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Social Networks and an Intelligence Cohort in Food Safety: An Empirical Analysis

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Abstract

To examine how an intelligence cohort works, a comparative analysis is conducted in the context of food recalls of meat and poultry products. An intelligence cohort addresses three fundamental strategies: identifiability, uniqueness, and the use of additive tasks. The concept of an intelligence cohort is tested in the context of a food recall, and its efficacy for managing processes is examined. The public sector accounts for more recall cases than does the private sector. The ratios are more imbalanced when recall cases involve biological hazards, the beef industry, and local markets. So, social media offers new opportunities to implement a strategy that organizes and mobilizes local consumers and suppliers. Centralized public operations alone are not the best solutions; however, a public agency's leading role is still necessary to safeguard the system. Both technical traceability and social traceability are feasible strategies, but performance improvement can be attained by integrating high social

traceability and high technical traceability. Social media offers new opportunities to implement a strategy that organizes and mobilizes consumers and suppliers to achieve high levels of food safety. Introducing the notion of an intelligence cohort to develop a food safety commons is unique.

Keywords: food safety, social networks, technical networks, intelligence cohort.

Introduction

Information and communication technologies open avenues that leverage social networks for a prosocial approach to food safety management. (This article is based on Wang, 2015). A pilot study showed that social networking could be a strategy for improving hazard communication (Wang, Van Fleet, & Van Fleet, 2014) . Individuals in a market could function as emergent leaders or social media influencers (Freberg, Graham, McGaughey, & Freberg, 2011) and exercise informational influence for the public good. However, such influence could be both a blessing and a curse. Spreading the word about negative events could intensify problems because social media users may create noise in the system (Gorry & Westbrook, 2009) , and their credibility questioned due to distortions or misinformation (Wright & Hinson, 2014; Carlson & Peake, 2013). However, such effects may be overstated (Chong & Druckman, 2007; Druckman, 2001) since, in real-world settings, social context provides references to arrive at collective rational choices. Nevertheless, negative effects are not without concerns. The commons dilemma (Shultz & Holbrook, Marketing and the tragedy of the commons: A synthesis, commentary, and analysis for action, 1999) and free-riding tendencies (Albanese & Van Fleet, Rational behavior in groups: The free-riding tendency, 1985a) indicate that collective rational choices may not lead to long-term, sustainable prosocial outcomes.

To reach negotiated agreements in communicative processes, opinion leaders propose claims which are open to objective appraisal in order to invite followers to take rationally motivated stances. Whether a validity claim can lead to an agreement and joint action depends on self-verification – how the validity claim is evaluated against the conditions of its validity, i.e., "background knowledge inter-subjectively shared by a communicative community of all participants" (Burke & Stets, 1999) . In this regard, stakeholders use social information to validate claims of food safety. In doing so, they seek out others who are using the same or similar information. As a result, a food safety commons evolves as collaborative relationships develop.

While collaboration among stakeholders would be expected to have positive results, as has the empowerment of employees in public sector organizations (Fernandez & Moldogaziev, 2011), organizing the food safety commons requires more than laissez-faire (Wang & Van Fleet, 2016). Food safety is a public good, and food recalls deal with crisis situations. Self-organization and communicative actions would not automatically lead to desired public interest. Due to goal incongruence, valid and rational decisions result in three different behavioral outcomes, i.e., prosocial, selfish, and free riding. Therefore, even with market-based forces (Wang, Van Fleet, & Mishra, 2016), coordination by the public agency is still necessary to maintain the integrity of the food system even with additional intelligence from consumers and suppliers.

Shultz and Holbrook (2009) posit that verification emanates from communicative interactions and collaborative efforts among all stakeholders. In the food safety commons, operational requirements of both collaboration and coordination suggest plural governance to regulate contrasting activities. Stakeholders with diverse knowledge, motivational backgrounds, and evolving needs require effective leadership from the public agency to design a platform to manage information processing and to engage different types of interactions so as to induce social influence while preserving prosocial collaborative partnerships. This article introduces the concept of an intelligence cohort, tests that concept in the context of food recall, and examines its efficacy for managing the dynamic processes of validity evaluation.

Food Recall

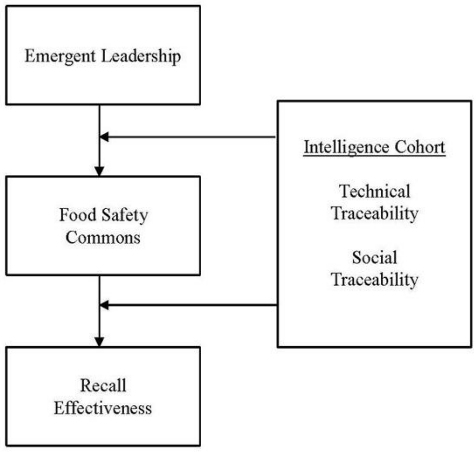
Food recall is not a simple process. It involves two-stages, identification and containment. In addition, understanding food recalls involves the sheer number of recalls and the quantity of food recalled. From 2009 to 2018, the number of recalls trended upwards from 69 in 2009 to 125 in 2018 (peaking at 150 in 2015). However, the number of pounds involved varied from a low of 3,475 115 in 2012 to a high of 58,140,787 in 2016. Finally, understanding the food recall process also must consider the sources of information or intelligence involved. Three stakeholders comprise the sources of hazard intelligence – suppliers, consumers, and public agencies. All three must be involved to preserve the integrity of the food system (Wang, Van Fleet, & Mishra, 2016).

Intelligence Cohort

An intelligence cohort is a managerial tool to collect and transform diverse traces of information in a system to generate useful intelligence and benchmark organizational performance. Derived from the notion of a competitive cohort (Flint & Van Fleet, 2011), an intelligence cohort is the set of identities that define and exemplify the relevant standards against which subsequent performance should be measured and compared. Similar to benchmarking (Watson, 1993), an intelligence cohort goes beyond the conventional way of identifying fixed and formalized performance standards. An intelligence cohort considers not only salient but also non-salient entities. Moreover, the sources of behavioral influence consist of both social and technical aspects – not limited to the social dimension of referent others but including the technical dimension of scientific references. Therefore, it is an encompassing approach to implement traceability strategies by providing a schematization on complex task environments and organizing diverse technical and social identities.

A general framework addressing situational effects and transaction cost economics is employed to test the concept. As diverse stakeholders are self-organized into a food safety community, group dynamics function, on the one hand, as "intervening variables" receiving negative impacts from contingencies such as food hazards, and, on the other hand, influencing organizational effectiveness. Consumers and suppliers act as emergent leaders to detect and correct food hazards. An intelligence cohort functions as a "situational filter" (Dunnette, 1963, p. 318) and structures the linkages between multiple stakeholders and collaborative community performance. As shown in Figure 2, the public agency takes a role of a servant leader, constructing an intelligence cohort, a food safety commons that encourages constructive engagement, mutual support, and resource sharing among consumers and suppliers. The agency also monitors interactions to identify vulnerable situations when they emerge and to take timely actions to neutralize them.

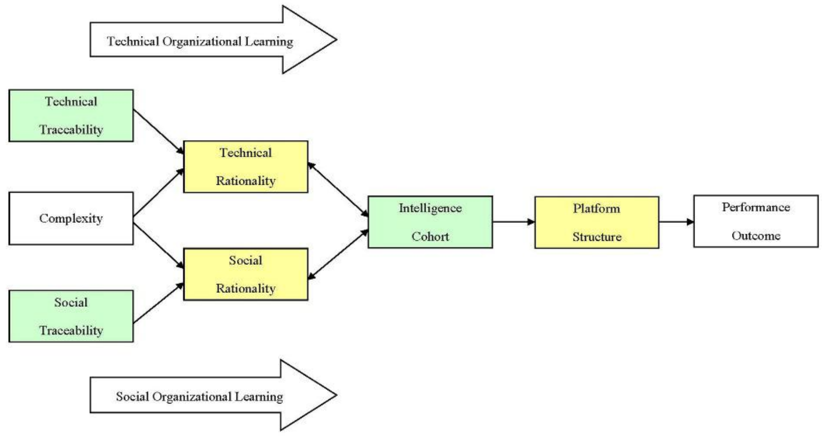
Figure 1 Intelligence cohort safeguards food safety commons



Traceability is the "eyes" of the system, crucial to decision making in collaborative but complex task conditions. Figure 2 illustrates how traceability, as an organizational learning mechanism, determines collaborative performance. First dispersed intelligence in the system is consolidated. Then the streams of social forces are molded into an interactive structure. The solidified social energies further set the course of organizational performance. The linkages present a strategic concern. In the food safety commons, symbolic interactions form the structure of the hazard communication, which consists of two dimensions – technical and social.

The technical dimension characterizes the generation of hazard intelligence and various information cues for coordination. The social dimension describes the responsiveness of stakeholders to these information cues. Due to bounded rationality and selective attention, stakeholders in general only respond voluntarily to salient information cues in proximity, i.e., social information. Therefore, in order to effectively coordinate stakeholder behaviors, a public agency needs to manage public attention by monitoring both the technical and social structure of hazard communication. This approach offers the public agency an opportunity to shape the structure of hazard communication and coordinate "smart" operations that, in the food safety community, diverse interests from multiple stakeholders are acknowledged while the integrity of the system is preserved.

Figure 2. Traceability, Intelligence Cohort, and Platform Structure



To examine how an intelligence cohort works – strategic choices on traceability orientations, dynamic structural characteristics, and performance implications -- a comparative analysis is conducted in the context of food recalls of meat and poultry products. Because of its public and voluntary nature, recalls of meat or poultry products are assisted by a "deputy," specifically, the Food Safety and Inspection Service (FSIS), USDA, to coordinate discretionary actions from various parties in the market and to ensure that public interests are safeguarded. A recall committee is formed within the public agency to coordinate cross functional, regional, and departmental operations. Two key coordinators in the teamwork, Recall Management Staff (RMS) and District Recall Officer (DRO), serve as "linking pins," which organize public and private stakeholders into an interaction-influence network and adapt the functional deployment of public operations to flexible task requirements in collaboration. Food recall operations often involve difficult decisions in crisis situations – with insufficient information and incomplete knowledge, while under relentless pressures from time-perishable resources, for example, escalating hazard impacts, deteriorating public health conditions, and unstable public sentiments. In such task environments, judgmental calls are contingent on intelligence available at the point of decision making. In this regard, deploying an intelligence cohort would provide invaluable guidance in the learning-by-doing processes and facilitate timely and quality decision making.

In managerial practice, developing the self-organized processes is accomplished through delegation, which involves three key activities: evaluating task competency, assigning responsibility, and maintaining accountability (Van Fleet, Van Fleet, & Seperich, 2014). An intelligence cohort addresses these considerations by integrating three fundamental strategies to structure complexity: identifiability, uniqueness, and the use of additive tasks. Further, the three strategies are linked to performance outcomes to create a temporal sense of urgency.

Table 1 summarizes traceability strategies under alternative technical and social task conditions. In Scenario 1, traceability is fully provided as private goods by the market mechanism. In Scenario 2, task identifiability evaluates individual performance, making an individual’s output identifiable and creating a task environment in which means-ends relationships are clarified. However, the push-based strategy of validation is only efficacious, given the availability of technical measurements. In Scenario 3, for non-identifiable situations, task uniqueness, a pull-based social strategy, resorts to self-selection and intrinsic motivation from stakeholders by providing special incentives to promote self-identification and feelings of worthiness bring about a higher level of contribution in a public task (Harkins & Petty, 1982). In the worst case, Scenario 4, when a task is not identifiable, and stakeholders are not motivated, building a “firewall” is an inevitable compromise to prevent potential damage and contain the loss within the “black box.” Creating an additive task structure enables resource sharing and social influence and facilitates contingency planning and effective responses.

Table 1. Additive task structure for traceability

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Technical dimension</td></tr>
<tr><td>Traceable</td><td>Non-traceable</td></tr>
<tr><td rowspan="2">Social dimension</td><td>Traceable</td><td>Scenario 1
Market mechanism</td><td>Scenario 3
Task uniqueness
Pull-based social strategy</td></tr>
<tr><td>Non-traceable</td><td>Scenario 2
Task identifiability
Push-based technical strategy</td><td>Scenario 4
“Black box”
Competitive mechanism</td></tr>
</table>

Empirical Results

Since 1994, the FSIS has systematically documented its recall operations, and the results of documentation were stored in the Recall Case Archive. As the data were recorded in a consistent, routine manner, the database offers an ideal opportunity to apply the grounded theory (Glaser & Strauss, 2009) through categorical data analysis. Table 2 lists seven variables encoded for the purpose of category generation. Recall effectiveness quantitatively and objectively measures the performance of collaborative food recall efforts – the percentage of intended recall items were actually retrieved from the market. Food hazards would require special technologies to reveal their presence, thus requiring different levels of technical traceability. Besides the technical dimension, multiple stakeholders collaborate in food recalls, creating the need for social traceability as an alternative type of identification. On the supply side, food recall characteristics might be categorized according to the types of industries, for example, beef, pork, and poultry. On the demand side, recall performance might be impacted by the extent of distribution, for example, national, regional, and local markets. The use of an Internet-based communicative platform (e.g., AskKaren.gov) would promote the access and use of intelligence in the system. After the encoded qualitative data are organized into three cohorts according to different performance outcomes, the analysis should discover useful information and improve recall performance.

Table 2. List of encoded variables

	Name	Type	Definition	Measure	Category
Y	Recall Effectiveness	Dependent, Categorical Variable	Percentage of announced recall quantity actually recovered	1) Recall rate = Actual recovered recall quantity ÷ Announced recall quantity 2) Criteria -High > 75% - Medium 25% -- 75% -Low <25% or indeterminable	1: high performance 2: medium performance 3: low performance
X_1	Technical Traceability	Independent, Binary Variable	Decisions determined by fixed rules and procedures	Detecting biological hazards requires a high degree; non-biological hazards indicate a low degree	1: low degree of technical traceability 2: high degree of technical traceability
X_2	Social Traceability	Independent, Binary	Decision making concentrated	When a hazard is detected y public agencies, centralized operations indicate a low degree of social	1: high degree of social traceability

		Variable	to an authority	traceability. When a hazard is detected by a supplier or a consumer, high involvement indicates a high degree of social traceability	2: low degree of social traceability
X_3	Industry	Independent, Categorical Variable	Type of recalled product	Beef, port, or poultry (and processed eggs). If a product consists of mixed ingredients, an industry type is determined by its major ingredient.	1: beef 2: pork 3: poultry
X_4	Market	Independent, Categorical Variable	Scope of product distribution	National market: product distributed to 10+ states Regional market: product distributed to 1-- 10 states Local market: product distributed within one state	1: national 2: regional 3: local
X_5	Internet	Independent, Binary Variable	Use of internet in recall operations	Whether internet information service (AskKaren.gov) is available, measured by a dummy variable	0: not available 1: available
X_6	Structural Change	Independent, Continuous Variable	Structural change in the environment of recall operations	Set by recall case number from 1 (the first data point) to 415 (the last data point). Indicates whether a significant structural change is observable in the recall data.	

Table 3 summarizes the analytical model settings and results. The three models are structurally varied to examine the effects of different organizational strategies. Cohort performance is compared and evaluated by two performance improvement levels -- the "high vs. low" group indicates high performance improvement, while the "medium vs. low" group indicates moderate performance improvement. Changes in recall effectiveness, the dependent variable, is explained by technical traceability, social traceability, industry types, market scopes, and the use of the Internet-based platform. In addition to the five performance drivers, a structural parameter is included to detect whether significant structural changes were present in the food system. The likelihood ratio of 0.3882 indicates an overall fit of the three models. In general, both industry types and market scopes do not significantly explain cohort performance. As Guide, Harrison, & Van Wassenhove (2003) argue, factors of regular forward supply chains would not predict behaviors in reverse supply chains. The use of the

Internet-based communicative platform is insignificant. Although, in theory, communication is antecedent to trust, which further leads to higher commitment and lower uncertainty (Morgan & Hunt, 1994), a dummy variable may not be sensitive enough to capture this effect. Lastly, no significant structural change is observed in the recall environment.

In Model 1, the base model, a laissez-faire setting, allows full interactions in an unstructured task environment. Regarding high performance improvement, technical traceability does not present a statistically significant effect on the performance differential. With the logit 0.8937, a high degree of social traceability is associated with improving cohort performance. The interaction term between technical and social traceability is not significant. As for moderate performance improvement, both technical and social traceability significantly and positively contribute to cohort performance. The logit values of 0.8328, and 0.9772, respectively, indicate that a low degree of technical traceability and a high degree of social traceability are associated with better cohort performance, while social traceability is a more powerful performance driver than technical traceability. However, after considering the negative interaction term between high social traceability and low technical traceability, the strategies are not so promising. The negative logit value of the interaction term -1.1976 suggests that not every interaction is "beneficial." Indeed, discretion and participation without sufficient competency and a shared value would backfire, as mentioned in Harkins and Petty (1982, p. 1227) and Albanese and Van Fleet (1985a, p. 248) . Interactions, when conflicting, would decrease the efficacy of the strategies. Therefore, task structure matters.

Table 3. Comparison of 3 models

	Model 1		Model 2		Model 3	
	Unstructured Tasks	Full Interaction	Additive Tasks	Technical-oriented	Additive Tasks	Social Oriented
Cohort Performance	High vs. Low	Medium vs. Low	High vs. Low	Medium vs. Low	High vs. Low	Medium vs. Low
Intercept	-0.9556	-0.0432	-039556	-0.0432	-0.9556	-0.0432
Tech. Traceability (Low vs. High)	-0.3518	0.8328***	-0.3518	0.8328***		
Social Traceability (High vs. Low)	0.8937**	0.9772***			0.8937**	0.9772***
Interaction (High Social & Low	-0.4608	-1.1976**				

Technical						
High Social Traceability, given Low Technical Traceability			0.4329	-0.2204		
High Social Traceability, given High Technical Traceability			0.8937**	0.9772***		
Low Tech. Traceability, given High Social Traceability					-0.8126*	-0.3648
Low Tech. Traceability, given Low Social Traceability					-0.3518	0.8328***
Industry						
Beef vs. Poultry	0.2201	-0.1351	0.2201	-0.1351	0.2201	-0.1351
Pork vs. Poultry	0.5416	0.2103	0.5416	0.2103	0.5416	0.2103
Market						
National vs. Local	-0.4092	-0.4132	-0.4092	-0.4132	-0.4092	-0.4132
Regional vs. Local	-0.1846	-0.4852	-0.1846	-0.4852	-0.1846	-0.4852
Web-based						
Not available vs. Available	-0.4851	-0.4777	-0.4851	-0.4777	-0.4851	-0.4777
Structural Changes	-0.0006	-0.0023	-0.0006	-0.0023	-0.0006	-0.0023
Likelihood Ratio	0.3882					

Remarks: Asterisks indicate significance levels 10% (*), 5% (**), and 1% (***)

In Models 2 and 3, a nested arrangement between the technical traceability and social traceability represents additive task structures that facilitate orderly organizational changes. Interestingly, statistical evidence shows that strategies under additive task structures have the potential to attain higher performance. On the one hand, in the technical-oriented Model 2, technical traceability is regarded as the strategic priority. Given the supply of a low level of technical traceability, a high social traceability level does not provide significant conclusions in both high and medium cohort performance changes. Whereas, given a high level of technical traceability, a high social traceability level becomes a significant performance driver in both cohort settings. Therefore, visibility in the task environment is a prerequisite to delegation, participation, and high collaborative performance. On the other hand, the social-oriented model 3 represents an alternative logic. Social traceability is prioritized as the umbrella strategy under which technical traceability is implemented. Given a high level of social traceability, a low level of technical traceability negatively impacts, with the logit -0.8126, on high performance improvement. The result reinforces the previous finding and argues for the importance of technical traceability and visibility. Given a low level of social traceability, a low level of technical traceability is associated with moderate performance improvement. Centralized operations controlled by the public agency would be more effective in a less visible task environment, although the performance improvement would be only moderate at best.

In Table 4, the logit transformation of model results reveals strategic implications. In the cohort of high improvement, comparing the two strategic orientations in Situation 1 and Situation 3, both technical and social approaches could lead to high performance, while social orientation would achieve better performance outcomes. The two strategic orientations are complementary. 49.16% of the high-performance cases are associated with a high level of technical traceability, given a high social traceability level. If the technical traceability is decreased to a low level, only 21.81% of the cases attained high performance. Thus, enhancing technical traceability would increase the efficacy of social traceability. Vice versa, 41.67% of the high-performance cases are related to a high level of social traceability, given a high technical traceability level. If social traceability is decreased to a low level, the strategic mix only accounts for 17.04% of the high-performance cases. Technical traceability becomes more effective with a higher level of social traceability. However, the complementary relationship is not fully supported in the cohort of moderate improvement. Statistically significant results only occur in Situation 1 and Situation 4. Potentially conflicting interpretations bring forth further inquiries.

Table 4 Probability Transformation of Model Results

Cohort Performance	Strategic Orientation			
High Improvement (High vs. Low)	Technical Traceability		Social Traceability	
	Situation 1 High Technical Traceability		Situation 3 High Social Traceability	
	High Social Traceability	41.67%*	High Technical Traceability	49.16%*
	Low Social Traceability	170.4%*	Low Technical Traceability	21.81%*
	Situation 2 Low Technical Traceability		Situation 4 Low Social Traceability	
	High Social Traceability	25.05%	High Technical Traceability	17.04%
	Low Social Traceability	16.24%	Low Technical Traceability	11.99%
Moderate Improvement (Medium vs. Low)	Situation 1 High Technical Traceability		Situation 3 High Social Traceability	
	High Social Traceability	22.02%*	High Technical Traceability	42.83%
	Low Social Traceability	8.29%*	Low Technical Traceability	29.83%
	Situation 2 Low Technical Traceability		Situation 4 Low Social Traceability	
	High Social Traceability	31.02%	High Technical Traceability	8.29%*
	Low Social Traceability	38.67%	Low Technical Traceability	19.05%*

First, regarding social orientation, focusing on the social orientation in Situation 3 and Situation 4, significant results were observed at both high and low social traceability levels. However, the high level of social traceability is associated with high performance improvement, while the low level of social traceability is only significant at the moderate performance improvement. Hence, improving social traceability increases cohort performance, which suggests the value of socialization and social learning. Given high social traceability, technical traceability is positively correlated with the density of the cases. Given low social traceability, the strategic effect is the opposite. Thus, effective technical traceability strategies are contingent on the social structure of the organization. Based on the statistical evidence derived from the current dataset, the low rate of recall effectiveness, 8.29%, indicates that resorting to a command-and-control strategy by combining low social traceability, which connotes centralized control, and high technical traceability, which connotes high investment in traceability technologies, does not lead to a satisfactory performance outcome.

Second, regarding technical orientation, focusing on the technical orientation in Situation 1 and Situation 2, significant results were only observed at the high level of technical traceability. Probability differentials between the two performance levels (41.67% vs. 22.02%; 17.04% vs. 8.29%) indicate the complementary effect of the social traceability. Moreover, technical learning may be required in order to fully utilize the enhanced technical traceability. In other words, a learning curve should be a consideration when investing in traceability technologies.

Lastly, regarding the role of the public agency, Situation 4 in the cohort of moderate performance improvement indicates the public agency's role. Centralized public operations are not the best solution, according to the model results. Nevertheless, before stakeholders are motivated and technical traceability is sufficiently supplied, a leading role of the public agency is necessary to safeguard the system, although the 19.05% of the cases at the medium performance level is far from ideal. The presence of both social and technical learning effects would suggest processes of delegation and learning toward high performance. It will be more appropriate for the public agency to function as an emergent or servant leader, with the mindset to promote, facilitate, and support market-based solutions.

In sum, empirical testing confirms that both technical traceability and social traceability are feasible strategies. From a managerial perspective, three guidelines are suggested in constructing an intelligence cohort. First, social significance supported by high technical traceability results in the highest performance improvement. Second, performance improvement can be attained by integrating high social traceability and high technical traceability. Third, the public agency should exercise limited authority and perform a supporting role to promote social and technical traceability in the system.

Table 5 identifies system deficiencies and presents "learning opportunities" through an analysis of the FSIS Recall Case Archive. Using the same variables and coding categories in the empirical model, the performance implications of a public-private partnership are analyzed based on two task roles and their densities of contribution. Currently, the public agency plays a major role in generating food hazard intelligence. Overall, the public sector accounts for 1.85 times more recall cases than does the private sector (65.48% vs. 35.42%). The ratios are more imbalanced when recall cases involve biological hazards (2.90 times; 74.37% vs. 25.63%), the beef industry (2.59 times; 72.13% vs. 27.82%), and local markets (2.94 times; 74.65% vs. 25.35%). Comparing the cases of biological hazards and non-biological hazards, the large difference in private participation (25.63% vs. 48.59%) suggests the need to create visible and searchable tools to facilitate stakeholders with less sufficient competence, "transforming experience and credence attributes into search attributes" (Caswell & Moiduszka, 1996, p. 1251) . Regarding the industry, private participation is relatively balanced in the poultry industry (40.38%) and even greater in the pork industry (55.22%), compared to that in the beef industry (27.87%). The situation calls for more effective strategies to improve responsibility and accountability in the beef industry. Regarding the market scope, private participation decreases dramatically in smaller markets (at the national level, 54.17%, regional, 30.07%, and local, 25.35%). The counterintuitive result may indicate the need to improve the capabilities of small, local suppliers. Social media would also offer new opportunities to implement a pull-based strategy that organizes and mobilizes local consumers and suppliers from the grassroots.

Table 5. Opportunities for performance improvement (number and percent)

Scenario	Group		Performance (n & %)						Sum	
			High		Medium		Low			
Overall		Consumer	9	2.17	18	4.34	33	7.95	60	14.46
		Supplier	22	5.30	35	8.43	30	7.23	87	20.56
	Group 1	Consumer & Supplier	31	7.47	53	12.77	63	15.18	147	35.42
	Group 2	Public Agency	45	10.84	80	19.28	143	34.46	268	64.58
Biological Hazards		Consumer	4	1.68	3	1.26	6	2.52	13	5.46
		Supplier	13	5.46	20	8.40	15	6.30	48	20.17
	Group 1	Consumer & Supplier	17	7.14	23	9.66	21	8.82	61	25.63
	Group 2	Public Agency	35	14.71	42	17.65	100	42.02	177	74.37

Non-biological Hazards		Consumer	5	2.82	15	8.47	27	15.25	47	26.55
		Supplier	9	5.08	15	8.47	15	8.47	39	22.03
	Group 1	Consumer & Supplier	14	7.91	30	16.95	42	23.73	86	48.59
	Group 2	Public Agency	10	5.65	38	21.47	43	24.29	91	51.41
Beef Industry		Consumer	6	2.46	6	2.46	12	4.92	24	9.84
		Supplier	13	5.33	12	4.92	19	7.79	44	18.03
	Group 1	Consumer & Supplier	19	7.79	18	7.38	31	12.70	68	27.87
	Group 2	Public Agency	28	11.48	55	22.54	93	38.11	176	72.13
Pork Industry		Consumer	1	1.49	6	8.96	9	13.43	16	23.88
		Supplier	6	8.96	10	14.93	5	7.46	21	31.34
	Group 1	Consumer & Supplier	7	10.45	16	23.88	14	20.90	37	55.22
	Group 2	Public Agency	7	10.45	8	11.94	15	22.39	30	44.78
Poultry Industry		Consumer	2	1.92	6	5.77	12	11.54	20	19.23
		Supplier	3	2.88	13	12.50	6	5.77	22	21.15
	Group 1	Consumer & Supplier	5	4.81	19	18.27	18	17.31	42	40.38
	Group 2	Public Agency	10	9.62	17	16.35	35	33.65	62	59.62
National Market		Consumer	4	3.33	11	9.17	2	16.67	35	29.17
		Supplier	7	5.83	15	12.50	8	6.67	30	25.00
	Group 1	Consumer & Supplier	11	9.17	26	21.67	28	23.33	65	54.17
	Group 2	Public Agency	8	6.67	14	11.67	33	27.50	55	45.83
Regional Market		Consumer	3	1.93	3	1.96	10	6.54	16	10.46
		Supplier	6	3.92	9	5.88	15	9.80	30	19.61
	Group 1	Consumer & Supplier	9	5.88	12	7.84	25	16.34	46	30.07
	Group 2	Public Agency	20	13.07	30	19.61	57	37.25	107	69.93
Local Market		Consumer	5	1.41	4	2.82	3	2.11	9	6.34
		Supplier	9	6.34	11	7.75	7	4.93	27	19.01
	Group 1	Consumer & Supplier	11	7.75	15	10.56	10	7.04	36	25.35
	Group 2	Public Agency	17	11.97	36	25.35	53	37.32	106	74.65

Discussion

Identity Visibility

A food safety commons accommodates dispersed information sources, and an intelligence cohort creates an additive task structure to organize that information. While traceability is the key to self-organization and collaborative performance improvement, the saliency of identities is mutually determined by technical and social information processing. It is not simply a grassroots movement lacking a strategic focus, nor solely a deliberate strategic plan subject to the "pitfalls of strategic planning" (Mintzberg, Rethinking strategic planning, Part I: Pitfalls and fallacies, 1994) . Rather, it represents a "deliberately emergent" or "process strategy" whereby a central agency manages the "process of strategy formation – concerning itself with the design of the structure, its staffing, procedures, and so on – while leaving the actual content to others" (Mintzberg, 1987, p. 71) . Therefore, a food safety commons is a practical policy tool for managing delegation and decentralized control in crisis situations.

A food safety commons involves heterogeneous stakeholders with different knowledge, competence, and motivation. As Flint and Van Fleet (2011, p. 113) point out, "governmental efforts to provide incubating environments for businesses might be influenced by how the targeted companies' managers and/or entrepreneurial owners select a competitive cohort. Performance outcomes in such a situation might be significantly affected by the competitive cohort effect regardless of the characteristics of the incubating environment provided to firms". Essentially, an intelligence cohort can be viewed as a simulator for "crafting strategy" (Mintzberg, 1987) , i.e., bridging two seemingly opposite decision-making processes (deliberate and grassroots), facilitating organizational learning (technical and social) so as to reduce complexity in task environments and identify feasible strategies.

While facilitating knowledge and resource sharing, multiplying identities derived from frequent symbolic interactions would cause sensory overload, exhaust cognitive resources, and result in counterproductive outcomes. Engulfed by waves of information cues, individuals would instead look for sources of visible and trustful information to create a focus of attention and maintain a feeling of locus of control. In this regard, the saliency of identities becomes a key to effectuate behavioral influences. An additively structured task environment improves communicative efficiency and promotes social exchange.

Identity Verification

Organizing interactions on the virtual network of hazard communication could be challenging. Economic analysis on social exchange indicates that communicative behaviors are incentivized by two structural factors, the validity of information cues to the receivers (covariance between preferences and signals) and the reliability of information cues (variance of signals). On the one hand, the dark side of diversity is that incongruent incentives intertwined with an ambiguous task environment would weaken market signals' coordinating power. On the other hand, such a pessimistic outlook would not be necessary. Market stability is attainable if diverse stakeholders voluntarily affiliate with a common social structure seeking distinctive and tight-knit groups and leaders (Belavadi & Hogg, 2019) . Prototypes, i.e., a cognitively-represented group formation (of in-groups and out-groups), as a result, become salient through social categorization processes, based on two kinds of human psychological needs - self-enhancement (corresponding to the covariance between preferences and signals; category fit) and uncertainty reduction (corresponding to the variance of signals; category accessibility). Interestingly, the two fundamental motives would create network effects in the processes of social categorization. Thus, the forming of prototypes itself is a self-reinforcing cycle to develop a focus of public attention "The more salient the group, the more profound is the effect" (Hogg, 2001, p. 189).

In the intelligence cohort, in order to induce voluntary behavioral changes, a necessary strategy is "to quickly identify a set of referent others having influence upon strategic decision makers" (Flint & Van Fleet, 2011, p. 104). Salient entities are the key enablers of a cohort's performance outcomes, as they form the foundation of a meaningful frame of reference for guiding desired behaviors. The notion conceptually corresponds to prominence (McCall & Simmons, 1978) or salience (Stryker, 1980). McCall & Simmons (1978, p. 65) define role identity as "the character and the role that an individual devises for himself as an occupant of a particular social position." When multiple role identities are involved in a social organization, different roles are organized in a hierarchy of prominence. The prominence of a role identity is determined by how others support an identity, commits to an identity, and receives extrinsic and intrinsic rewards from an identity (McCall & Simmons, 1978; Stets & Burke, 2003) . Stryker (1980) emphasizes a somewhat more dynamic perspective and argues that a salience hierarchy, rather than a prominence hierarchy hypothesized by McCall and Simmons, in which a salient identity is one that is likely to be activated more frequently across different situations. Stets and Burke (2003, p. 12) argue that

McCall and Simmons address “what an individual values” (the cognitive aspect) while Stryker emphasizes “how an individual will likely behave in a situation” (the behavioral aspect). It is a self-affirming mechanism of “identity verification” (Burke & Stets, 1999) that bridges the cognitive and behavioral aspects and constructs the integrity of multiple identities enacted by an individual. In Burke and Stets’ (1999, p. 347), identity verification is the key linkage in a self-verification-commitment process that “leads directly and indirectly, through positive emotions and trust, to the development of committed relationships, positive emotional attachments, and a group orientation; all of these characteristics of a stable social structure” (i.e., a rational economic order). The concept of intelligence cohort concurs with the sociological view on the effects of identity verification on emotional arousal as a powerful driver in heuristic decision making. It recognizes the important role of emotions to induce social influence and initiate behavioral changes (Flint & Van Fleet, 2011, p. 100).

System Safeguard

In collaborative partnerships, markets and hierarchies are organized in a plural governance structure, the hybrid, which flexibly accommodates the co-existence of disparate social forces. A viable hybrid governance structure is critically determined by the deployment of safeguards, i.e., organizational design, to mitigate system disturbances, which suggests the function of an intelligence cohort (Williamson, 1998). In general, three leading styles of safeguards mediate exchange interfaces for hybrid transactions (Williamson, 2008, p. 10).

1) Power: A power safeguard focuses on the exercise of centralized control. Muscular stakeholders either vertically integrate operations to gain full control or pass their costs and responsibility to less powerful stakeholders, who are forced to provide safeguards and to absorb potential risks. In this approach, investments in specific assets for system safeguards are made in a myopic and inefficient fashion. Thus, transactions are not conducted under informed and prudent decisions. Often, decisions are driven by short-term orientation and interests of the muscular stakeholders. This approach invites the escalation of strategic behaviors and zero-sum games in a world of asymmetric information and knowledge.

2) Naive trust: The benign safeguard assumes cooperation between stakeholders to deal with unforeseen contingencies and their willingness to promote long-term relationships and to pursue mutual gains. In contrast to the muscular approach, trust replaces power as the central concept. While this approach has the potential to be both effective and efficient, the blind

faith would turn out to be wishful thinking when stakeholders do not share a common vision and internalize a collective value. Especially in a world of diversity and conflict interests, additional organizational design instruments are often required to maintain cooperation. As Williamson (2008, p. 10) points out, reputation effects deter defections, but safeguards are still needed.

3) Credible commitments: In Williamson's view, credible commitments are the ideal design of system safeguards to effect hazard mitigation. "[O]ut of awareness that all complex contracts are incomplete and thus pose cooperative adaptation needs, the parties exercise feasible foresight" (Williamson, 2008, p. 10). Credible commitments can take flexible forms. Different contracting practices can be interpreted piecemeal as partial efforts to reduce the escalation of conflict. The cost effectiveness of different ways of credible commitment varies with the attributes of transactions (i.e., asset specificity, uncertainty, and frequency). "Whatever the form, credible commitment serves as governance supports and should be introduced in cost-effective degree" (Williamson, 2008, p. 11) . However, economic considerations of safeguards at the same time raise a concern on "excesses of calculativeness" (Williamson, 2008, p. 13) , which, when perceived negatively, would decrease the credibility of a safeguard and increase transaction costs instead.

Dynamic transactions move from market to hierarchy, attended by a loss of incentive intensity, and added bureaucratic costs. Hybrid governance has the potential to break this tradeoff. However, coordinating among heterogeneous stakeholders requires a convergence of expectations. Stakeholders need to share a sense of collective responsibility and mutual dependency. A consensus is not reachable without congruent information, communication, and expectations. In highly complex situations, taking the hostage approach as Williamson prescribes (1983) would be prohibitive, and a hybrid governance structure would break down, resulting in a no-win situation (c.f. Follett's notions of community and responsibility; (Follett, 2012)).

Involvement

Push-based strategies are often perceived as cold, hard, unpleasant measures without care or sentiment. In fact, a push-based strategy also involves feelings. Simon (1987, p. 62) recognized that the role of emotion in making decisions may not always be negative. Although resorting to negative feelings such as fear, guilt, or aggression is sometimes seductive for its seeming efficiency and effectiveness, the impact is only short-term and subject to diminishing marginal returns. Moreover, unintended consequences are always a concern.

One missing notion of the push-based strategy is the possibility of organizational members' active participation in the alignment between individual goals and the collective goal, which may not always be conflicted. Celsi and Olson (1988) argue that organizational members' perceived personal relevance is the essential characteristic of voluntary behaviors for such active participation. "We suggest that a concept is personally relevant to the extent that [organizational members] perceive it to be self-related or in some way instrumental in achieving their personal goals and values" (Celsi & Olson, 1988, p. 211) . The attitude of personal relevance to goal attainment is reflected in the behavior of felt involvement. Felt involvement, defined as a member's overall feeling of personal relevance (Celsi & Olson, 1988), is the central concept to explain the processes by which organizational members focus and make sense of their environment (Olson, 1978). In this pull-based strategy, members of an organization are "getting involved" when they pay attention to certain attributes of the organization and internalize the collective value indicated by those attributes. Both technical and social traceability are critical to reveal behavioral intentions. When individuals are self-identified to certain identities, individual goals and the collective goal are aligned. In this case, implementing a push-based strategy may be additional, generate waste, or, even worse, demotivate entrepreneurial and prosocial behaviors. Embracing diversity and organizing social influence can be a creative strategy to leverage collaboration for innovative performance outcomes. Through communicative actions, rationally motivated collaborative partners would voluntarily contribute to the fulfillment of the collective value, as argued: "not all individuals have only purely selfish personal goals" (Albanese & Van Fleet, 1985b, p. 127).

Conclusion

An intelligence cohort has been shown to be a useful approach to managing information and communication technologies in the context of food safety. It opens information avenues to leverage connective and interactive social and technical networks for a prosocial approach to food safety management. Social media offers new opportunities to implement a strategy that organizes and mobilizes consumers and suppliers to achieve high levels of food safety.

Centralized public operations alone are not the best solution. Nevertheless, before stakeholders are motivated and technical traceability is sufficiently supplied, a leading role of the public agency is still necessary to safeguard the system. Centralized operations controlled by the public agency would be more effective in a less visible task environment. Both technical traceability and social traceability are feasible strategies, but performance improvement can be attained by integrating high social traceability and high technical traceability. Public agencies should perform only a supporting role to promote social and technical traceability in the system, and their authority should be limited.

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