and information technology (Ali, 2014). The progressive five stage food safety model breaks down food safety culture into five capability areas. To ensure content validity of the model a Delphi method was applied with three rounds of review and revision with a seven-member panel. Following finalization of the model this was applied to the measurement of food safety culture at one Canadian protein company (Jespersen et al., 2016). To validate the model and mixed method a comparative study of eight existing evaluation systems was conducted (Denzin, 2012; Jespersen, Griffiths, et al., 2017). One of the key findings in the comparative study was general weakness in how the evaluation systems were validated. None of the evaluation systems had applied and published a structured triangulation as a commonly applied method for validating social science scales (Denzin, 2012; Jespersen, Griffiths, et al., 2017). A content analysis method was proposed to accurately reflect an organization's food safety culture (Jespersen, 2017; Jespersen & Edwards, Submitted; Jespersen & Wallace, 2017) as well as a method to assess response bias in the form of social desirability (Jespersen, MacLaurin, et al., 2017). Five dimensions of food safety culture (Values and Mission, People Systems, Adaptability, Consistency, and Risk Awareness) were proposed based on the results from the comparative study (Denzin, 2012; Jespersen, Griffiths, et al., 2017). These dimensions have been adopted by the Global Food Safety Initiative (GFSI) in the GFSI position paper on a culture of food safety (Quentin & Jespersen, 2018).

2.2.1 Development of a self-assessment scale

The scale was developed by Jespersen et al. (2016) and includes question statements pertaining to four areas (Table 3) to measure food safety culture maturity; social norms, behavioural intent, motivation, and social desirability. Social norms are measures that relate to a person's perception of what other people would approve of regarding given behaviours. The individual participants were asked a series of statements 'Most people whose opinion I value would approve of…'. Behavioural intent is measured through statements designed to gauge a participant's intent to carry out a specific food safety behaviour consistently. Motivation in a cultural context is measured by asking the respondent to prioritize who in their social network they are motivated by to carry out food safety behaviours; manager, peers, family/friend, or self.

Social desirability is a social science research measure that quantifies the tendency of study participants to answer questions in a way to be viewed favourably by others. It can take the form of over-reporting ‘good behaviour’ or under-reporting ‘undesirable behaviour’ and rated on a scale from zero to 18. The objective is to get a score of zero where study participants answer truthfully independent of other’s views of them. Research can be advanced by considering social desirability, statistically speaking, as a control variable. By measuring humans’ tendency to answer food safety related questions in manner that will be viewed favourably by others, the food industry can get a more authentic and valid assessment of food safety culture (Jespersen, MacLaurin, et al., 2017).

(Table 3)

2.2.2 Developing a textual coding framework

Textual data, including documents and, following transcription, semi-structured interview data involve large amounts of text that is commonly subjected to content analysis to determine patterns, trends and relationships as well as frequencies of words used in a document or by an interview subject (Vaismoradi et al, 2013). A deductive content analysis approach was chosen in order to apply method triangulation to increase validity of food safety culture evaluation results. This used a coding framework based on the dimensions of food safety culture identified by Jespersen, Griffiths and Wallace (2017) from a study of eight culture or food safety culture evaluation systems. The content analysis of food safety performance documents provided an insight into the documented food safety culture e.g., level of consistency, adaptability, and perceived value of food safety, whilst the analysis of interview data explored the lived food safety culture as vocalized by the interview subjects.

The process for developing the coding framework and coding content was reported by Jespersen and Wallace (2017) and is shown in annex 1. Detailed research questions were defined (step 1) and the theoretical framework of five dimensions of food safety culture (Jespersen, Griffiths and Wallace (2016)) was used as a starting point for determination of coding nodes. Two independent coders first read and re-read the data to gain an immersive sense of the whole before deducing appropriate sub-nodes and establishing the coding framework (step 2). The framework (annex 2) was an important component as it connects the coded data to the theoretical framework and the research domain. The nodes and sub-notes were input into NVivo (step 3) and, following this, coders were trained (step 4) and two documents coded by same coders (step 5). The results were analyzed by detailed review of verbatim data to look for similarities and differences between coders. A decision was made to go back to the coding framework and update with addition of sub-nodes and to go back to the test documents for recoding (step 6). Following this loop, the decision was made to carry on with the full document coding as coders were considered "consistent" based on another detailed verbatim review (step 7). Midway discussions between coders allowed comparison of experience, and discussion of coding difficulties and issues. These results led to another rework of the two selected documents and finalization of the 30 documents (step 8). Finally, the data was analyzed to derive information to answer the research questions (step 9).

The process included two checks for consistency evaluated through calculation of percentage pairwise agreement. (Neuendorf, 2002) argues that the goal for pairwise agreement in social sciences often are .8 but that .9 levels are most appropriate. This higher threshold level has also been suggested to account for some weaknesses in this method (Lombard, Snyder-Duch, & Bracken, 2002). Based on these references the standard for this research for pairwise agreement level was set to .9 (90% agreement).

2.2.3 Constructing the food safety maturity model

The maturity model was designed to assesses food safety culture on a scale from zero to five. The model and scale are sub-divided into five stages each with a description of a capability area e.g., people systems at a given maturity score e.g., three. The descriptor for a company's people system in a maturity stage three is 'deep understanding for the importance of food safety systems with clearly defined and communicated responsibilities.'

Each stage on the maturity scale has two identifiers a numerical and textual i.e., stage 1/doubt, stage 2/react to, stage 3/know of, stage 4/predict, and stage 5/internalize. The numerical identifiers are aligned with the scale used in the online self-assessment. For example, a self-assessment of two in the self-assessment equals a 'disagree' on the Likert scale of 'strongly disagree to strongly agree 'and a stage 2/react on the maturity scale. In addition, the maturity scale was aligned to the levels of Crosby's Quality Management Maturity Grid (Crosby, 1972).

To apply the maturity scale, all responses from each of the participants in the self-assessment were added and a mean maturity rating for each capability area and aggregated mean for all capability areas calculated. Depending on the mean ratings a maturity score for the capability areas, the plant over all, or the company over all could be estimated. As such, maturity ratings could fall into any of the five stages on the maturity scale and model, and an interpretation of stages could be provided based on the descriptors of the stages and the detailed content of the capability areas in the maturity model as shown in the maturity model construct (Table 4).

2.3 Research aims

As previously stated, gaps were identified relating to the validation of assessment methods (Jespersen, Griffiths and Wallace, 2017) and how food safety culture research has not yet progressed to include an evaluation of organizational performance and effectiveness. Thus, it is not currently possible to determine the impact of food safety culture on the economic performance of a business. Therefore, it is important to understand how validated assessment measures of food safety culture maturity can be combined with economic performance measures such as COPQ to understand how improvement of food safety culture can support business effectiveness. In order to move forward the debate in this area, this research aims to, 1) validate or revise the initial food safety maturity model based on new learnings, 2) apply the principles of cost of poor quality to assess economic value of maturing food safety culture, and 3) suggest a dynamic model that captures the constant interactions that cause sub-cultures to adapt to and integrate change in a food manufacturing setting.

3. Materials and methods

This research was part of a large study of food safety culture performance conducted in collaboration with five multi-national North American-based food manufacturing companies from October 2015 to March 2016.

3.1 Data collection at five global food manufacturing companies

Five companies were approached to participate in the study based on their previous interests in the subject and willingness to have the researcher collect data virtually and on-site in all their manufacturing plants. Study data collection methods included an online survey, interviews and review of performance documents. Data were collected from 21 food manufacturing plants and 1,273 leaders in executive, management, and supervisory roles from all functional areas were asked to participate in the online survey, 379 documents were collected and coded, and 42 on-site interviews were conducted and coded (Table 5).

(Table 5)

3.2 Maturity calculation using method triangulation

Three methods were applied in the study of triangulation (Jespersen and Wallace, 2017) with the aim of collectively minimizing the method weaknesses of the individual methods and providing complementary data from the plants under investigation based on the strengths and practicalities of each: Method 1- Self-assessment scale, analyzed quantitatively using SPSS; Method 2 – Performance document content analysis, qualitative analysis using NVivo; : Method

3 – Semi-structured interviews, qualitative analysis using NVivo. Strengths and weaknesses of each method were explored and are reported elsewhere (Jespersen and Wallace, 2017). For example, survey and interviews can help assign causation, survey can help mitigate impact of interviewer skill and experience, content can help penetrate the group language and symbol mechanisms, content and survey can get data to close the attitude to behaviour gap, survey social desirability and interviews can help identify insincere respondents. Application of the methods was as follows:

Method 1: Self-assessment scale. All salaried staff in each manufacturing plant were invited to participate in an online survey between November 2015 and March 2016. The scale was developed by (Jespersen et al., 2016) and included questions pertaining to four areas to measure food safety culture maturity; social norms, behavioral intent, motivation, and social desirability. Response data were imported into SPSS [Computer Software] IBM Corporation, New York, U.S.A. from Qualtrics [Computer Software] Qualtrics, Provo, Utah, USA and readied (e.g., removal of incomplete data sets, reversal of negative scales) for analysis. An aggregated maturity score (mean and standard deviation) as well as maturity level by dimension (mean and standard deviation) were calculated for each plant with control for social desirability score (Jespersen, MacLaurin, et al., 2017).

Method 2: Content analysis of performance documents. Each of the manufacturing plants were asked to share food safety documents (e.g., food safety audit reports, food safety meeting minutes, inspection reports, and Good Manufacturing Practice (GMP) records) dating back 12-

months from November 2015. Content analysis was applied to these documents using the predefined coding framework of Jespersen and Wallace (2017) (See 2.4 and Annexes 1 and 2) which was translated into nodes in NVivo [Computer Software] QSR International, Doncaster, Australia. Each document was imported into NVivo and all documents were coded by two researchers.

Method 3: Content analysis of semi-structured interviews. Semi-structured interviews with senior plant leader and senior food safety leader were arranged through the participating company sponsors. Senior leaders at a plant were all invited to participate and the focus on senior leaders was chosen as direction for an organizations culture is generally set at a senior level (Denison et al., 2012; Graham, Harvey, Popadak, & Rajgopal, 2017). Interview questions were shared in advance with the interviewees and informed consent obtained for each interview. All interviews were recorded and each audio file transcribed and codified to ensure anonymity of the interview and uploaded to NVivo for content analysis. The same coding framework was used for the interview files as the food safety documents (Jespersen and Wallace, 2017) (See 2.4 and Annexes 1 and 2).

3.3 Further development of the food safety maturity model

Based on the findings in this research the model was revised to incorporate learnings from the five companies and increase its applicability. As such, the capability areas were evaluated against the dimensions found in the comparative analysis (Jespersen, Griffiths, et al., 2017) and amended to better integrate learnings from organizational culture e.g., the first model was found to have an overemphasis on the dimension ‘consistency’ through the capability areas process thinking, technology enabler, and tools/infrastructure but an under representation of the dimension ‘adaptability’ which was found to assess how an organization’s culture prepares, accepts, and sustains changes. The capability characteristics were also reviewed to better understand if these were described as organizational norms e.g., ‘people system’ in stage react ‘Individuals are recognized sporadically after having solved a food safety problem’ was not changed as this was already defined as an organizational norm whereas the capability area ‘perceived value’ in stage internalized ‘ongoing business improvement and growth enabled by food safety’ was found not defined as an organizational norm and redefined to ‘Frontline employees are trusted to act correct and celebrate food safety performance on their line/in their area.’ The content for each value and stage intersect was redefined as norms by finishing the sentence ‘Food safety <VALUE> at company x can be described as <STAGE> through …’ This was different from the content of the original model (Jespersen et al. 2016) where content was derived by summarizing the behaviours behind each capability area and stage. This method ties dimensions, values, and norms to food safety culture through each stage of maturity, resulting in a model that is simpler for organizations to apply in the context of their own organizational values and norms. This also provides a path to improve food safety culture directly tied to stated value, norms, and organizational effectiveness as demonstrated by other studies (Denison et al., 2012; Graham et al., 2017; Kotter & Heskett, 1992). A fifth dimension specific to ‘Hazards and Risks’ was added as this was a significant topic during the interviews and was included to reflect the importance of organizational awareness specific to a company’s products and processes.

This dimension was also found to be included in other food safety culture assessment systems (De Boeck, Mortier, Jacxsens, Dequidt, & Vlerick, 2017) through the comparative analysis of Jespersen, Griffiths and Wallace (2017).

3.4 Estimation of cost of poor quality

The cost of poor quality (COPQ) was calculated using the proposed percentage of sales per maturity stage (Table 6) (Crosby, 1972).

(Table 6)

To enable this calculation, the stage descriptors in the food safety maturity model were aligned to the stages of the Crosby model. For example, Crosby’s stage 1 describes a stage of ‘reacting’ ‘blaming’ hiding’, and ‘firefighting’ similar behaviours are included in the stage 1 of the food safety maturity model. The Crosby model also describes a progressive maturation from reacting to understanding to integration of quality. The food safety model applies a similar progressive maturation specific to food safety.

The COPQ results were estimated by applying the percentages in table 6 to each of the company’s annualized sales in U.S. dollars and the mean maturity that had been calculated using the triangulation method. A mean COPQ (based on actual maturity assessment) and estimates for moving one stage up and one stage down on the maturity model were estimated to illustrate the cost of a deteriorating food safety culture compared to an improved food safety culture.

These estimates are indented to illustrate the potential economic impact of food safety maturity and to call upon further empirical research to validate the food safety components of each of the four components of COPQ (table 1).

3.5 Development of dynamic model for food safety culture

Through the study of existing research of organizational culture, organizational effectiveness, and economic impact (Denison, 1997; Graham et al., 2017; Kotter & Heskett, 1992) a summary of key learnings was developed and this information was used to identify potential building blocks of a dynamic model for food safety culture. The findings from this existing research in organizational culture were augmented with the findings from research of food safety culture where predictive validity had been proven by Ball (Ball *et al*., 2009), De Boeck (De Boeck et al., 2017), Hinsz (Hinsz & Nickell, 2015), Jespersen and Edwards (Jespersen & Edwards, Submitted), and the results of this study. Synthesising the information from these sources and discussion and integration within this academic and industry-based research team allowed the establishment of likely building blocks and design of the suggested model of dynamic interactions between building blocks.

4. Results

4.1 Organizational characteristics

Organizational characteristics were calculated based on demographic data collected in the survey (Table 7).

(Table 7)

Mean age of respondents (n=816) was 34-44 years, with 10-14 years of experience in the food industry and current company, and 5-9 years in current role. Comparing the individual company mean to this baseline group mean, respondents in company A were older – 45-54 years. Respondents in company B had less experience in both current company and role – 5-9 years. Respondents in company C also had less experience – 5-9 years in current company but 2-4 years in role and thereby the least experience in the study. Respondents in company D were older than the mean baseline – 45-54 years and had the longest tenure in the industry – 15-19 years and the company and role – 10-14 years. Respondents in company E also had shorter tenure in their current role – 2-4 years, but unlike company C, were at baseline for experience in both industry and company – 10-14 years. Mean industry tenure (F (3, 925) = 6.88, $p < .001$), company tenure (F (3, 925) = 5.74, $p < .001$), tenure in current role (F (3, 925) = 5.89, $p < .001$) and age (F (4, 925) = 7.65, $p < .001$) were all found to be significantly different between the companies.

Functional ratios (%MFG/%FSQ) for companies A, B, and D were similar – 86/13, 82/18, and 85/12. Respondents from company C were mostly involved in manufacturing – 92/8;

while company E had the lowest participation from manufacturing – 78/22. Despite these differences, many respondents in all companies were, not surprisingly, from manufacturing. It should be noted that manufacturing in this context includes all functions except food safety and quality with a direct reporting relationship to a senior manufacturing leader e.g., S. VP Manufacturing or plant manager (e.g., sanitation, maintenance, and finance).

The span of control ratios (%Leader/%Supervisor) for companies A and E were similar – 37/63 and 35/65 – with these companies providing most supervisors in the study. Respondents for company B had slightly more supervisors responding at 46/54 and company's C and D had the most leaders of the five companies responding – 58/42 and 55/45.

4.2 Food safety maturity

Based on the self-assessment scale, aggregated maturity for companies A, B, and D were in the 'Know' stage at 3.36, 3.31, and 3.05. Company C had the lowest maturity of 2.80 and in the 'React' stage. Finally, company E had the highest maturity of 4.01 and in the 'Predict' stage (Table 8).

Maturity was found to be significantly different (F (4, 785) = 5.727, $p < .001$) across the five companies. In analysing social desirability, the companies were also found to be significantly different, (F (4, 460) = 10.079, $p < .001$). Companies A and E scored the lowest at mean 4.10 and 4.98 out of a total possible score of 18. Company C had the highest score of all at 7.56 with companies B and D lower at 7.16 and 6.67 respectively. Maturity was also found to be significantly different between functions (*F* (4, 460) = 10.079, $p < .001$). FSQ rated on average maturity 16% higher than manufacturing and other functions. Span of control also influenced maturity ratings and were significantly different (*F* (4, 460) = 10.079, $p < .001$). As such, average maturity rating of supervisors was 28% lower than that of leaders. This supports the findings by Manning (2017) who investigated the impact of subcultures on food safety management and the stratification that naturally occurred due to these sub-cultures (Manning, 2017).

The individual triangulation scores (Figure 1) shows how the assessment results vary by method with the self-assessment scores (black circle) tends to show a higher maturity score then those of the interviews and performance document reviews.

(Figure 1)

4.3 Revised food safety maturity model

Based on the method described in section 3.3. food safety maturity model 1.0 (Jespersen et al., 2016) was updated to version 2.0 (Table 9). Dimensions and values that were updated are highlighted in table 9.

Table 1: Food safety culture - maturity model version 2.0

(Table 9)

4.4 Estimated cost of poor quality and economic impact

Company A spent most, due to it also having the highest annualized sales, but this was followed by company C with the second highest COPQ due to its low maturity rating. Collectively it is estimated that the companies spent $1.14 billion in sales on COPQ annually in their current stages of maturity. If they all slide down one maturity stage they would spend an additional $0.38 billions of sales and if they all move up one stage they save an additional $0.43 billions of sales (Figure 2).

(Figure 2)

4.5 Suggested model of dynamic interactions in food safety culture

The suggested model of dynamic interactions developed through this research is portrayed in Figure 3. This is presented as a model for further testing and examples are given to illustrate the dynamic nature of the model and the connectivity between the building blocks and interactions in response to a food safety marketplace trigger.

The structure consists of cultural building blocks and dynamic interactions. Each building block is connected to others through the interactions. There are four main building blocks; I. Organizational effectiveness, II. Organizational culture norms, III. Working group learned and shared assumptions, and behaviours, and IV. Individual intent and behaviours. There are seven interactions between the building blocks that indicate how each building block is either influenced or is influencing. For example, the external environment influences an organizations culture and norms e.g., recall of products from a competitor, a shortage of qualified employees (arrow #1). Such interactions can cause a review of formal systems arrow e.g., are policies and procedures actually guiding behaviours and actions everyday? (arrow #2) and the organizations values e.g., is a value of 'integrity' translated in to behaviours of 'see something – say something' everyday? (arrow #3) which in turn triggers an alignment of values to the formal systems e.g., is a value of 'integrity' translated into the formal system for performance evaluation? The organizations norms influence how working groups take decisions everyday e.g., recognizing those that consistently bring forward issues to solve (arrow #5) and the individual's intent to behave (arrow #6 and #7) e.g., 'I see others get recognized by our manager when speaking up, I better do so as well if something needs correction.

(Figure 3)

5. Discussion

This research sought to address three areas to further the scientific knowledge base for food safety culture, 1) validating or revising the initial food safety maturity model based on new learnings, 2) applying the principles of cost of poor quality to assessing economic value of maturing food safety culture, and 3) suggesting a dynamic model that captures the constant interactions that cause cultures to adapt to and integrate change.

By applying three data collection methods (Jespersen & Wallace, 2017) the research was able to calculate a food safety maturity score for five global companies and 21 of their manufacturing plants. The companies aggregated maturity scores were found to be significantly different and ranging from stage 2 – Doubt – to stage 4 – Predict of the food safety maturity model. The qualitative data gathered through the coding of 379 performance documents and 42 interviews with plant leaders and food safety managers were applied to further develop the existing food safety maturity model (Jespersen et al 2016). The maturity model was redefined to provide a path for food manufacturers seeking to improve their food safety culture and to provide a link to existing literature on cost of poor quality as a function of organizational maturity (Crosby, 1972; Duffy, 2017; Schiffauerova & Thomson, 2006). It was found that dimensions of food safety culture could be described across the maturity model stages in forms of norms, e.g., 'Frontline teams and supervisors make use of leading indicators to improve food safety systems' (dimension = consistency), to better integrate food safety into a food company's existing values. A fifth dimension was added 'Risks and Hazards' to better link the importance of hazard awareness and learnings from HACCP deployment (Wallace, 2009; Wallace, Holyoak, Powell, & Dykes, 2012). This Risks and Hazards dimension was identified by Jespersen, Griffiths and Wallace (2017) in their comparative analysis of existing food safety culture evaluation systems. It has been questioned whether this dimension should be part of a food safety culture framework or whether it should be considered in the evaluation of food safety management systems and risk awareness (Jespersen and Wallace, 2017) as it is one of the least tangible and least defined dimensions in food safety culture research (De Boeck *et al.* 2018). However, it was included due to the importance of understanding the organization's overall approach to managing risks and hazards as opposed to the technical detail of hazard analysis which is addressed in food safety management systems. It is hoped that the delineation of maturity over the Risks and Hazards dimension presented here will help to further understanding of the interactions between cultural and technical systems in food safety.

By use of the maturity model and the data collected, an aggregated maturity score was used to calculate aggregated 'cost of poor quality' per company to demonstrate the economic impact the maturity of the company's food safety culture. This cost varied substantially by company, partially due to the dependence on company sales in the equation and the difference in food safety maturity level. As such, cost of poor quality ranged from $400M to $2.4B when calculated using Crosby's guidance for percentage per maturity stage (Crosby, 1972). It shows the significance of food safety maturity and its potential economic impact on a food manufacturer's performance.

To realize this economic value the research suggests a need to apply learnings from studies that have demonstrated predictive validity of cultural factors and their impact on food safety behaviours and performance. As such, a dynamic model of food safety culture is proposed to better understand the interactions that must be considered when taking steps to mature food safety culture. The four building blocks are: organizational effectiveness, organizational culture norms, learned and shared assumptions of working groups, and individual intent and behaviours. It is proposed that it is through actions and interactions between these building blocks that a food manufacturer’s food safety culture maturity can be evaluated and improved such that the individual employee adapts to organizational norm.

This research builds on empirical findings from studies conducted on organizational culture (Denison, 1997; Graham et al., 2017; Guiso et al., 2014; Kotter & Heskett, 1992) and as such is an adaptation of proven relations between organizational culture and economic performance, as well as the connection between culture, values, norms, and behaviours. The research also makes use of predictive research conducted specifically in the food safety domain and further develops the field of food safety culture by integrating factors impacting food safety performance in the revised maturity model and the food safety culture dynamic model building blocks.

It is through the integration of all cultural building blocks and interactions rather than through focus on a single block or action that sustainable results are achieved, that food safety culture is matured, and the company can realize both risk reduction and economic gain. This research is innovative in that it connects maturity, cost of poor quality, and predictive factors of food safety.

The limitations in the research lie in its geographical reach, as the participating organizations are global but with headquarters situated in North America. In addition, the five companies were approached to participate in the study based on their previous interests in the subject and willingness to have the researcher collect data virtually and on-site in all their manufacturing plants. As such, the findings may have been affected by existing company interests in food safety culture and the results cannot be generalised across all food manufacturing plants. Also, the theoretical application of the COPQ proportions has yet to be tested in practice within the food industry. Further research is needed to empirically demonstrate the connection between food safety culture and economic performance and this should be global in scope and include food manufacturing companies of all sizes and representative of all commodities. Similarly, further research is needed to test the food safety dynamic model and interactions across a range of food industry organizations.

In conclusion, as food companies recognize more and more the strategic importance of their food safety culture, its reliable and valid evaluation gains importance. This research provides a framework for maturing food safety culture to be integrated into an organization's culture, its values, and norms. By quantifying food safety maturity using a validated, triangulation method, companies can estimate the proportion of their sales wasted through cost of poor quality, and design interventions specific to the four cultural building blocks individually proven to impact food safety performance. This might facilitate a change in the design of interventions to strengthen food safety management and control activities.

6. Acknowledgements

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The impact of maturing food safety culture and a pathway to economic gain –

Tables and Figures

Table 2: COPQ activities and examples of possible quality and food safety activities(Adapted from Duffy, 2017, Hutton, 2001; Surak & Wilson, 2007; Wallace, Sperber, & Mortimore, 2011; Mortimore and Wallace, 2013)

COPQ activities	Quality examples	Food safety examples
Prevention cost	Establish specification for incoming ingredients and all employee training.	Metal detector calibration, process equipment preventative maintenance, and all employee training.
Appraisal cost	Quality audits.	Food safety audits.
	Checking incoming ingredients against specification.	Metal detector checks, environmental monitoring, and GMP audits.
Internal failure cost	Waste in the form of products that cannot be shipped.	Incorrect cooking temperature causing rework.
External failure cost	Product withdrawal.	Product recall.

Table 3: Financial performance differences between companies who invested in a performance-enhancing culture and those that did not (Kotter and Heskett, 1992).

	Average increase for 12 firms with performance-enhancing cultures	**Average increase for 12 firms without performance-enhancing cultures**
Revenue growth	682%	166%
Employment growth	282%	36%
Stock price growth	901%	74%
Net income growth	756%	1%

Table 4: Sample statements per area in the self-assessment questionnaire

Area	Sample statements
Social norms	Most people whose opinion I value would approve if I review the preventive control plan(s) quarterly to verify effectiveness. Most people whose opinion I value would approve if I always acknowledge manufacturing leaders who make good food safety decisions.
Behavioural intent	I will do all I can whenever my team does not have the right tools to complete food safety tasks. I will improve food safety processes every day
Motivation	I want to do what my manager thinks I should do for food safety. I want to do what I have learned through food safety training.
Social desirability	I appreciate other people's opinions regarding food safety. It bothers me if people dislike me because of my views about food safety.

Table 5: Maturity model construct

	Stages				
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5

	Doubt	React to	Know of	Predict	Internalize
Stage characteristic	Most food safety actions are taken due to external pressures (e.g., regulators).	Food safety actions are solved by the quality department and mostly to close gaps and remove issues.	Food safety knowledge is prevailing across the organization and everyone acts to improve food safety.	Food safety actions are taken based mostly on results from predictive analysis'.	Food safety actions are driven by everyone and mostly based on managing risks.
Capability area characteristic (sample from the 'People System' capability area)	Individuals complete food safety tasks out of fear for negative consequences.	Individuals are recognized sporadically after having solved a food safety problem.	Leaders recognize teams and individuals according to a documented system of positive and negative consequences.	Leaders reward teams for collectively improving food safety processes/procedures.	Cross functional/level teams nominate other teams for being proactive and thinking strategic around food safety.

Table 6: Data collected from the five participating companies

Data	Company					
	A	B	C	D	E	Total (Mean)
Number of plants	11	3	2	2	3	21
Survey Response rate (Percentage)	72	77	72.5	77	59	(72)
Performance documents (#)	268	3	33	50	25	379
Interviews (#)	22	8	4	4	4	42

Table 7: Maturity stages and cost of quality as percentage of sales (Crosby, 1972).

Maturity stage	1	2	3	4	5
Percentage (%)	20	18	12	8	2.5

Table 8: Aggregated company demographics and baseline (mean and total)

Category	Measure	Company					
		A	B	C	D	E	Mean (Total)
Demographics	# plants	11	4	2	2	2	(21)
	Years in food industry (mean)	10-14	10-14	10-14	15-19	10-14	10-14
	Years in the company (mean)	10-14	5-9	5-9	10-14	10-14	10-14
	Years in current role (mean)	5-9	5-9	2-4	10-14	2-4	5-9
	Age (mean)	45-54	34-44	34-44	45-54	34-44	34-44
	Functional distribution (%MFG/%FSQ*)	86/14	82/18	92/8	85/12	78/22	n/a
	Role distribution (%Leader/%Supervisor)	37/63	46/54	58/42	55/45	35/65	46/54

*Manufacturing and Food Safety & Quality

Table 9: Food safety maturity by company

Category	Measure	Company					
		A	B	C	D	E	Mean (Total)
Cultural performance	Culture Stage	Know	Know	React	Know	Predict	Know
	Maturity [1-5]	3.36	3.31	2.80	3.05	4.01	3.3
	Social desirability [1-18]	4.10	7.16	7.56	6.67	4.98	6.09

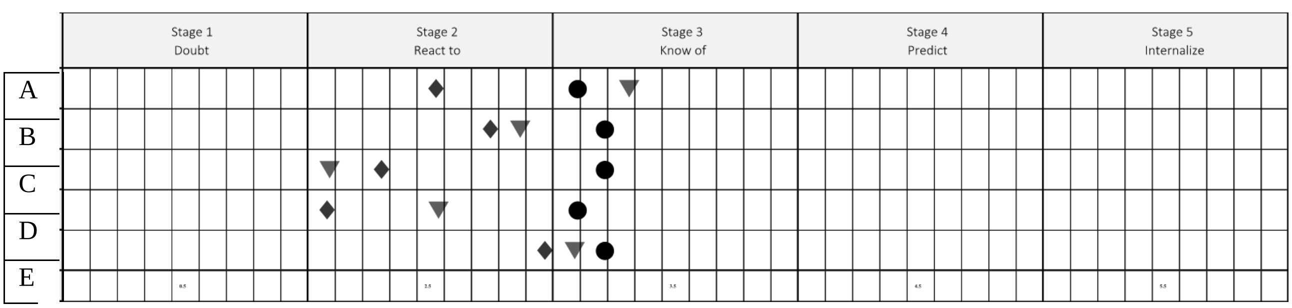

Figure 1: Plant Maturity - Plot of mean values as per method triangulation. Ledger: Dot = Self-assessment scale result, Diamond – Performance document coding result, and Triangle = Interview coding result.

Table 10: Food safety culture - maturity model version 2.0

		Stage				
Dimension	Values	Stage 1 Doubt	Stage 2 React	Stage 3 Know	Stage 4 Predict	Stage 5 Internalize
Values and Mission	Integrity and trust	Employees have little trust that management will act on food safety without external pressure	Employees trust that management will act and do the right thing for food safety after an issue have occurred	Everyone trusts that food safety issues are solved because we know it protects our business	Everybody is trusted to invest in food safety information to make future performance stronger	Frontline employees are trusted to act correct and celebrate food safety performance on their line/in their area
	Being responsible	Nobody knows who has the duty to deal with food safety	Everybody readily takes responsibility, but it is unclear what that means	Detailed food safety responsibility is written into job descriptions for everybody	Decision makers are certified food safety professionals and responsible for driving cost out of the food safety system	Frontline is responsible for bubbling improvement plans to leaders, leaders are responsible for incorporating these into long-term business planning
	Ethics	Moral principle …don't look	Moral principle...invest if we must	Moral principle...improve system	Moral principle...reduce cost by taking out variation	Moral principle...grow business
People System	Reward and recognize	Individuals complete food safety tasks out of fear for negative consequences	Individuals are recognized sporadically after having solved a food safety problem	Leaders recognize teams and individuals according to a documented system of positive and negative consequences	Leaders reward teams for collectively improving food safety processes/procedures	Cross functional/level teams nominate other teams for being proactive and thinking strategic around food safety
	Competently communicating	Top-down 'tell' with little 'why' content and understanding of the importance of the task	Food safety information is communicated by FSQ as problems occur using, if available, facts discovered as the problem was solved	There is a deep understanding of the food safety system and performance is communicated by some functional leaders on a regular basis	Frontline leaders are having regular communications on food safety performance using data and tracking the teams' improvement actions	Food safety communication cadence is an organizational habit that involves everybody in specific team discussions
	Together we make the difference	silos…	problem communication…	fragmented delivery of information…	Food safety and quality critical conversations…	habit…

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Adaptability	Innovate	Scrambling to meet changed requirements	Aware of coming change but do not update procedures before last minute	Change is analysed and incorporated into written food safety system including changes to competencies/job descriptions	Innovation is driven by data internally to reduce food safety costs	Innovation is suggested by frontline teams and bubbling up to impact companywide system. Quick to adapt as they have technology interface in their hands
	Embrace and drive change	Nothing is stable, so it does not matter if we must change…again	We know change is coming and will deal with it last minute…	We know the change and have analysed the impact on individuals and teams according to a pre-defined change curve…	We look for cost reduction opportunities and plan these in our continuous improvement program…	Frontline teams have full autonomy to drive change in the food safety system, support teams are responsible for spreading new and best practices across the company…
Consistency	Data and reporting	Data are not used to solve problems and mostly sitting in a filing cabinet or in unused reports	It is left to the individual to identify needed data and ways to derive information from these	Leading indicators are used to find root causes of food safety problems and solutions are built into the food safety management system	Leading indicators are continuously updated through precisely and accurately collected data	Frontline teams and supervisors make use of leading indicators to improve food safety systems
	Technology enabled success	Little to no new value placed on buying or adopting technology	Technology is bought in reaction to a specific need e.g., faster pathogen testing results	Technology is seen in the context of the business system to integrate functions, procedures, and capabilities (e.g., ERP specification system)	Automation is used frequently and seen as an integral part of reducing food safety cost	Enterprise Resource Planning (ERP) is used in an integrated way with automated workflows that make the enterprise quick to adapt
	Quality of all we do	Unstructured problem solving to remove the immediate pain	'plan, do, check, act' with emphasis on control and expectation of 100% perfect solutions from the start	Structured, documented problem solving with high risk of analysis paralysis	'plan, do, study, act' with emphasis on study and an iterative approach to improvement	Identifying risks through horizon scanning and continuous improvement followed by mitigation plans built into the food safety system
Risks and Hazards	Risk perception	The organization relies mostly on external sources and inspections to understand and act on its risks and doesn't identify risks internally	Actions to manage risks are mostly taken in response to external audits or inspections and internal identification is sometimes incorrect	Risks are understood and continually challenged by a cross-functional team through planned risk management	Understanding and reducing risks are an integral part of the organization's continuous improvement efforts	The organization relies on frontline teams to manage existing risks and to identify new ones through peer observations

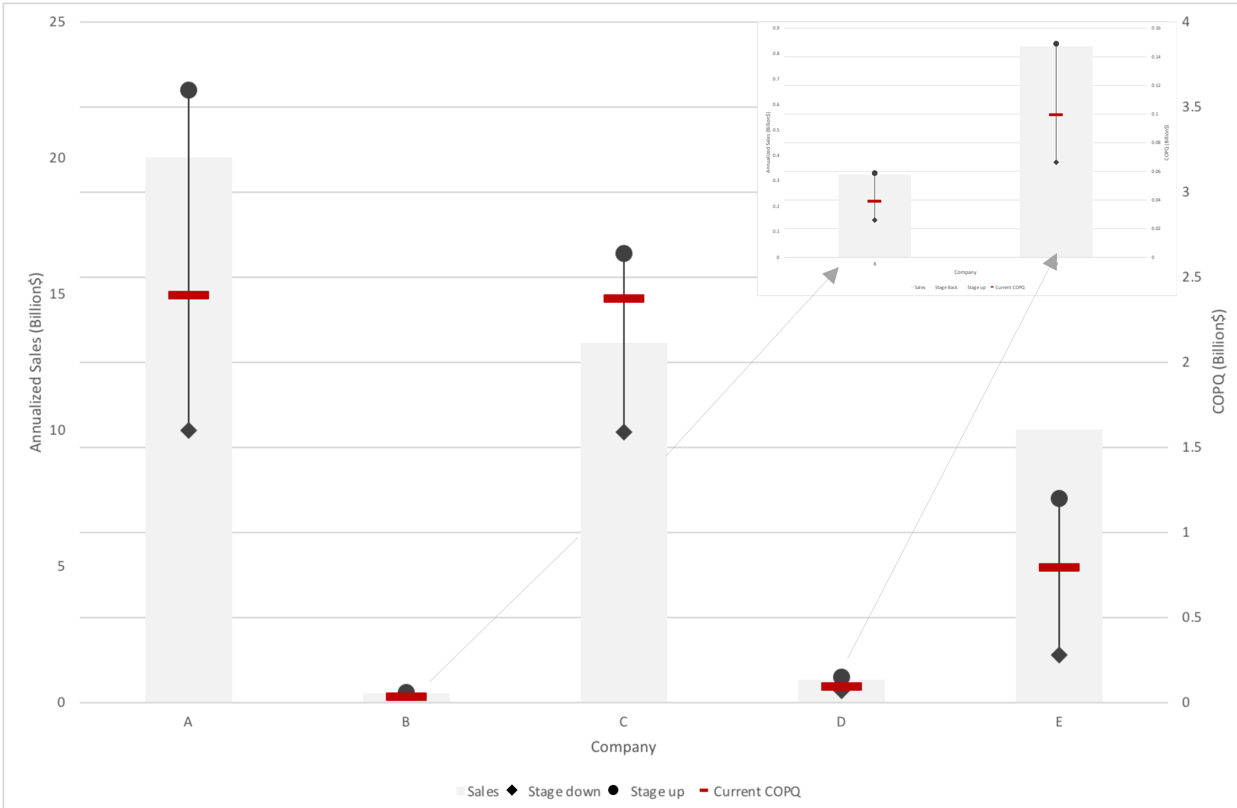


Figure 2: Annualized sales per company and COPQ based on evaluation result (bar), one maturity stage up (dot), and one stage down (diamond).

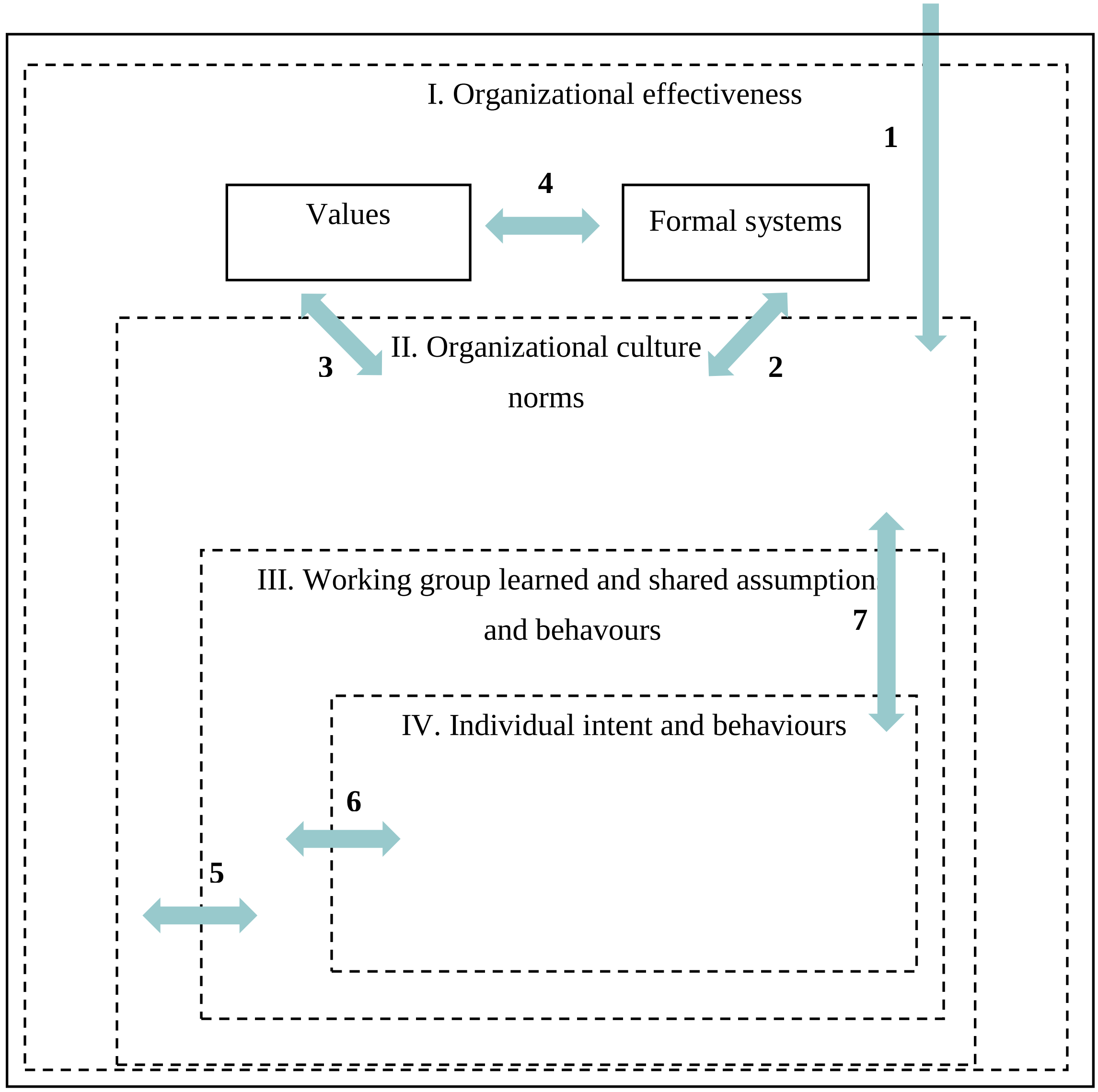


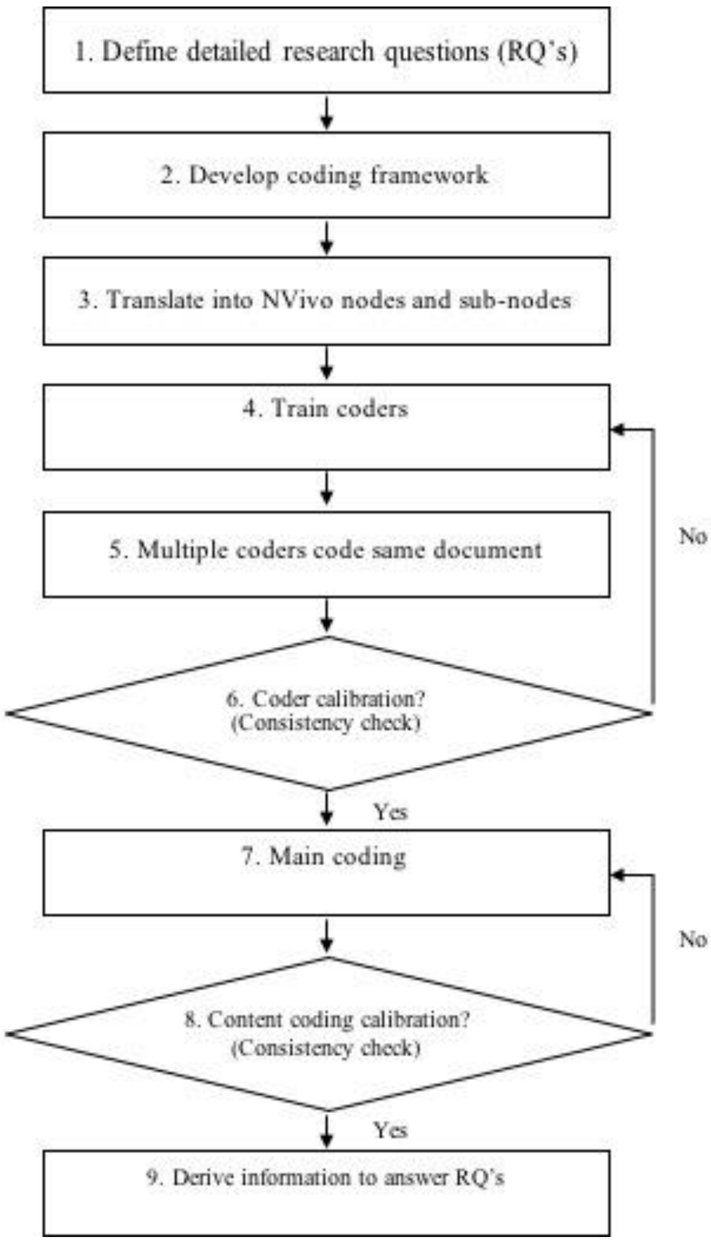
Figure 3: Dynamic model of a culture of food safety

‘Interactions’ e.g., adapt and integrate

Culture building blocks

External environment boundary

Annex 1: Coding process applied to deriving data through content analysis (Source: Jespersen and Wallace, 2017)



Annex 11: Coding framework used in the content analysis of textual data (Semi-structured interviews and performance documents) (Source: Jespersen and Wallace (2017)).

Node	Sub-Nodes
Values and Mission	Compliance.
	Measures/metrics/KPIs.
	Mission, vision, goals.
	Ownership/owning.
	Plan/roadmap, direction.
	Recall/recalls/withdrawals.
	Responsibility, accountability, commitment.
	Direction, setting expectations, corporate direction.
	Financials, budgets, and prioritizing.
People Systems	Any reference to persons' role/education/job and group or team and references to individuals.
	Behaviour/practice, work routine.
	Communication and dialog.
	Involvement.
	Consequence, escalation.
	Pride.
	Rewards and celebration.
	Training, education, learning, proficiency.
	Cross-functional.
	Unionized.
	Rotation and retention.
	"Making choices…"
Consistency	Actions, tasks, action due date.
	Non-conformance, reoccurring.
	Technology.
	Tools, infrastructure, and policies/procedures.
	References to third party standards.
	Problems, breakdowns, and issues.
Adaptability	Change readiness, open to change, change ready.
	Improvement, must improve, continuous improvement, improvement process, improvement system, continuous improvement, Six Sigma, Lean manufacturing.
Risks and Hazards	Leaders risk awareness and perception.
	Operator risk awareness and perception.
	Risks, hazards.

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