

1 **Triangulation and the importance of establishing valid methods for** 2 **food safety culture evaluation**

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12 **Abstract**

13 The research evaluates maturity of food safety culture in five multi-national food
14 companies using method triangulation, specifically self-assessment scale, performance
15 documents, and semi-structured interviews. Weaknesses associated with each individual method
16 are known but there are few studies in food safety where a method triangulation approach is used
17 for both data collection and data analysis. Significantly, this research shows that individual
18 results taken in isolation can lead to wrong conclusions, resulting in potentially failing tactics
19 and wasted investments. However, by applying method triangulation and reviewing results from

20 a range of culture measurement tools it is possible to better direct investments and interventions.
21 The findings add to the food safety culture paradigm beyond a single evaluation of food safety
22 culture using generic culture surveys.

23

24 **Keywords**

25 Method triangulation, food safety culture evaluation, maturity profiling culture scale,
26 content analysis, semi-structured interview.

27

28 **Highlights**

- 29 • Establishes importance of triangulation for valid food safety culture evaluation
- 30 • Compares data from scale, performance documents, and semi-structured interviews
- 31 • Confirms need for multiple methods for trustworthy evaluation of food safety culture
- 32 • Applies culture coding framework to interview transcripts and performance documents
- 33 • Inter-coder and construct validity, and discrimination in food safety culture profiles

34

35

36 **1.0 Introduction**

37 The understanding of culture to enable organizational effectiveness has been studied at
38 length since 1970 and before. (Hofstede, 1980, 2001, 2013) studied national culture through his
39 cross-cultural organizational studies research, starting with the international (IBM) survey in
40 1966, and showed predictive validity of his ‘Values Survey Module’ instrument to dimensions of
41 national culture. D. R. Denison (1997) developed a model for corporate culture and

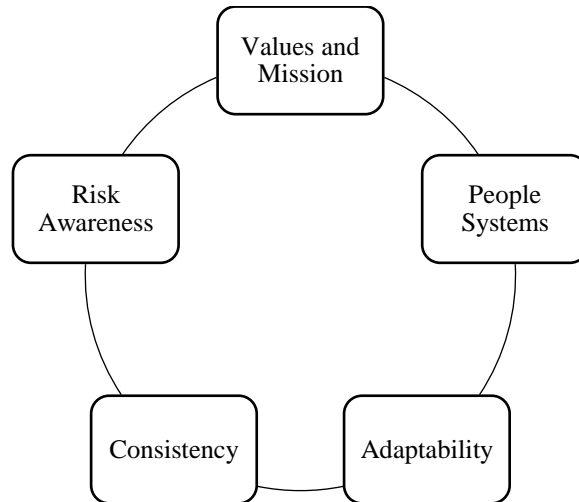
42 organizational effectiveness through his research on organizational culture evaluation methods
43 with predictive validity of two measures of organizational effectiveness: behavioral data and
44 financial data (D. Denison, Hooijberg, Lane, & Lief, 2012; D. R. Denison, 1997; D. R. Denison
45 & Mishra, 1995). These types of evaluations appeal to leaders in organizations as they quantify
46 areas of strength and weakness in an accessible and validated form. Culture researchers, in all
47 domains, must take seriously these lessons from early front-runners, like Hofstede and Denison,
48 to understand the dichotomy of fulfilling leaders needs for aggregated, leading indicators of
49 culture change progress and developing meaningful and trustworthy measurement tools.
50 (Guldenmund, 2000) discusses this dichotomy specific to the people safety culture domain. He
51 postulates that assumptions are often made that organizations are homogeneous and can be
52 evaluated using an organization-wide, generic questionnaire survey but that this approach can be
53 risky and virtually meaningless as organizations are highly heterogeneous and made up of formal
54 and informal working groups (Guldenmund, 2000). This suggests that other approaches are
55 needed to understand the heterogeneity of organizations which are typically made up of sub-
56 groups and macro-cultures (Schein & Schein, 2017).

57 **1.1 Theoretical framework**

58 To link the food safety domain with existing models for organizational culture, safety
59 climate/culture, and food safety climate/culture, Jespersen et al (2017) developed a theoretical
60 framework based on eight existing cultural evaluation models (Ball, Wilcock, & Aung, 2009; De
61 Boeck, Jacxsens, Bollaerts, Uyttendaele, & Vlerick, 2016; De Boeck, Mortier, Jacxsens,
62 Dequidt, & Vlerick, 2017; Denison et al., 2012; Denison, 1997; Denison & Mishra, 1995;
63 Jespersen, Griffiths, Maclaurin, Chapman, & Wallace, 2016; Srinivasan & Kurey, 2014; Taylor,

64 2015; Wilcock, Ball, & Fajumo, 2011; Wright, 2013). The framework was developed through
65 content analysis of eight culture or food safety culture evaluation systems. Each of the systems
66 had been applied to evaluate culture in food companies by applying mostly self-assessment
67 surveys. Content analysis was completed in NVivo 11 [Computer Software] QSR International,
68 Doncaster, Australia] by importing textual material into NVivo and coding content to nodes
69 deduced from literature review. The researchers deduced the dimensions from the coded material
70 by comparing the details of the specific dimensions from each system. Although these had been
71 named differently by each author, i.e., dimensions, traits, capability areas, categories, elements,
72 Jespersen et al (2017) aligned the descriptors in this framework under the title “dimensions.”
73 Together the five dimensions (Figure 1) encompass all the individual dimensions in the eight
74 culture evaluation systems, although none of the eight systems covers all five dimensions. The
75 framework (Jespersen et al, 2017) was the first work to compare and contrast culture evaluation
76 systems with the goal of developing one theoretical framework. Its development is an attempt to
77 bring consensus to the theory of food safety culture and the framework has been applied by the
78 Global Food Safety Initiative (GFSI) in its work to provide guidance to its stakeholders on food
79 safety culture (pers. comm. Robach¹, 2016).

¹ Mike Robach, Chair of Global Food Safety Initiative Board.



80

81 **Figure 1: Food safety culture – dimensional framework (Jespersen, Griffiths,**
 82 **and Wallace, 2017)**

83 **1.2 Food safety culture evaluation systems**

84 Jespersen et al (2017) report that it is necessary to determine the trustworthiness of
 85 culture evaluation system results to assess their validity and reliability and this is particularly
 86 important where cultural evaluation is being used as part of consumer protection measures in the
 87 food safety domain. However, current systems for evaluating culture are fragmented and built on
 88 disparate scientific theories (De Boeck, Jacxsens, Bollaerts, & Vlerick, 2015; Guldenmund,
 89 2000), and many make use of single evaluation methods, e.g. a self-assessment scale or audit
 90 (Jespersen et al, 2017), an approach not without its limitations (Guldenmund, 2000). Thus it is
 91 important to consider whether food safety culture evaluation systems could be strengthened by
 92 extension with additional evaluation methods and whether this can give richer information about
 93 the heterogeneous organisations in the global food supply chain.

94 **1.3 Method Triangulation**

95 Triangulation has for more than 75 years been an accepted method to confirm that the
96 variance of a phenomenon is tested and not the variance of the method(s) used (Campbell, 1959;
97 Denzin, 1970; Denzin, 2012; Miles, 1994). These and other authors have defined six types of
98 triangulation including the one applied in this research – method triangulation. Method
99 triangulation means to *gather information pertaining to the same phenomenon through more*
100 *than one method, primarily to determine if there is a convergence and hence, increased validity*
101 *in the findings* (Carugi, 2016; Kopinak, 1999). Triangulation enables examination of similarities
102 and discrepancies in a research topic, and the assessment of socially desirable responding in
103 sensitive and complex topics (Bauwens, 2010). In addition, it allows researchers to strive for
104 completeness and confirmation of research findings (Yeasmin & Rahman, 2012) as weaknesses
105 in one method can be counterbalanced by the strength in others (Carugi, 2016; Kopinak, 1999).
106 Given both the inner and outer influences that can significantly influence the strength of
107 organizational and -food safety culture, as in other social science domains e.g., health (Carugi,
108 2016; Kopinak, 1999), it is reasonable to assume that combining or triangulating methods in the
109 investigation process can provide a more comprehensive evaluation of cultural strength. Social
110 realities, such as those existing in organizational and food safety cultures, are inherently complex
111 and therefor difficult to evaluate with one method (Yeasmin & Rahman, 2012). Triangulation
112 can lead to an elaboration and enrichment of findings e.g., by providing more detail, multilayered
113 and multi-dimensional perspectives of the phenomenon being studied (Carugi, 2016; Kopinak,
114 1999) and increase credibility of scientific knowledge by improving both internal consistency
115 and generalizability (Yeasmin & Rahman, 2012). Quoting McKinlay (1992), “rigid adherence to

116 one approach at the expense or to the exclusion of the other, is destructively parochial and results
117 in often incomplete or even inaccurate explanations and by extension, wrongly focused research.
118 In the data analysis phase triangulation offers several benefits: verification of overlapping
119 results, validation of quantitatively generated constructs through comparison, opportunity to
120 probe and investigate potential causes of discrepancies due to instruments or misrepresentation
121 of data, and clarity of ambiguous and provocative replies or questions (Floyd, 1993). There are
122 difficulties related to the application of method triangulation. There must be consistent and clear
123 foci between the different methods and, in advance of the research, the researcher must have
124 clear prior understanding of the main ontological and epistemological position of the
125 phenomenon under investigation without which the findings and conclusions might be
126 meaningless (Norman K Denzin & Lincoln, 2011). Also, triangulation is time consuming and
127 will increase the time needed to complete a study; however, the authors would argue that this
128 approach is essential in establishment of new evaluation methods. Lastly triangulation is carried
129 out with complex research designs and there are limited guidelines available to researchers as for
130 how to meaningfully combine different data types, interpret divergent results, decide what to do
131 with overlapping concepts, and how to weigh different sources of information (Carugi, 2016;
132 Kopinak, 1999). Further literature discussion would be beneficial to overcome gaps in guidance;
133 however, discussion of potential approaches with other researchers to reach consensus in
134 triangulation plans would seem to be a good way forward and was applied in this research. The
135 objective of this research was to develop and apply method triangulation to increase validity of
136 food safety culture evaluation results.

137 **2.0 Materials and methods**

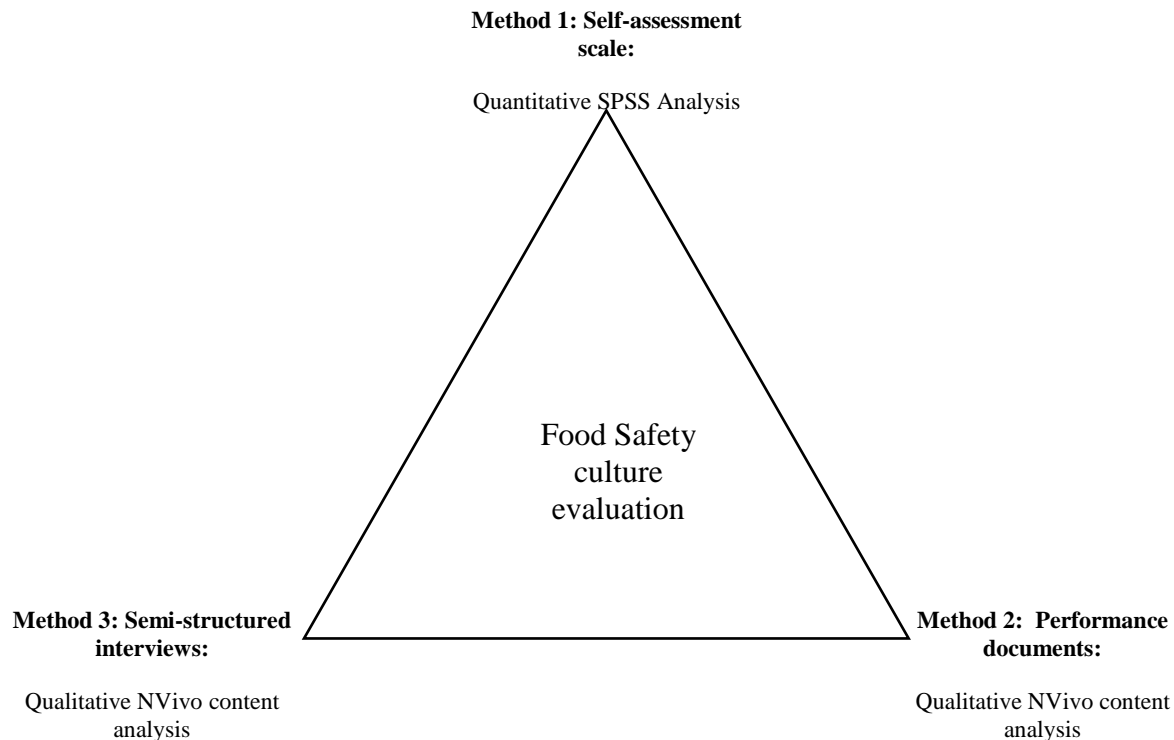
138 This research was part of a large study of food safety culture performance conducted in
139 collaboration with five multi-national North American-based food manufacturing companies
140 from October 2015 to March 2016. The five companies volunteered to participate in the research
141 and provided the researcher access to total 21 plants. The companies varied in sizes from total
142 three manufacturing sites to over 100 per company. Products manufactured by the companies
143 varied as well from prepared meats, canned vegetables, milk powder, and cheese. To reach
144 saturation in qualitative research there are various guidelines regarding sample sizes (Creswell,
145 1998; Denzin & Lincoln, 2011). For this triangulation study, one plant from each company was
146 sampled and three data sets were collected from each plant (Table 1).

147 **Table 1: Sources by plant and data type**

Plant ID	1	2	3	4	5
Self-assessment responses	63	14	10	15	71
Performance documents	5	1	6	5	3
Semi-structured interviews	2	2	2	2	2

148

149 The authors believe this sample size to be large enough to obtain a result that could help
150 test the hypothesis that triangulation provides a more comprehensive evaluation of culture than
151 relying on a single method. Three data sets were; food safety culture maturity self-assessment
152 responses, food safety documents, and semi-structured interviews with plant leaders (Figure 2).



154 Each method was selected to provide as much data possible on the same phenomenon –

Figure 2: Methods and data triangulation applied to evaluate of food safety culture.

155 food safety culture – to counter weaknesses in each other method, to gain depth of
156 understanding and to make use of already existing data e.g., food safety documents.

157 **2.1 Methods strengths and weaknesses**

158 Three methods were selected for the study of triangulation (Figure 2). These three were
159 selected as they were believed to collectively minimize the method weaknesses of the individual
160 methods and provide complementary data from the plants under investigation based on the
161 strengths and practicalities of each. Strength and weaknesses of each of the three methods are

162 discussed to illustrate how each method can mitigate weaknesses in others through method
163 triangulation. Method 1- Scale: The strengths of scales or survey are that they are simple and
164 straightforward methods for respondents to share knowledge, they provide generalizable
165 information, and maintain respondent anonymity. The weaknesses are that data are affected by
166 the characteristics of the respondents, there can be a gap between respondents' actual beliefs and
167 attitudes to the responses, low response rates that can make it difficult to know if the results are
168 representatives of all groups, and insincere responses can be hard to detect (Denzin, 1970;
169 Robson, 2011). Method 2 – Performance document content analysis: Strengths of content
170 analysis are data gathering is virtually unobtrusive, low cost, can be used non-reactively, and
171 data can relatively easy be generated for longitudinal analysis. The weaknesses of this method
172 are potential difficulty in locating content relevant to the research questions, that it is limited to
173 analyzing records and information that others have decided were worth preserving, and it is
174 ineffective for testing causality as such content analysis can be used to say what is present but
175 not why (Berg, 2012; Robson, 2011). Method 3 – Semi-structured interviews: Strengths of semi-
176 structured interviews are the ability to follow up on leads, providing a moving trail of
177 investigation based on the respondents answer. They are especially suitable for collecting data
178 of sensitive topics because of interviewers ability to investigate underlying motivations, and
179 capture non-verbal clues that can help better understand the verbal responses. The weaknesses
180 are quality of data is highly dependent on the skills and experience of the interviewer, internal
181 consistency can be difficult to demonstrate due to lack of standardization, interviews are time
182 consuming, it can be difficult to penetrate a groups language and mechanisms of symbolisms,
183 and there can be a resistance for the interviewee to “tell it all” (Berg, 2012; Brinkmann, 2015;

184 Holstein, 1995; Robson, 2011). As such, the weaknesses of each method are countered by either
185 one or both the other methods. For example, survey and interviews can help assign causation,
186 survey can help mitigate impact of interviewer skill and experience, content can help penetrate
187 the group language and symbol mechanisms, content and survey can get data to close the attitude
188 to behaviour gap, survey social desirability and interviews can help identify insincere
189 respondents.

190 **2.2 Response analysis of self-assessment scale.**

191 All salaried staff in each manufacturing plant were invited to participate in an online
192 survey between November 2015 and March 2016. The survey invitation was sent via email with
193 a letter of invitation and purpose of the study for which the data were to be used. The participants
194 were also informed of the confidential nature of their individual responses and encouraged
195 through total three contact points (i.e., invitation, reminder, final reminder) to participate in the
196 study. The scale was developed by (Jespersen et al., 2016) and included questions pertaining to
197 four areas to measure food safety culture maturity; social norms, behavioral intent, motivation,
198 and social desirability. Response data were imported into SPSS [Computer Software] IBM
199 Corporation, New York, U.S.A. from Qualtrics [Computer Software] Qualtrics, Provo, Utah,
200 USA and readied (e.g., removal of incomplete data sets, reversal of negative scales) for analysis.
201 An aggregated maturity score (mean and standard deviation) as well as maturity level by
202 dimension (mean and standard deviation) were calculated for each plant with control for social
203 desirability score (Jespersen, Maclaurin & Vlerick, 2017) amended with the findings from
204 (Jespersen & Edwards, Under review)

205 **2.3 Content analysis of performance documents.**

206 The content analysis of food safety performance documents provides an insight into the
207 documented food safety culture e.g., level of consistency, adaptability, and perceived value of
208 food safety. Each of the manufacturing plants were asked to share food safety documents dating
209 back 12-months from November 2015. Food safety documents such as food safety audit reports,
210 food safety meeting minutes, inspection reports, and Good Manufacturing Practice (GMP)
211 records were obtained from each plant. Content analysis was applied to generate textual data
212 from these documents using a predefined coding framework deduced from literature review and
213 analysis of food safety culture and organizational culture evaluation tools. The coding
214 framework (Table 2) was defined using the theoretical framework (Figure 1) of food safety
215 culture and translated into nodes in NVivo [Computer Software] QSR International, Doncaster,
216 Australia. Sub-nodes were deduced through literature review and induced throughout the coding
217 process. Each document was imported into NVivo and all documents were coded by two
218 researchers.

219 **2.4 Content analysis of semi-structured interviews.**

220 Semi-structured interviews with senior plant leader and senior food safety leader were
221 arranged through the participating company sponsors. Invitation to the interview was sent via
222 email from the lead researcher and logistical detail arranged directly with the plant leader.
223 Interview questions were shared in advance with the interviewees and informed consent obtained
224 for each interview. All interviews were recorded and each audio file transcribed and codified to
225 ensure anonymity of the interview and uploaded to NVivo for content analysis. The same coding
226 framework was used for the interview files as the food safety documents (Table 2)

227
228

Table 2: Coding framework used in the content and textual analysis'. Adapted from Jespersen, Griffith, 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.

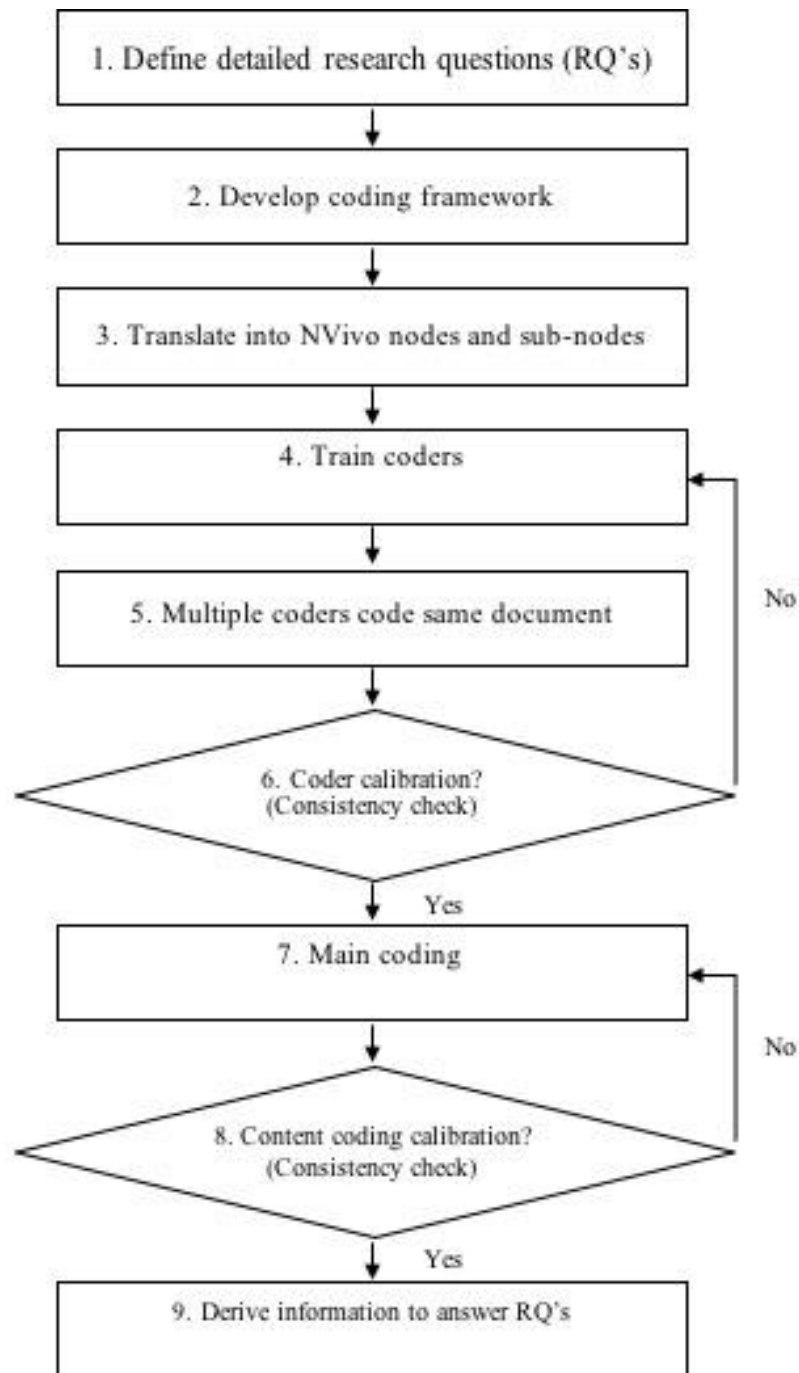
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230 **2.5 Content coding.**

231 The content was coded using practices already applied in the food safety domain

232 (Wallace, 2009). The process for coding content (Figure 3) was used by two independent coders

233 to ensure validity of data. The process consists of two checks for consistency evaluated through
234 calculation of percentage pairwise agreement. (Neuendorf, 2002) argues that the goal for
235 pairwise agreement in social sciences often are .8 but that .9 levels are most appropriate. This
236 higher threshold level has also been suggested to account for some weaknesses in this method
237 (Lombard, Snyder-Duch, & Bracken, 2002). Based on these references the standard for this
238 research for pairwise agreement level was set to .9 (90% agreement). Detailed research questions
239 were defined (step 1) and a coding framework was deduced (step 2) and translated into NVivo
240 nodes and sub-nodes (step 3). The framework was an important component as it connects the
241 coded data to the theoretical framework and the research domain. Following this, coders were
242 trained (step 4) and two documents coded by same coders (step 5). The results were analyzed by
243 detailed review of verbatim data to look for similarities and differences between coders. A
244 decision was made to go back to the coding framework and update with addition of sub-nodes
245 and to go back to the test documents for recoding (step 6). Following this loop, the decision was
246 made to carry on with the full document coding as coders were considered “consistent” based on
247 another detailed verbatim review (step 7). Midway discussions between coders allowed
248 comparison of experience, and discussion of coding difficulties and issues. These results led to
249 another rework of the two selected documents and finalization of the 30 documents (step 8).
250 Finally, the data was analyzed to derive information to answer the RQs (step 9).



251

Figure 3: Coding process applied to deriving data through content analysis

252

253 **2.6 Data triangulation.**

254 An updated version of the food safety maturity model (Jespersen et al., 2016) was used to
255 plot maturity by plant by cultural dimension based on the theoretical framework and scale
256 analysis (Jespersen and Edwards, 2017, under review). Three data points were plotted for each
257 plant, (1) quantitative results from the self-assessment scale were plotted directly on the model's
258 scale from stage one to stage five, (2) qualitative data based on the results from the file analysis
259 was grouped by plant by dimension and each cluster was plotted on the stage of maturity with
260 best fit to maturity model descriptors and behaviours, and (3) qualitative data based on the results
261 from the semi-structured interview analysis was grouped by plant by dimension and each group
262 was plotted on the stage of maturity with best fit to maturity model descriptors and behaviours.
263 By reviewing coded material for both (2) and (3) and comparing verbatim samples to the
264 definition of each maturity stage an individual score for (2) and (3) was assigned. For example,
265 "...yes, so we have some proactive and mainly reactive plethora of data, all manual...everything
266 is manual, right" this verbatim sample would be tagged as a stage 3 statement "knowing."
267 Taking another example, "...this company has never had a recall. I can't be the one that lets that
268 happen..." this verbatim sample would be tagged as a stage 2 "reactive" statement. In this way,
269 all codes were reviewed and placed in stage of maturity with best fit and an aggregated mean
270 score calculated from proportions of coded results in each stage. The triangulation allowed for
271 interpretation of findings for similarities, differences, identifying relationships, extracting
272 themes, and creating generalizations and to ensure that strengths and weaknesses of each method
273 were offset.

274 **3.0 Results**

275 **3.1 Self-assessment results.**

276 Differences in overall, aggregated maturity ratings through the self-assessment scale for
277 the five plants in the sub-set are not statistically significant for the overall maturity $F(4,182)$
278 $= .273, p = .895$ (Table 3).

279 **Table 3: Sample size and mean maturity score from self-assessment scale.**
280 **Total and by individual dimension by plant. Lowest maturity score = 1; highest**
281 **maturity score = 5.**

Maturity	Plant				
	1	2	3	4	5
N (Response rate)	63 (82%)	14 (78%)	10 (43%)	15 (58%)	71 (41%)
Overall, aggregated score	3.14	3.18	3.17	3.06	3.15
Values and Mission	3.10	3.39	2.82	2.79	3.29
People	3.41	3.41	3.46	3.44	3.29
Consistency	2.93	2.76	3.22	2.97	2.87

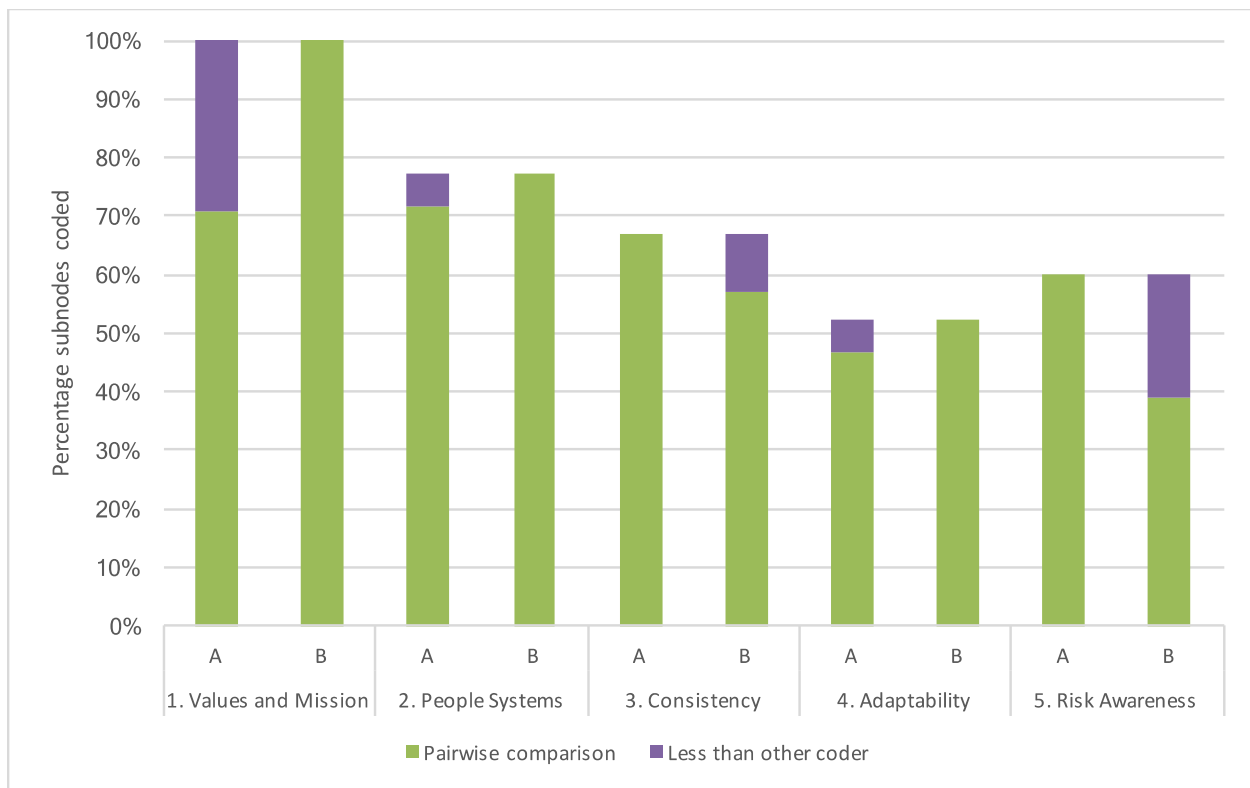
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283 The dimensions of Risk Awareness and Adaptability emerged from the food safety
284 culture dimensional framework developed by assessing 8 culture evaluation systems (Jespersen
285 et al, 2017); however, these dimensions did not form part of the earlier Jespersen *et al* (2016)
286 tool and the subsequent evaluation scale which was tested through this research. As such, these
287 two dimensions could not be part of the method triangulation validation of the self-assessment
288 scale.

289 **3.2 Coding comparisons.**

290 A comparison of Coders by dimension is shown in Figure 4. Total 4,522 references were
291 coded in 10 interview transcripts and 20 performance documents. Coders are considered similar
292 if within the set standard of 90% agreement. Agreement between coders was calculated for each
293 dimension and lowest level of pairwise agreement was calculated to 90.4%. This result was
294 obtained after coding and recoding as per Figure 3. As such, content from two dimensions
295 needed to be recoded; Values and Mission and Risk Perception. The bar chart (Figure 4) shows
296 that coders are within 90% agreement on scoring except for Values and Mission (69%
297 agreement) and Risk Awareness (79% agreement).

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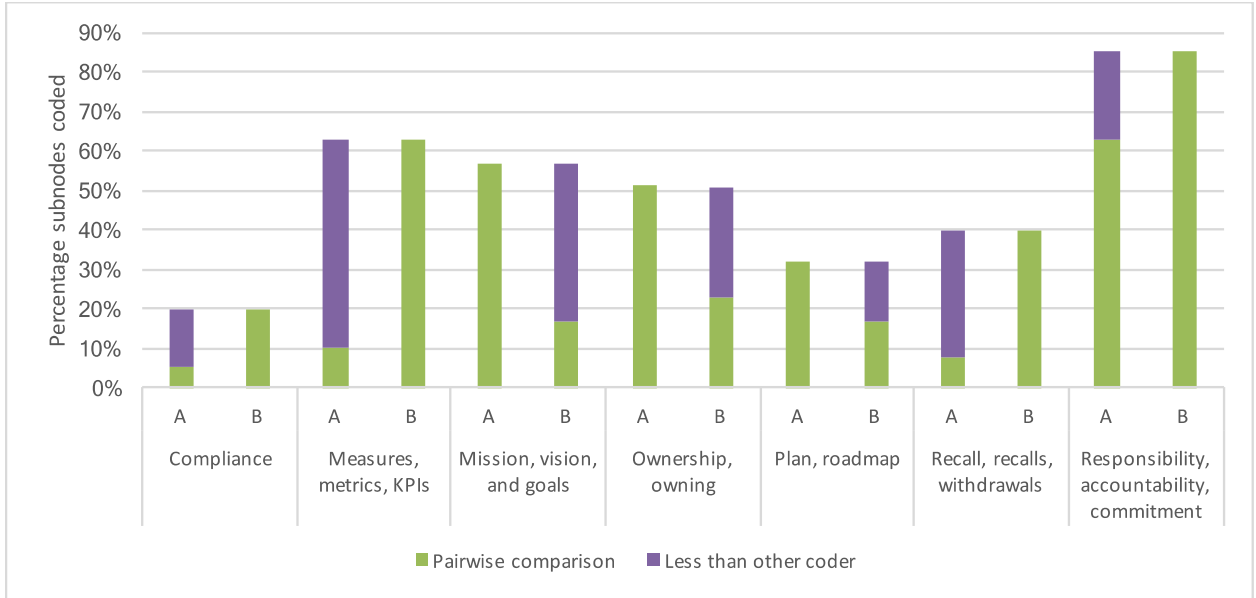


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300 **Figure 4: Codes by dimension with pairwise comparison and difference by**
301 **coder (A and B = two different coders).**

302

303 In looking at the sub-nodes for Values and Mission (Figure 5) most of this difference
304 comes from differences in scoring of sub-nodes “Measures, metrics, and KPIs” and “Mission,
305 Vision, and Goals”. Coder B coded 52.1% more in the “Measures” than coder A and Coder A
306 coded 40.3% more in “Mission” than Coder B. In addition, in “Recall, recalls, withdrawals”
307 Coder B coded 32.5% more than Coder A, the sub-node “Measures”, where verbatim data show
308 that Coder B coded any “metric” e.g., LM Product 0%, whereas Coder A was looking for
309 measures taken to improve. Sub-node “Mission” verbatim shows that Coder A coded any
310 paragraph or statement leading to direction or priority of the organization. Coder A also included
311 any reference to “policy” which Coder B did not. Sub-node “Recall” verbatim show that Coder
312 A coded any paragraph with the word “recall” whereas Coder B coded paragraphs that indicate
313 recall as a potential outcome of a situation or environment. The differences between coders were
314 reviewed by both coders, discussed, and where needed, amendments were made to increase
315 clarity of application of the coding framework.



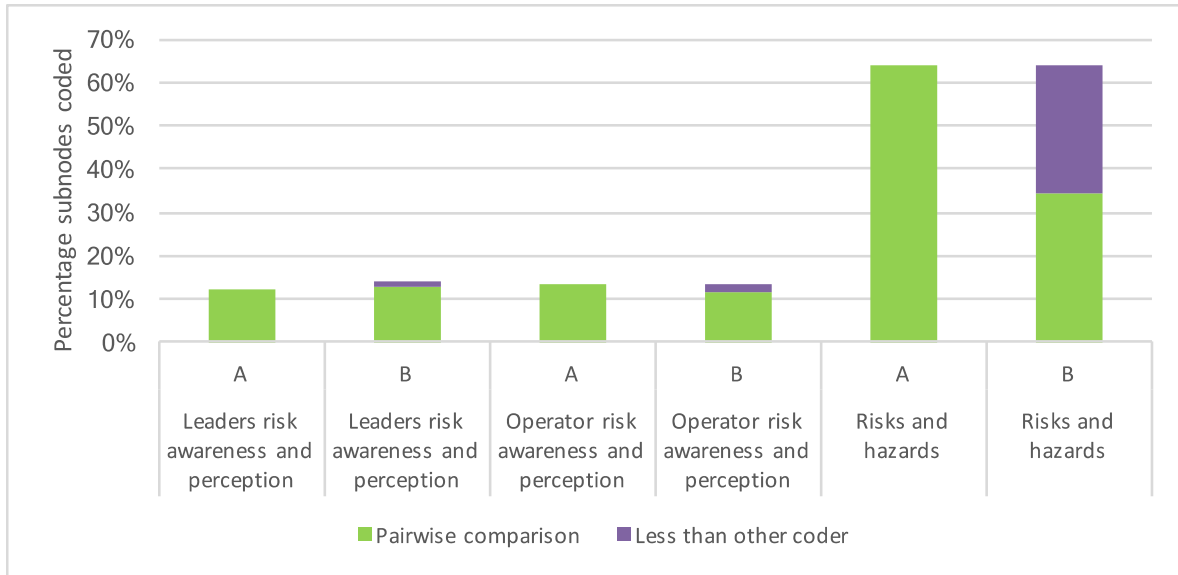
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317 **Figure 5: Values and Mission by sub-node and by coder (A and B = two**
 318 **different coders).**

319

320 For Risk Awareness (Figure 6), most of the difference comes from the sub-node “Risks
 321 and Hazards.” Coder A coded 29.75% more in this sub-node than coder B. In looking at the
 322 verbatim, it shows that HACCP, risk assessment, contamination, foreign material, CCP, specific
 323 foreign material findings, food security were examples of words and phrases being coded.
 324 Generally, Coder A has more detailed word coding on hazards and risks and Coder B coded
 325 specific bacteria references and risks and hazards more generally.

326



327

328 **Figure 6: Risk by coder and sub-nodes (A and B = two different coders).**

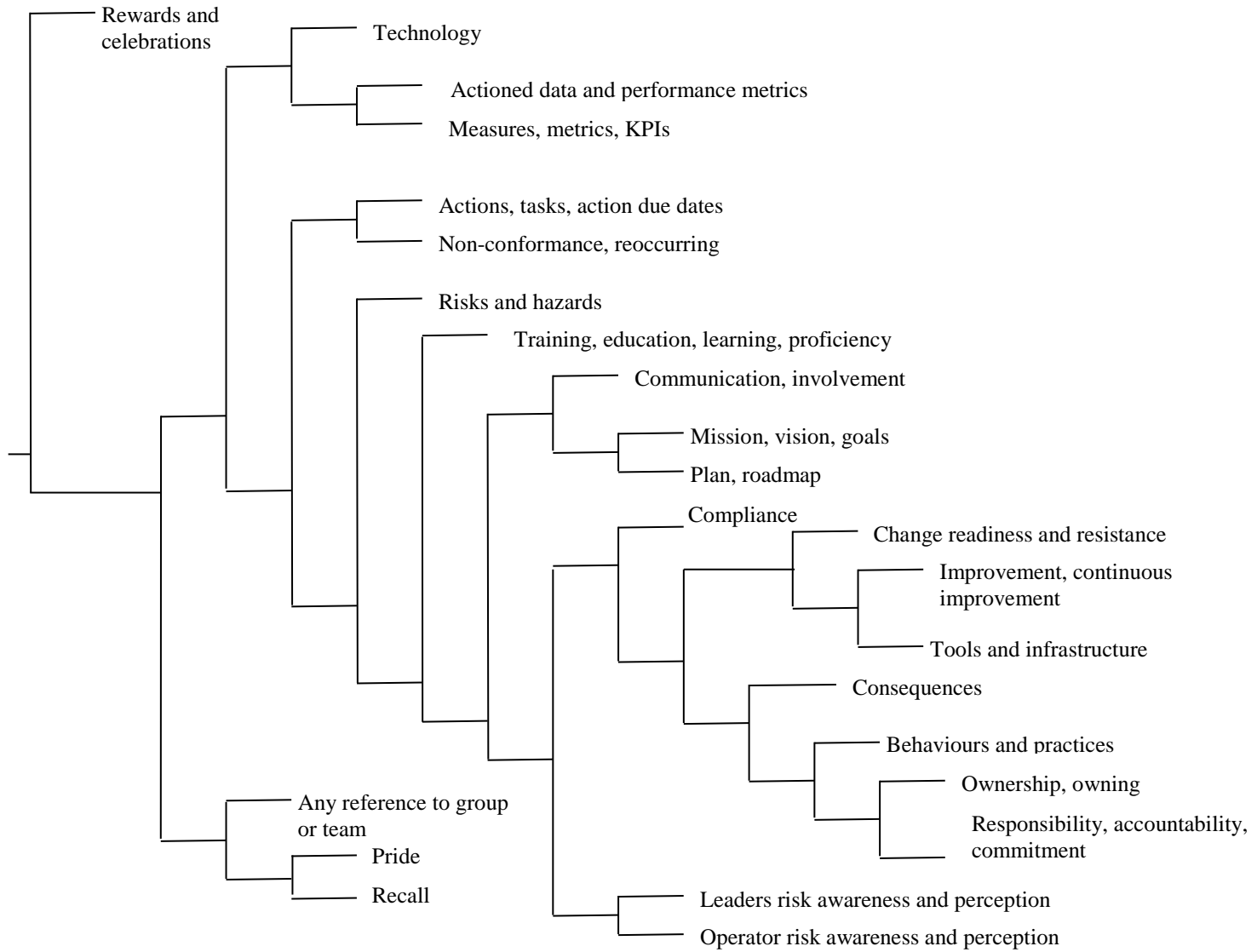
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330 3.3 Coding Discrimination and Cluster Analysis

331 To investigate if data from the coding framework and process can discriminate between
 332 the food safety culture dimensions a cluster analysis of the coded sections of the verbatim
 333 content was completed (Figure 7). The Pearson’s coefficient shows values at or equal to 0.5 or
 334 above for similar items and values less than of 0.5 or less for items distinctly different. The
 335 distinctly different items were discussed by the coders and the coding framework was updated.
 336 As such, eight major “stems’ of similar word content were identified, (1) Rewards and
 337 Celebration, (2) Technology and Data, (3) Risks and Hazards, (4) Actions/NCs, (5) Training,
 338 education, learning proficiency (6) A group of items related to, vision, mission, values,
 339 improvements, consequences, awareness, and ownership (7) Team, and (8) Pride and Recall. The
 340 eight “stems” can be directly aligned to the five dimensions but also add more structure to the

341 sub-nodes. This suggested dimensional framework (Figure 8) raises interesting questions that can
342 be useful in the assessment of maturity e.g., what is the connection between pride and recall?
343 What is driving similarity between leaders and employee risk awareness and change,
344 communication, and responsibility? The revised sub-nodes help get closer to some of the
345 manifest data in the texts analyzed. For example, original sub-node was worded as ‘mission,
346 vision, and goals’ this lead to significant discrepancy between coder A and B (figure 5). By
347 revising this sub-node to two sub-nodes ‘direction’ and ‘goal’ the coders were able to meet the
348 standard of 90% agreement and the content coded provided more clarity as for how the
349 organization set both direction and goals or not. In other words, more accuracy in coding by
350 individual coders was gained using these revised sub-nodes and this allowed not only better
351 consistency between the coders but also more detail to be identified from the data, thereby
352 adding to the overall analysis of an organizations food safety culture maturity.

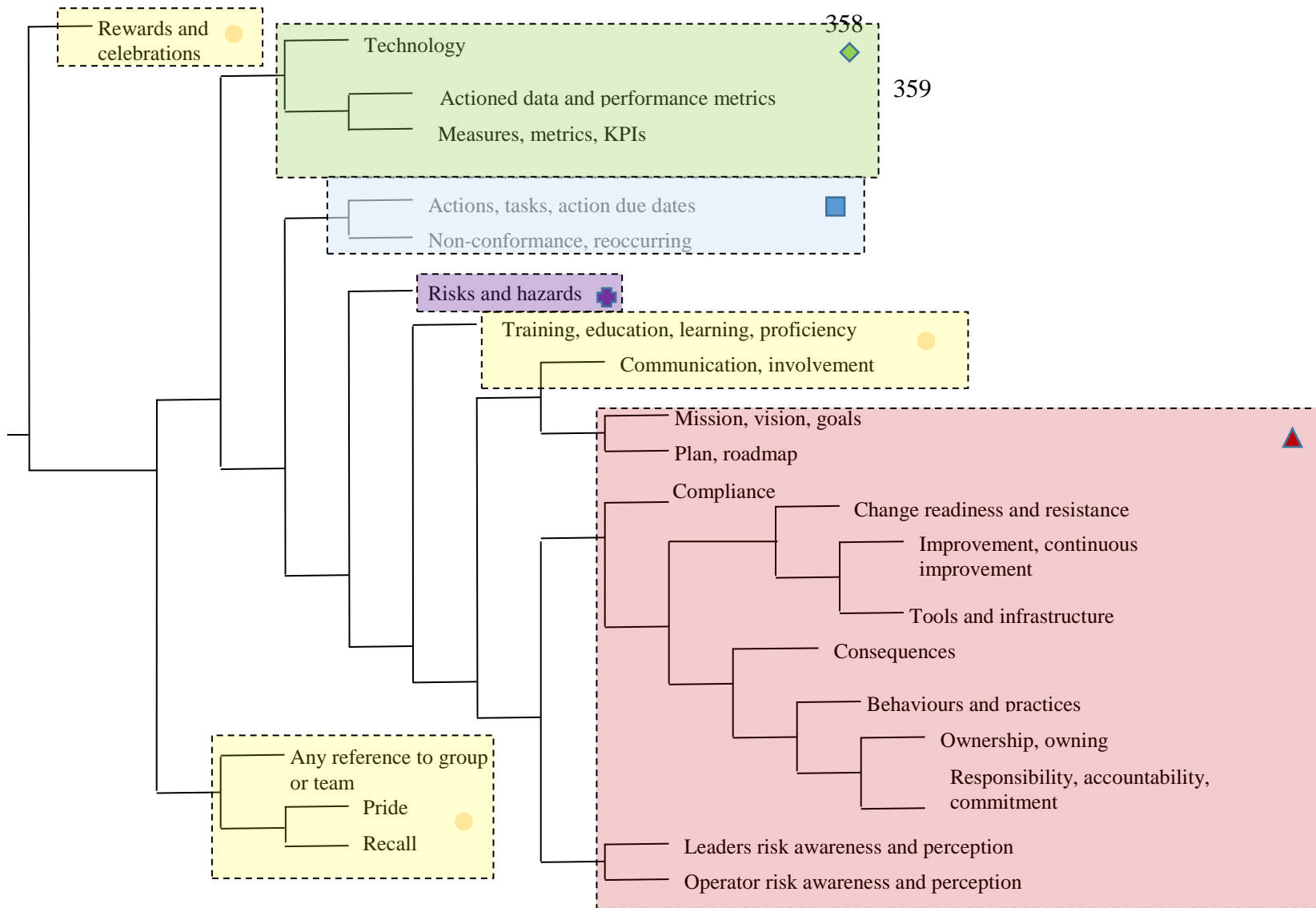
353 **Figure 7: Nodes clustered by word similarity**



355 **Figure 8: Revised dimension framework and sub-nodes based on cluster analysis. Ledger: Red (▲) = Vision and Mission,**

356 **Yellow (●) = People, Green (◆) = Consistency, Blue (■) = Adaptability, and Purple (■) = Risks and Hazards.**

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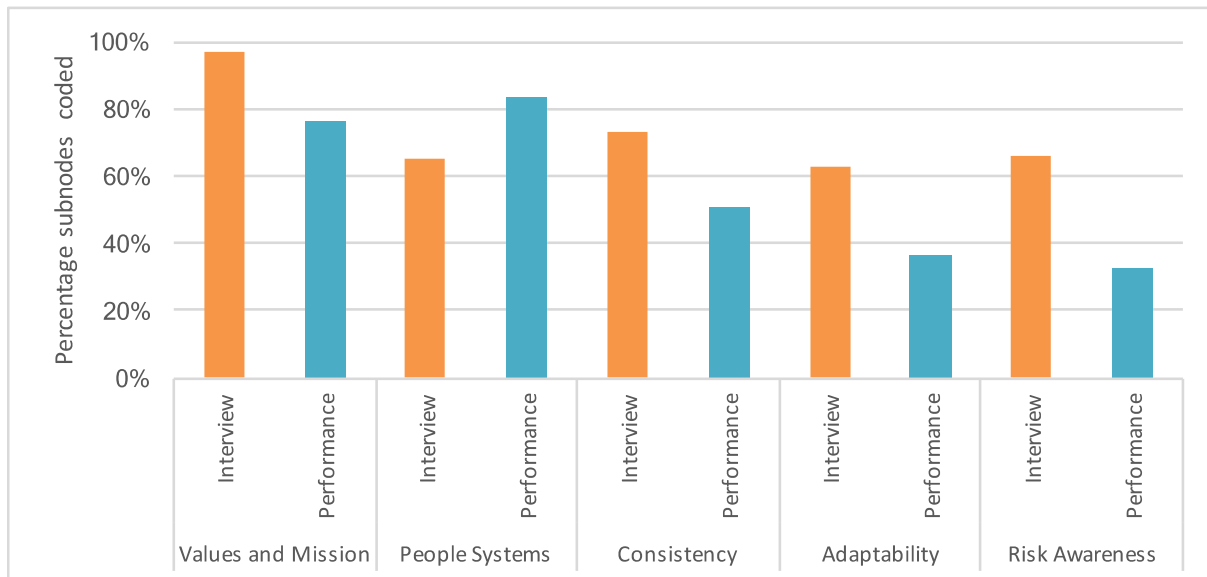


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361 **3.4 Content Analysis comparison – performance documents and interviews**

362 A comparison of data from the performance documents and interview transcripts was
363 completed to investigate if method triangulation increases the validity and
364 quality/trustworthiness of food safety culture evaluation (Figure 9). Except for audit reports
365 which include reproduction of requirements from respective standards, performance documents,
366 mean word count ranges between 767 – 1,986 per document depending on document type
367 compared to interview transcripts mean word count between 4,601 – 7,369 per transcript
368 depending on function. Food safety and Quality interviews were generally longer than
369 Manufacturing. As such, it was to be expected that content of the interview transcripts was more
370 detailed and targeted for the purpose. The chart shows that more content was coded in the
371 interviews than in the performance documents except for the dimension “people systems.” This
372 is interesting as most of the documents submitted for analysis were technical in nature e.g., audit
373 reports, meeting minutes, and inspection reports. Still these documents provide valuable data
374 related to people systems, specifically rewards and celebrations, teams, knowledge, and learning.

375



376

377 **Figure 9: Coding by document type by dimension**

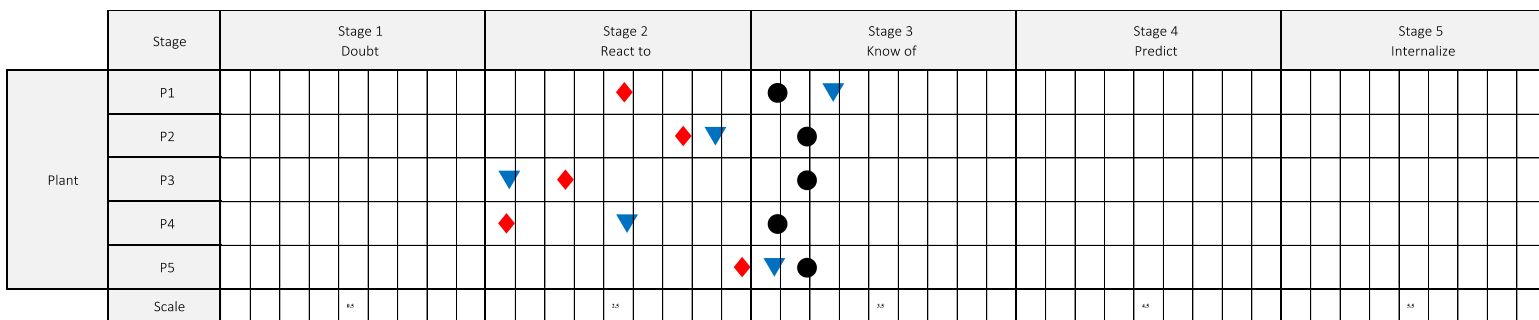
377

378 **3.5 Plant discrimination – method triangulation.**

378

379 The triangulation analysis revealed a difference between and within plants. Based on the
380 coding consistency and discrimination it was concluded that the coding process is a valid method
381 for evaluating food safety culture. Based on this conclusion three scores per plant were plotted
382 on the maturity model (Figure 10). This shows some disparity both within and between plants.
383 The results for P2 and P5 have the least difference between methods. This means that the
384 individuals rating of food safety maturity, the documented performance, and what was said by
385 leaders in conversation are telling similar stories. In a reevaluation situation, it could be
386 considered to only apply one of the three methods to save time and effort. P3 shows the greatest
387 difference between methods. This means that individuals rate the plants food safety maturity
388 significantly higher than what was found in documented data and what was being said by

389 leaders. In follow up, it would be important to schedule more interviews and focus groups to
 390 better understand this difference as a scale does not provide a complete picture to help the plant
 391 change. P1 and P4 have comparatively low scores for the documented performance compared
 392 with their other measures and it might be interesting to look at the purpose of the submitted
 393 documents and if there is an opportunity to better used these; however, what was evaluated by
 394 the individual and said by leaders are relatively close, particularly in P1, P5 and, to a lesser
 395 extent, P2. P1 is especially interesting as leaders appear to evaluate maturity directionally higher
 396 than all employees. This reflects the findings in earlier study with a significant difference
 397 between leaders and supervisor (Jespersen et al., 2016)



398 **Figure 10: Plant Maturity - Plot of mean values as per method triangulation.**
 399 **Ledger: Dot = Self-assessment scale result, Diamond – Performance document coding**
 400 **result, and Triangle = Interview coding result.**
 401

402

403 **4.0 Discussion and conclusion**

404 The objective of this research was to develop and apply method triangulation to increase
 405 validity of food safety culture evaluation results. Data from multiple sources were collected and
 406 evaluation results from each plotted on a food safety culture maturity model. Data were analyzed

407 for inter-coder and construct validity, and capability of discrimination within a food safety
408 culture maturity profiling system. Results from analysis of data from three methods, self-
409 assessment scale, document content analysis, and semi-structured interviews, were aggregated
410 and plotted on a food safety culture maturity scale. The dispersion between the mean results per
411 method per plant confirms the need to apply triangulation to get an accurate and trustworthy
412 evaluation of food safety culture. With use of just one of the methods applied in this research the
413 stage of maturity would have been evaluated either too low or too high and subsequent tactical
414 interventions would not have been as effective as intended. For example, a learning program for
415 frontline supervisors in stage 2 “reactive” is largely about creating a personal connection to build
416 a strong foundation of “why food safety is important to you?” A program in stage 3 “knowing” is
417 mostly about increasing cognitive capacity for solving problems, finding root causes, and
418 removing issues permanently. These are two very different objectives that, if applied to the
419 wrong stage, would likely fail and be seen as not valuable to business results. The results showed
420 that mean maturity for all plants was generally higher when assessed through the self-assessment
421 scale ranging from 3.06 – 3.18. The results from the semi-structured interviews were closer to
422 the self-assessment scale for two plants and lower than the self-assessment scores for the other
423 three plants. It was also found that results from the food safety and quality leader interviews
424 generally rated maturity higher than that for manufacturing leaders. The findings from the two
425 functions were found to be significantly different both in maturity assessments and amount of
426 textual data. Mean maturity scores derived from the textual data were the lowest of the three
427 measures except for one plant. In general, more action content (e.g., tasks, follow up) was

428 captured in the textual data and this was to be expected given the original purposes of the
429 documents e.g., meeting minutes and inspection reports.

430 A coding framework was applied to derive data via content and textual analysis. The
431 framework was consistently applied by two researchers within 90% agreement except for two
432 dimensions; Values and Mission and Risks and Hazards. This difference called for clarification
433 and better definition of the sub-nodes e.g., “mission” this sub-node is better defined as
434 “direction” and can include content related to mission, vision, strategies and generally where a
435 specific direction for food safety is documented. In the Risks and Hazards dimension it was
436 found that one coder coded very specific words e.g., hazards, CCP. It is worth noting that this
437 coder has a long and detailed background in defining hazard and risk management strategies and
438 was likely influenced by this in the coding. This underlines the importance of the iterative coding
439 process with the two checks for consistency; however, it also questions if Risks and Hazards is,
440 in fact, a stand-alone dimension. Is content related to “hazards” and “CCPs” relevant for
441 evaluating culture? Because of this issue and the fact that only two systems (De Boeck et al.,
442 2017; Wright, 2013) have separated out Risks as a stand-alone dimension (Jespersen, Griffith,
443 and Wallace, 2017), it is worth discussing if this dimension should remain in the food safety
444 culture theoretical framework (Figure 1) or if is best considered in the evaluation of food safety
445 management systems.

446 This study was conducted as part of a larger study with 21 plants but this analysis was
447 completed with data from a sub-set of five. This was done both to ensure that there was enough
448 time to execute the coding process fully on 10 interview transcripts and 20 performance

449 documents by two researchers and to analyze a sufficiently large sample for triangulation
450 purposes. It is recommended that more work is done with more researchers to promulgate
451 content analysis as a method for evaluating both food safety performance and food safety culture
452 maturity. It was unexpected that such similarity would be found in the five plants, where
453 performance ranged from stage 2 maturity “reactive” to stage 3 “know” (Jespersen & Edwards,
454 Under review; Jespersen et al., 2016) or all plants and documents. This could be due to the
455 geographical dispersion of the plants, this subset all being in North America, and therefor under
456 similar North American legal systems and customer expectations. It could also be a case of
457 selection bias as the participating companies were not gathered via randomization or quasi-
458 random assignment, rather through senior leader interest and board willingness to participate in
459 the research. In this research, selection would be present if those who participated in the study
460 and responded to the survey are those that have internalized the importance of culture and/or
461 those that engage in “cheap talk” about culture. It is reasonable to assume some sampling bias
462 due to the voluntary nature of the participants.

463 In summary, the research adds information and knowledge, derived through a transparent
464 and rigorous process, to the food safety culture domain. Specifically, it adds proof that reliance
465 on a single method for evaluation food safety culture can give inaccurate results and should be
466 treated with caution. This has practical significance for companies who invest, not just in such
467 results, but in subsequent improvement tactics.

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