Heard It through the Grapevine:

Traceability, Intelligence Cohort, and Collaborative Hazard Intelligence

by

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ABSTRACT

Designing a hazard intelligence platform enables public agencies to organize diversity and manage complexity in collaborative partnerships. To maintain the integrity of the platform while preserving the prosocial ethos, understanding the dynamics of "non-regulatory supplements" to central governance is crucial. In conceptualization, social responsiveness is shaped by communicative actions, in which coordination is attained through negotiated agreements by way of the evaluation of validity claims. The dynamic processes involve information processing and knowledge sharing. The access and the use of collaborative intelligence can be examined by notions of traceability and intelligence cohort. Empirical evidence indicates that social traceability is statistical significant and positively associated with the improvement of collaborative performance. Moreover, social traceability positively contributes to the efficacy of technical traceability, but not vice versa. Furthermore, technical traceability significantly contributes to both moderate and high performance improvement; while social traceability is only significant for moderate performance improvement. Therefore, the social effect is limited and contingent. The results further suggest strategic considerations. Social significance: social traceability is the fundamental consideration to high cohort performance. Cocktail therapy: high cohort performance involves an integrative strategy with high social traceability and high technical traceability. Servant leadership: public agencies should exercise limited authority and perform a supporting role in the provision of appropriate technical traceability, while actively promoting social traceability in the system.

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Chapter 1
Introduction

1. Background

Food safety is among the top priorities in the public policy agenda of the United States. Since the enactment of the Pure Food and Drug Act and the Federal Meat Inspection Act in 1906, public agencies have spent considerable effort redefining leadership roles and revising food safety strategies so as to cope with changing market conditions and shifting policy objectives. For example, in 1940, the Food and Drug Administration (FDA) was split from the U.S. Department of Agriculture (USDA) and moved to the Federal Security Agency, which was later reorganized as the Department of Health and Human Services. In 1957, the Poultry Products Inspection Act authorized mandatory poultry inspections, after explosive growth in consumer demand for poultry products. In 1958, the Federal Food, Drug, and Cosmetic Act of 1938 was amended with the Food Additive Amendment to address public concerns over invisible hazards from chemicals. In 1981, the Food Safety and Quality Service, responsible for the grading and inspections of meat and poultry products, was reorganized as the Food Safety and Inspection Service (FSIS). In 1993, an outbreak of E. Coli O157:H7 signaled a compromised food safety system. In 1996, as a response to this new type of emerging threat from microbial pathogens, the FSIS rule of Pathogen Reduction and Hazard Analysis and Critical Control Point (HACCP) Systems was finalized. In 2000, HACCP was mandatory and implemented in all FSIS- and state-inspected meat and poultry processing plants.

In spite of the level of public investment, approximately 2 billion U.S. dollars annually in food-inspection related operations, food safety remains a major concern. Recent studies estimate that contaminated food consumed in the U.S. caused 47.8 million illnesses, 134,839 hospitalizations, and 3,037 deaths (Scallan, Hoekstra, Angulo, Tauxe, Widdowson, Roy, Jones and Griffin, 2011; Scallan, Griffin, Angulo, Tauxe, and Hoekstra, 2011), and economic losses of at least $14 billion annually (Batz, Hoffmann, and Glenn Morris, 2011). The high impact on the economy and social welfare indicates the urgency of the food safety problem and the need for more effective food safety management.

Table 1. Budget Summary of Federal Food Inspections (Dollars in Millions)

	2011 Enacted	2012 Estimate	2013 Budget
FSIS	1,018	1,014	1,006
FDA	1,175	1,145	1,151
Total	2,193	2,159	2,157

Source: USDA FY 2013 Budget Summary and Annual Performance Plan; 2013 FDA Budget Summary

In 2009, the President's Food Safety Working Group (FSWG) advocated a new, public-health focused approach to upgrade the U.S. food safety system. FDA and FSIS, the two leading federal agencies of food safety management, take actions on respective initiatives: the FDA Food Safety Modernization Act (FSMA) and the FSIS HACCP-Based Inspection Models Project (HIMP). While the FSMA receives a general public welcome and support, the implementation of the HIMP has encountered unexpected obstacles. The HIMP had an early jumpstart in 1999 when the FSIS first introduced the HIMP pilot program in 20 selected poultry plants, with a schedule to expand the program to approximately 200 facilities nationwide by the end of 2012. The new inspection system intends to create a win-win strategy through a public-private partnership. By replacing judgment inspections (conducted by federal inspectors) with self-inspections (operated by line workers), the FSIS delegates the authority of sensory inspections on the processing lines to poultry plants and requests them to take more responsibility on the quality assurance of their own products. The FSIS estimates that it will save $85 million over three years by retiring around 1,000 federal inspectors. Poultry companies estimate that it will save $250 million a year, as the new inspection method increases throughput rates and improves operational efficiency.

However, the plan to expand HIMP has drawn intense opposition. For example, the Food Integrity Campaign of the Government Accountability Project, a non-profit interest group, called the HIMP "a disaster waiting to happen" (Food Integrity Campaign [FIC], 2012a) and the expansion of the HIMP "an immediate threat to food safety" (FIC, 2012a). In the traditional non-HIMP setting, each processing line, equipped with three federal inspectors along the line, is operated at a throughput rate up to 140 birds per minute (bpm). On the contrary, in the HIMP setting, a processing line is run at a rate up to 175 bpm with one federal inspector positioned at the end of the line. Some federal inspectors argued that short-staffed, discouraged inspectors simply are incapable of handling the expanding span of operation. "[I]t's easy for an inspector to spot quality control problems like fecal contamination, bruising and feathers. But not at 160+ birds per minute, especially when half the birds is not in line-of-sight? Blink and you've missed half a dozen birds" (Jolly, 2012, para. 10). A retired veteran inspector commented, "I'm afraid that the birds covered in bile, feces, and pus will become chicken nuggets and be served to young children" (Underwood, 2012, para. 2). Moreover, some line workers said that they are powerless to stop the line when they spot defects because their efficiency-minded supervisors are not willing to slow down operations. Another complained the faster line speed increases the risk of occupational hazards such as fatigue and injuries, because jobs at the processing line are highly repetitive and labor-intensive in nature. Furthermore, line workers may not have sufficient skills to perform adequate self-inspections. Turnover rates of the low-paid, processing-line jobs are high. A line worker said that "some would come into the plant and work one hour, and resign … Every week they had to hire new workers" (Jamieson, 2012, para. 3). But, "visually inspecting the chickens as they literally 'fly-by' at rapid speed" (Ferguson, 2012, para. 3) requires learning and experience, which are hampered by high labor turnover.

Whereas there are criticisms, the HIMP is well-intentioned and a key move to revamp the U.S. food safety system for the 21st century. As an industry practitioner points out, "the days of 'poke-and-sniff' inspection are thankfully long gone and those on-line inspectors are the last vestige of that practice. You can't see or smell Campylobacter or Salmonella. Visual inspection for pathogen detection is a pointless pursuit" (Jolley, 2012, para. 9). "The proposed inspection system will better protect the public from food-borne illnesses by reducing reliance on old-fashioned visual and sensory inspection and moving to prevention-oriented inspection systems based on actual risk to consumers" (Peterson, 2012). In defense of the HIMP, an administrator of the FSIS argues: "the data is clear that in these plants [HIMP-adopted], the poultry produced has lower rates of Salmonella, a pathogen that sickens more than 1 million people in the U.S. every year. These plants also maintain superior performance on removing the visual and quality defects that don't make people sick. Those are the facts, based on the data" (Jolley, 2012, para. 15). The industry seconds the view: "our members believe a statistically valid, scientifically-based approach to poultry processing will improve food safety and better protect public health" (National Chicken Council [NCC], 2012, para. 1).

The situation becomes even more complicated when an issue of trust is involved in public relations. "The companies cannot be trusted to watch themselves", a federal inspector said (Avila, 2012, para. 5), for that "productivity is their main responsibility, rather than ensuring food safety" (FIC, 2012b). Although self- inspection is only one part of an integral system which includes multiple measures such as testing and protocols, "it seems that many in the chicken industry know how to cheat the system by rigging the tests", a reporter said (Ferguson, 2012, para. 5). Some even regard the delegation as "letting the fox guard the henhouse" (Jolley, 2012, para. 25). On May, 2012, after an extended public comment, the controversy continues. The National Chicken Council and the National Turkey Federation, the representatives of the industry, while strongly supporting the HIMP for "it takes the handcuffs off production and saves the poultry industry millions annually" (Jolley, 2012, para. 16), express their concerns on public relations: "The folks who are against the idea will suggest that faster line speeds will create more food safety problems and will be the first to scream ‘I told you so’ when the first recall happens. It won’t matter that line speed might not be the cause” (Jolley, 2012, para. 17). In an increasingly complex food system, it is extremely difficult to rule out all possible sources of hazards with a single function of ex ante control. Thus, it is fairly to argue that “perfection is impossible” and to view “outbreak response as an integral part of the prevention system” (Taylor, 2011). Nevertheless, when preventive control fails in a food safety environment lacking a consensus and trust, “the fallout created by the inevitable recall if the plan is perceived as being pushed through without due diligence would be devastating to the poultry industry” (Jolley, 2012, para. 24).

2. Complexity

The new policy initiatives shift the direction of food safety management from reaction to prevention. The main reason for this radical change is that an increasingly complex food system renders ineffective the traditional approach of food safety management. The U.S. food system is characterized by its complexity. Complexity, a phenomenon associated with inter-correlated activities “in which a great many independent agents are interacting with each other in a great many ways” (Waldrop, 1992, p11), suggests that our food system is formed and shaped by the simultaneous interplay of multiple consumers and suppliers with heterogeneous preferences. With the scale of consumption -- more than 1 billion meals are consumed every day; with varieties of food choices – hundred thousands of food products are available and new products are introduced frequently; with specialization in food supply – from farm to table a number of suppliers may be involved in the integration and transformation of multiple food ingredients; and with reliance on global sourcing – food imports in 2011 comprise approximately 15% of the total U.S. food supply, 75% of seafood, 50% of fresh fruit, and 20% of vegetables, it is unlikely to accurately predict how this system would change, because means-end relationships under interactions and interdependencies are often unknown or at least not clear. Under this environment, effective management to secure consumption experiences free of food safety concerns is a daunting challenge, as a food hazard may occur unexpectedly at any point in the complex food system and pose a threat to the public health.

The traditional command and control approach of food safety inspection was introduced in the early twentieth century, when the food system was less complex. The design of the operations followed a closed-system logic that ex ante optimization would turn food hazards into an insignificant random factor which could be properly handled by a reactive strategy. Taylor (1997: p15-16) offers a glimpse of this control orientation in food safety inspections.

"In the USDA system, inspections carry out continuous inspections of meat and poultry plants by physically examining every carcass passing through slaughter houses and making daily inspections of plants that process products ranging from fresh, cut-up chicken parts to pepperoni pizza and chicken noodle soup. USDA employs nearly 7,500 full-time inspectors who continuously inspect more than 6,000 plants. In 1994, inspectors individually examined approximately 130 million head of livestock, and 7.5 billion

chickens, turkeys, and other poultry. Carcasses and processed products cannot be shipped into commerce without the USDA mark of inspection."

Under conditions of complexity, exercising command and control is a different case. It raises a concern of "the folly of Type II errors", a threat to the effectiveness of a public program (Landau and Stout, 1979). In statistics, a Type II error refer to a false negative, i.e., a false null hypothesis is not rejected by the statistical testing method employed. In the context of food safety management, a Type II error occurs when a food safety inspection program fails to detect food hazards and allows them to pass through the food system without being captured, indicating the deficiency of the control technology employed by the program. Landau and Stout (1979) argue that the efficacy of any control technology is subject to the level of knowledge available to the control system. Because the "administrative man" under uncertainty is characterized by bounded rationality, i.e., cognitive limits on rational decision making for problem solving (March and Simon, 1958), knowledge acquisition is necessary for effective control. However, learning in the complex and dynamic task environment is contingent upon circumstantial knowledge. This situational learning requirement contradicts the nature of public operations, which are best suited for routine and standardized processes. If the task environment is not stable enough and requires frequent learning, given bounded rationality, routine decision making, standard procedures, and environmental complexity, a public preventive control program would face a disadvantageous situation and suffer from unintended consequences due to Type II errors.

The current policy initiatives address this concern by “de-complexifying” the food system with rules and standards. If the task environment is more stable and predictable, the burden of constant situational learning would be relieved, so that the command and control program could stay effective. Following this rationale, The Hazard Analysis Critical Control Point (HACCP) and other science-based measures serve as key policy tools for implementing preventive control, which is the dominant logic (Prahalad and Bettis, 1986) of the new food safety management system. A stabilized food system would facilitate proactive food safety inspection in two ways. First, it relieves workload, because some food hazards are removed at sources. Second, it enables quicker response, because food hazards would be detected earlier in a less ambiguous environment. In addition, when the preventive control fails, the system would have more sufficient resources and response time for the effective containment of food hazards.

Whatever the benefits, challenges remain. Across the farm-to-table spectrum of the food system, many critical points are in fact located beyond the reach of the command-and-control of the food safety agencies or science-based analytical measures. For example, before an imported product enters the U.S. food safety inspection system, it may be produced under different jurisdiction and food safety standards. During product transformation, food ingredients may be mixed and blended and lose their identities for food safety traceability. After a product is sold to consumers, suppliers may not have power and incentives to further guarantee food safety, but food hazards may still arise from consumers’ improper handling or consumption practices. Moreover, the food system constantly evolves, as differentiated products and services with new features are entering the market, and as new pathogens and hazards are emerging. Furthermore, a food hazard is a “bad”. In a sense, it is a pathological phenomenon of a diseased food system, a by-product from human errors or system failures. Because it is not a regular, and generally, not even an intentional output, it is regarded as a “surprise” to the system, something characterized by its random nature and not fully known to the centralized command of the food safety agencies.

3. Collaborative Partnerships

If imperfect knowledge is an inherent characteristic of the complex food system and if situational learning is a constant requirement for effective food safety management, preventive control, to a greater or lesser degree, is always subject to Type II errors. Prahalad’s argument is poignant: “the dominant logic …, like blinders on a horse, allows organizations to perform well at their current task in the short term. The logic keeps us focused on the road ahead, but also limits our peripheral vision” (Prahalad, 2004, p178). The good intention to create an operational focus instead bring forth “the pretense of knowledge” (Hayek, 1989), the “tragic irony” described by Landau and Stout (1979) from “an attempt to control a problem that should be managed” (p153): “time after time, control systems, imposed in the name of error prevention, result only in the elimination of search procedures, the curtailment of the freedom to analyze, and a general inability to detect and correct error” (p155). Therefore, the policy goal of preventive control should be further reinforced by some added capabilities beyond the traditional command and control approach that relies on a sole central authority to enforce food safety.

The FSWG proposes a grand vision to modernize food safety “by building collaborative partnerships with consumers, industry and our regulatory partners” (FSWG, “Our Commitment”). A collaborative partnership is defined as “an alliance among people and organizations from multiple sectors … working together to achieve a common purpose” (Rouses and Fawcett, 2000, p369). In the field of public health, it is regarded as an increasingly popular strategy (Rouses and Fawcett, 2000) and viable approach to develop knowledge and initiate action (Israel, Shultz, Parker, and Becker, 1998). While current public strategies focus on strengthening command and control “by fostering coordination throughout the government including enhancing our food safety laws for the 21st century” (FSWG, “Our Charge”), the broader definition of collaboration points out an alternative path to reduce Type II errors by promoting prosocial behavior among collaborative partners including all stakeholders in the food system.

Prosocial behavior refers to “voluntary, intentional behavior that results in benefits for another (Eisenberg and Miller, 1987, p92), such as helping, sharing, donating, cooperating, and volunteering (Brief and Motowidlo, 1986). In the complex food system, if each individual acts as a social entrepreneur, by performing food safety inspection in his or her local niche, sharing circumstantial knowledge, passing hazard intelligence, and even coordinating with one another to remove hazardous materials, prosocial behaviors become constructive engagements that transform the complex food system into an “organized complexity” (Hayek ,1989). Research shows that improvised, emergent prosocial behaviors indeed complement and contribute to public operations to cope with contingencies in a natural disaster (Rodriguez, Trainor, and Quarantelli, 2006).

However, collaborative partnerships for food safety inspection require more than prosociality. Food safety inspection deals with contingencies. When a food hazard occurs unexpectedly, time would not be not gracefully given for orderly acquisition of sufficient knowledge. Problem-solving is oftentimes processes of “muddling through” out of compromised decision-making and learning-by-doing processes. Moreover, food safety involves hard science. Detecting certain kinds of food hazards, especially biological and chemical ones, would require special technologies or professional skills not equipped by or available for everyone in the food system. Furthermore, food safety inspection requires high reliability. Any failures would result in serious losses to individuals and society. Casual voluntarism, which is often driven by feelings and heuristics, needs to be assured in order to guarantee satisfactory performance outcomes. In this regard, system governance still requires certain centralized control to secure the bottom line of food quality.

Paradoxically, centralized control would inevitably suppress prosocial qualities, such as empathy (Eisenberg and Miller, 1987), emotional expressiveness (Roberts and Strayer, 1996), and autonomous motivation (Weinstein and Ryau, 2010), which are critical to prosocial ethos that carries the keys to define meaningful problems, devise creative solutions, and drive innovative outcomes. As an alternative thinking, centralized control is not the only feasible approach to achieve system governance. Promoting and deploying prosocial activities, if properly designed and managed, could be a case of “mutual coercion mutually agreed upon” (Hardin, 1968), coordinating activities and exercising decentralized control. Resulting private ordering also provides a foundation for implementing more efficient public policies. In the social era, “there’s no way we could ever be this collaborative” (Merchant, 2013). When command and control regulation is increasingly unpopular, understanding the dynamics of non-regulatory supplements to central governance becomes crucial.

4. Research Question

Food safety management in the 21st century needs creative strategies for combating challenges in the complex food system. This dissertation echoes the call for a new, public-health focus of food safety management and contributes to the implementation of the envisioned collaborative partnerships (FSWG) with two objectives. First, it proposes a hazard intelligence platform that utilizes open source intelligence (OSINT), organizes diverse collaborative partners, and coordinates prosocial activities. Second, it tests the hazard intelligence platform that empowers multiple collaborative partners, including consumers, suppliers, producers, laboratories, public agencies, etc., to perform various kinds of inspections so as to safeguard the food system.

Operating the hazard intelligence platform involves plural governance. In addition to formal hazard communications, “non-regulatory supplements” represent hazard information and intelligence resulting from social sharing. Such informal social communication (Festinger, 1950) would not be controlled and understood by the public agency. Thus, a platform is a necessary policy instrument to reveal and visualize the landscape of prosocial activities in the food system. The supplementary inputs are collected and stored in the conceptualized “intelligence platform” and serve as linkages among collaborative partners, leading to the formation of fluid and flexible “intelligence cohorts”. In turn, the social inputs provide a form of social traceability that, when coupled with technical traceability, contributes to stronger identification of food hazards and higher visibility in the food system.

To examine the potential of the hazard intelligence platform along with notions of traceability and intelligence cohorts raises the research question on the relationships between different sources of hazard intelligence and system performance. Specifically, three questions are of interest:

1. How should public agencies engage collaborative partners for high-performance innovation?
2. Do social inputs significantly contribute to collaborative performance?
3. How do social inputs contribute to collaborative performance?

The theory of communicative action (Habermas, 1984) and transaction cost economics (Williamson, 1985) are adopted as the theoretical framework to address the self-organization of prosocial behaviors and plural governance (technical and social) on fundamental activities behind the notion of food safety inspection such as engagement, interaction, and exchange so as to develop models, propositions, and hypotheses. Empirical studies are conducted in the context of food recall. Food recall deals with response and recovery when formal food safety control systems fail. The reverse logistics activity provides an ideal focus to examine the performance of the prosocial aspect of collaborative partnerships. Data are collected from the open-source Recall Case Archive of the Food Safety and Inspection Service, USDA. The grounded theory approach, a creative research strategy developed in anthropology and sociology for studying complex phenomena, provides guidelines for data processing. The categorical data analysis, specifically, multinomial regression and nested logit regression, is applied to obtain empirical results.

The dissertation is structured as follows (Table 2). Chapter 1 provides the rationale and raises research questions. Chapter 2 explains the context of empirical studies, including a brief introduction to food recall, methods, and data. Chapter 3 discusses the conceptual background with 5 topics. Chapter 4 introduces the mental model and a brief economic analysis. The two chapters represent a normative approach to address the first research question. Chapter 5 defines two kinds of traceability, and answers the second research question regarding the significance of the social approach. Chapter 6 applies the notion of intelligence cohorts and corresponds to the third research question regarding the integration of the technical and social approaches. Chapter 7 summarizes the preceding chapters and concludes with future research agenda.

Table 2. Structure of the dissertation

Research Question	Research Topic	Hazard Communication	Explanation	Empirical Study
	Chapter 1 Introduction	Complexity	In complexity, centralized command and control would suffer from Type II errors. Effective preventive control needs "non-regulatory supplements".	**Chapter 2** Context; Data; Method - Food recall - Grounded theory approach - FSIS Recall case archive - Categorical data analysis
How should the public agency engage collaborative partners for high-performance innovation?	**Chapter 3** Intelligence Platform **Chapter 4** Constructive Engagement	Collaborative Partnerships	An alliance among people and organizations from multiple sectors … working together to achieve a common purpose.	
		Communicative Actions	The interaction of at least two subjects capable of speech and action who establish interpersonal relations, in order to coordinate their actions by way of agreement.	
		Negotiated Agreement	A shared interpretation that multiple actors negotiate definitions of a complex situation which would consequently admit of consensus.	
How do social inputs contribute to collaborative performance?	**Chapter 6** Intelligence Cohort	Validity Evaluation	An actor proposes a claim, open for objective appraisal in order to invite other actors to take a "rationally motivated position", which depends on how its validity claims are evaluated against the conditions of its validity.	Transaction cost economics Plural governance structure as system safeguard (built-in checks and balances)
Do social inputs significantly contribute to collaborative performance?	**Chapter 5** Traceability	Validity Claims Action Situation (Technical) Plans of Actions (Social)	Validity claims are rational expressions, which have "the character of meaningful actions, intelligent in their context, through which the action relates to something in the objective world". Knowledge is embodied in symbolic expression; rationality is extracted through argumentation, "continuing communicative action with reflective means".	Transaction cost economics - Uncertainty: Insufficient traceability - Asset specificity: Technical traceability (High = competent) - Frequency: Social traceability (High = prosocial)
	Chapter 7 Conclusion	1. Social traceability is significant. 2. Prosocial behavior in general improves collaborative performance. 3. The most efficacious strategy is integrating both high level of social traceability and high level of technical traceability in a nested structure that safeguarding self-organization with technical capabilities.		

Chapter 2

Empirical Context

1. Food Recall

Definition

Food recalls in the meat and poultry industry occur when contaminated products are deemed hazardous to public health and retrieved from markets and distribution channels. Recalls, by definition, are distinct from other actions of consumer protection taken by food suppliers (See Table 1). In contrast to market withdrawal, recalls deal with food hazards which would expose consumers to vulnerable situations. In contrast to stock recovery, recalls go beyond the boundaries of a single food supplier and hence involve joint operations across a "technologically separable interface" (Williamson, 1981, p552). Because of its public nature, oftentimes a recall of a meat or poultry product is assisted by the FSIS to coordinate voluntary actions taken from multiple parties and to safeguard public interests.

Since the public agency does not exercise absolute authority and only provides necessary coordination and assistance, a food recall is by nature a collaborative action. Multiple stakeholders in the food safety community – consumers, buyers, distributors, suppliers, third-party service providers, and public agencies – all share the responsibility of an effective recall to assure a food market safe and clean.

Table 1. Comparison between voluntary firm actions of product removal

Activity	Definition
Food recall	A firm's voluntary removal of distributed meat or poultry product from commerce when there is reason to believe that such products are adulterated or misbranded under the provisions of the Federal Meat Inspection Act or the Poultry Products Inspection Act.
Market withdrawal	A firm's voluntary removal or correction of a distributed product that involves a minor company quality program or regulatory program infraction that would not cause the product to be adulterated or misbranded.
Stock recovery	A firm's voluntary removal or correction of product that has not been marketed or that has not left the direct control of the firm; in other words, no portion of the lot has been released for sale or use.

* Source of reference: FSIS Directive 8080.1 Revision 6

Public Task Force

To adapt FSIS' functional organizational structure to collaborative task requirements, a cross functional teamwork is set up as the recall committee, "a committee of representatives from various FSIS offices and staffs assembled to respond to potential or real health hazard incidents reported to the Recall Management Staff (RMS)" (FSIS Directive 8080.1, rev7, p6). The recall committee consists of representatives from multiple departments and groups, for example, Health Hazard Evaluation Board (HHEB), Office of Policy and Program Development (OPPD), Office of Public Health Science (OPHS), Congressional and Public Affairs Office (CPAO), Office of Public Affairs and Consumer Education (OPACE), Office of International Affairs (OIA), Office of Program

Evaluation, Enforcement, and Review (OPEER), Office of Food Defense and Emergency Response (OFDER), etc. At the core of the public recall operations are two key positions, Recall Management Staff (RMS) and District Recall Officer (DRO), that serve as coordinators, in Likert's term "linking pins" (Likert and Likert, 1976, p184), maintaining the structure of an interaction-influence network which connects diverse and dispersed resources in the food system. As for communications with stakeholders, representatives from the CPAO are responsible for media relations. Members from the OPACE manage general public relations and consumer competence in food safety knowledge.

Public Operations

A recall case starts from an identification of a food hazard. If a food hazard does not exist, there is no need for any public intervention which will disturb the spontaneous order of the market. When a food hazard occurs, a system-wise awareness of the problem is necessary to create a sense of urgency in the food safety community so as to activate the food system's self-correcting mechanism. While creating such awareness involves collective actions and organizational learning, essentially, it is initiated by individual learning and organization-wide knowledge sharing. "All learning takes place inside individual human heads; an organization learns in only two ways: (a) by the learning of its members or (b) by ingesting new members who have knowledge the organization didn't previously have" (Simon, 1991, p125). Indeed, food hazards can be detected and hazard intelligence can be generated by different members of a food system (Table 2) – in general, consumers, suppliers, and public agencies.

After a suspicious food hazard is detected in the system, a preliminary inquiry is conducted to determine whether it is a false alarm. Making a decision to initiate a recall case requires due diligence, because a recall will distort regular operations in the market and could result in high social and economic costs. In a normal FSIS preliminary inquiry, a District Recall Officer (DRO) is in charge of inspection to collect field intelligence – product, contact, and other relevant information. If a potential food hazard involves imported products, a representative of the Office of International Affairs (OIA) will be the liaison to collect additional information. All information is forwarded to the designated Recall Management Staff (RMS). Gathered information is translated into intelligence and transferred to the Recall Committee for further deliberations.

Table 2. Sources of hazard intelligence

	Scenario	Stakeholder
1	The company that manufactures or distributes the product	Firm
2	Consumer complaints reported through the FSIS Consumer Complaint Monitoring System (CCMS)	Consumer
3	Test results from FSIS sampling programs	Public agency
4	Observations or information gathered by FSIS inspection program personnel in routine duties or investigations	Public agency
5	Epidemiological or laboratory data submitted by State or local public health departments, other USDA agencies, and other Federal food safety agencies such as FDA, CDC.	Public agency
6	Other agencies such as Department of Defense, Department of Homeland Security, Customs and Border Protection, the Animal and Plant Health Inspection Service, and foreign inspection officials.	Public agency

* Reference: FSIS Directive 8080.1 rev6

Determining a recall case is a difficult decision which involves seemingly irreconcilable trade-offs under time pressure. When clear science-based evidence is not available, for example, inconclusive or inconsistent laboratory testing results, the Recall Committee needs to make a judgment call. In this case, two questions are debated (FSIS Directive 8080.1 rev7, p7):

1) Does FSIS have reason to believe that the product in question is adulterated or misbranded under the Federal Meat Inspection Act (FMIA) or the Poultry Products Inspection Act (PPIA)?

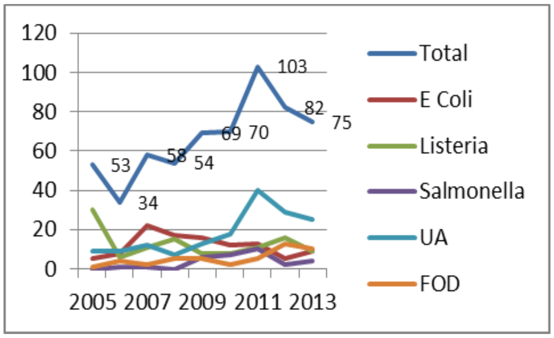
2) Does any of the product in question remain in commerce or available to consumers?

If the answers for both questions are “yes”, the Recall Committee issues a recall recommendation. However, loopholes exist. For example, regarding the second question, “the Committee determines that the product is so long out of date that it is unlikely to still be available to consumers, or the Committee is unable to identify a responsible party for the product. In these circumstances, the Committee should not recommend a recall” (FSIS Directive 8080.1 rev7, p8). Although the suspicious food hazard is not recognized as a threat serious enough to the society, it could still cause harms to consumers at the individual level. Because some biological food hazards are contagious, individual cases of infection could be escalated if food safety conditions are not secured. Therefore, system safeguard is required. Moreover, consumer vulnerability is a concern. Additional consumer education, organization, and communication are desired to build the last line of defense in the system.

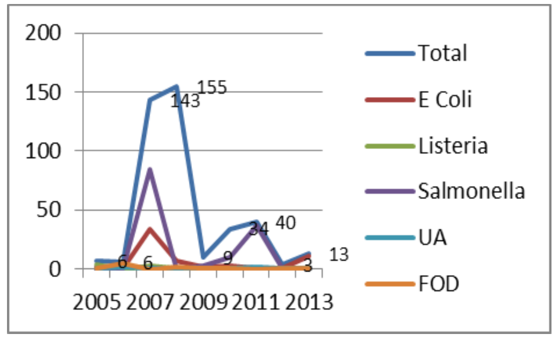
When the Recall Committee recommends a recall, a recall recommendation will be prepared by the Recall Management Staff (RMS). After the decision is approved by the Assistant Administrator (AA) of the Office of Field Operations (OFO), a written letter is sent to the recalling firm. The firm could follow the FSIS “Product Recall Guidelines for Firms” to recover products in commerce as soon as possible. The RMS also notifies CPAO to issue a Recall Release to the media, to contact other public health partners through the email subscription service, and to update information on the FSIS website.

The recalling firm is responsible for developing a recall strategy and implementing it, based on the recall recommendation, including communicating with relevant stakeholders and removing recalled products from commerce. While the Food Safety Modernization Act has endowed FDA with authority to issue a mandatory recall when a firm fails to take necessary actions to assure public health, currently recall of meat and poultry is on a voluntary basis. In other words, FSIS has no legal authority to mandate what a firm should do – the public agency only advises, and a recall is subject to a firm's implementation. Nevertheless, if a firm refuses to cooperate and take responsibility, FSIS can exercise its influence through "bully pulpit" -- providing information for consumers to boycott questionable products, withdrawing public inspectors to technically shut down a firm's operations, or, as the last resort, detaining defective products in commerce (FSIS Directive 8410.1 "Detention and Seizure"). Based on the Directive 8080.1 rev6, FSIS would conduct effective checks to verify the firm's actions, subject to risk-based criteria and "availability of Agency personnel" (p16), revision 7 clarifies this somewhat ambiguous definition and specifies FSIS' responsibilities in the verification the effectiveness of industry's recall operations (attachment 1 of the rev7).

Table 3 Plural patterns of food recall operations



Number of recalls



Number of pounds recalled

Note: (1) UA stands for undeclared allergen; FOD, foreign object debris.
(2) Quantity recalled measured in 1,000,000 pounds
(3) Source of data: Food Safety and Inspection Service, USDA.

Verifying recall effectiveness is a challenge to standardized public operations. Food recalls involve bifurcate operations with two separate processes of different and sometimes conflicting natures. First, food hazards are “admitted” into the system on a discrete, case by case basis. Second, food hazards are removed from the system on a continuous, volume basis. Table 3, for example, shows that the overall number of recall cases has generally increased over time, while the number of pounds recalled decreased. In the decision-making processes, a Recall Committee would make two types of mistakes. On the one hand, a Type I error, a false positive, fails to identify a food hazard as a real threat and exposes Public Health to the risk of food-borne illnesses. On the other hand, a Type II error, a false negative, fails to specify a food hazard and would cause tremendous economic losses to food suppliers and unnecessary disturbances to the society. From the standpoint of the public agency, protecting vulnerable consumers should always be the top priority. Nevertheless, scapegoating suppliers, although it can pacify public uneasiness in the short run, is not an ideal solution. After all, suppliers can be vulnerable too.

If the actions taken by the recalling firm meet FSIS requirements, RMS submits a recommendation of case closure to the AA OFO. If approved, RMS notifies the recalling firm. Subsequently, the FSIS web master moves recall case files to the Recall Case Archive on the FSIS website. Table 4 summaries the general procedures of a recall case.

Table 4 Two-stage processes of food recalls

Stage	Process	Activity
1	Hazard identification	1. Detecting food hazards 2. Conducting preliminary inquiry 3. Making recall recommendations
2	Hazard control	1. Initiating collaborative recall actions 1) Firm actions 2) Public notification and hazard communication 3) Effectiveness checks 2. Closing the case

2. Grounded Theory Approach

Definition

Grounded theory is a research approach first proposed by Glaser and Strauss (2009) as an alternative theory developing strategy based on data collection (cf., the orthodox approach, mentioned in Turner (1981), which focuses on the quantitative testing of hypotheses derived from theories specified a priori). Glaser and Strauss (2009) used the term "grounded" to describe the approach's emphasis on "the discovery of theory from data", suggesting a post-hoc, iterative, and structural characteristics of its analytical processes. In other words, grounded theory is a general methodology for developing theory that is grounded in data systematically gathered and analyzed (Strauss and Corbin, 1994).

The main advantages of grounded theory lie in its flexibility and pragmatism (Corbin and Strauss, 1990). As Turner (1981, p225) points out, it allows researchers to develop their own conceptual models pertinent to the substantive areas of their studies and to apply their "creative intelligence to the full" in solving real-world problems. Moreover, it is especially suitable for studying social phenomena of interactions and the underlying rationality, because the approach "tracking the cognitive problems of data analysis by bringing them out into the open" (Turner, 1981, p230). Martin and Turner (1986) argue the choice of research methods for studying work organizations must take into account the complexities – entities operating in divergent or conflicting ways, so as not to risk the research bias mentioned by Glaser and Strauss (2009, p1): "an overemphasis … on the verification of theory and a resultant 'de-emphasis' on the prior step of discovering what concepts and hypotheses are relevant for the area that one wishes to research". Considering the nature of agribusiness as an applied science and the food safety problem under study, it is believed that grounded theory is the ideal empirical approach not only to generate useful knowledge but also promising to discover practical solutions.

Procedures

While one important feature of grounded theory is its “fitness”, “faithful to the everyday realities of a substantive area” (Strauss and Corbin, 1994, p276), to achieve intended research objectives, “ to develop a well-integrated set of concepts that provide a thorough theoretical explanation of social phenomena under study” (Corbin and Strauss, 1990, p5), valid studies still need to follow specific procedures concerning “how to record data, how to label or classify data in ways which facilitate the rearrangement of the material to reveal new properties, and how to tackle this reshuffling process” (Turner, 1981, p229). Referring to the 9 stages discussed in Turner (1981, p231) and 11 canons listed in Corbin and Strauss (1990, p6), a framework of “3C” procedures was set up that fit the research context, with an emphasis on three key components, i.e., concept, category, and comparative. The 3C framework represents an iterative process of knowledge exploration on the research topic in order to identify key variables and define the research problem.

1) Concept discovery:

Concepts are the basic units of analysis (Corbin and Strauss, 1990). To conceptualize a complex phenomenon, Glaser and Strauss (2009, p35) argue that "multiple formal theories are also necessary, since one theory never handles all relevancies, and because by comparing many theories we can begin to arrive at more inclusive, parsimonious levels." Further, because actual raw data or direct, clear-cut measures are often not available in complex situations, coded data serve as indicators of the phenomena. Therefore, conceptual labels are assigned to give the relatively fluid qualitative data a workable structure. As the research strategies recommended by Corbin and Strauss

(1990), coded data are conceptualized into exploratory models with intentions to "build a theoretical explanation by specifying phenomena in terms of conditions that give rise to them, how they are expressed through action/interaction, the consequences that result from them, and variations of these qualifiers" (Corbin and Strauss, 1990, p9).

2) Category generation:

Categories are the cornerstones of the grounded theory approach (Corbin and Strauss, 1990, p7).

In a formal research process, qualitative data are first documented through observations of a phenomenon in interests. The collected data are then transformed into categories through data coding for further exploration on meaningful patterns.

3) Comparative analysis:

Glaser and Strauss (2009, p1) advised "a major strategy that we shall emphasize for furthering the discovery of grounded theory is a general method of comparative analysis". Turner (1981, p241) also mentioned a specific technique to "use extreme comparisons to the maximum to identify key variables and test emerging relationships". Corbin and Strauss (1990) argued that constant comparisons help researchers reduce bias, achieve precision and consistency, and find patterns or regularities in the data structure.

3. Categorical Data Analysis

Categorical data analysis is a statistical modeling technique for studying how independent variable(s) explain and predict a dependent variable which takes discrete values, for example, categorical (1, 2, 3) or binary (0, 1). To analyze a complex phenomenon and to explore the structure of a problem, one intuitive research strategy is to assume a linear relationship between independent variable(s) and the dependent variable and apply a class of generalized linear models (GLMs), for example, logistic regression model, probit regression model, log-linear models, multi-nominal logistic regression model, or discrete choice models, based on the nature of the variables. A GLM consists of three basic components.

1) Random component, which identifies the response variable (Y) by assuming a probability distribution for it.
2) Systematic component, which specifies a set of explanatory variable(s), denoted by X's.
3) Link function, which describes the relationship between the expected value of the response variable (Y) and the explanatory variable(s), X's.

Logistic regression models are a class of GLMs under specified model conditions. The dependent variable is binary and assumed to follow the binomial distribution. The link function, say $g[\pi(x)]$, is a logit function in the form $g[\pi(x)] = \log\{\pi(x) / [1-\pi(x)]\}$, where $\pi(x)$ denotes the probability of the "success" outcome in an event, an odds ratio, $\{\pi(x) / [1-\pi(x)]\}$, expresses the relationship between two specified states of the phenomenon in the probability form, $\pi(x)$ and $[1-\pi(x)]$, and the logit, $g[\pi(x)]$, logarithm of an odds ratio, measures how the relationship behaves.

The use of logit concerns two fundamental modeling issues. First, based on the law of diminishing returns and the deprivation-satiation proposition, "s-shaped curves are often realistic shapes for the relationship … [because] a fixed change in x may have less impact when π is near 0 or 1" (Agresti, 2007, p70). In other words, using a probability-based expression to model responses would better capture the nature of the data. Second, the logit is the preferred form than a probability term in modeling. Contrary to a logistic regression model, a linear probability model assumes an identity link function and directly apply ordinary least squares to estimate parameters. However, a probability takes values only between 0 and 1 but the potential range for the systematic component would not be bounded so, rendering the statistical model invalid and undermining its predictive power. As a logit can be any real number, the logit transformation in the logistic regression model preserve the assumed linearity while preventing such a structural defect in modeling.

Logistic regression models can take various forms or be extended to multi-category responses by changing model specifications (in terms of the systematic component and/or the random component), according to how it is believed the configuration can better facilitate problem solving (Table 5).

Table 5. Different configurations of logistic regression models

	Model name	Response variable	Explanatory variable
1	Ordinary logistic regression	Binary (two categories)	One variable
2	Multiple logistic regression	Binary (two categories)	Multiple variables
3	Multi-category logit	Nominal (more than two categories)	Multiple variables
4	Cumulative logit	Ordinal (more than two categories)	Multiple variables
5	Nested logit	Binary, nominal, or Ordinal	Multiple variables Nested structure

1) Basic form:

The model has one response variable which is divided into two complementary categories, for example, success or failure, yes or no, presence or not presence, etc. The change of the response variable is predicted by one explanatory variable.

2) Multiple explanatory variables (variation 1):

The system component of the model can be easily extended to multiple explanatory variables. The outcome of the response variable is simultaneously determined by the whole set of the explanatory variables. The marginal effect of each explanatory variable on the response variable is interpreted as ceteris paribus, all other explanatory variables are held constant.

3) One response variable with more than two categories (variation 2):

When the response variable has more than two categories, the random component follows a multinomial distribution rather than a binomial distribution. Since the odds ratio only measures two states at one time, a baseline category is specified to facilitate comparisons among multiple categories. The model is composed of (J-1) equations if J categories are identified for the response variable. For example, when a response has three categories, say, high, medium, and low (as the case of this study), and the category "low" is chosen as the baseline for comparisons, the model has two equations for measuring two relationships respectively (high vs. low and medium vs. low). Although the relationship between high and medium is not explicitly stated, it can still be inferred by comparing the two equations in the model.

4) Ordinal response categories (variation 3):

When the response variable has more than two categories and the categories can be ordered, a cumulative logit model can take advantage of the category ordering and provide simpler model outcomes and alternative interpretations. To utilize the additional information and improve modeling efficiency, the model needs to meet the proportional odds property (Agresti, 2007, p180). If the proportional odds assumption is supported, all categories are used to generate cumulative logits. Moreover, each explanatory variable has the same effect on equations for different cumulative logits. Thus, the model has one summarized equation that describes the general disposition of the response variable.

Agresti (2007) argues that "latent variable motivation" is the main reason for modeling with proportional odds structure. The categories are ordered according to a certain criterion, a process that "relates to a model for an assumed underlying continuous variable", if the explanatory variables can be plausibly associated with the latent variable. For example, in this study, we argue that the transaction cost (Williamson, 1985), i.e., the cost of coordination (Ouchi, 1979), is the latent variable underlying the explanatory variables, specifically, technical traceability and social traceability.

5) Ordered explanatory variables (variation 4):

A nested logit model can be utilized to better interpret the relationships between explanatory variables in the systematic component. In this structure, explanatory variables form a tree diagram of a Bayesian decision-making process. An explanatory variable is located under other explanatory variables being set as the netting variables, and thus its effect on the response variable is conditioned by those of the netting variables. The ordered structure enables researchers to model the phenomenon under study as sequential choices and measure differential effects of comparative path-goal strategies.

Incorporating logistic regression analysis into the empirical research framework provides an opportunity to enhance the potential of grounded theory methodology. The comparative nature of the logit is consistent with Glaser and Strauss' (2009) notion that "grounded theory is a general method of comparative analysis" and their ideal of "constant comparative method" (Glaser and Strauss, 2009). Moreover, the combination of qualitative data generation and quantitative data analysis also concurs Strauss and Corbin's (1994) strategy to adopt multiple, complementary methods for researches both practical and rigorous. Furthermore, the data processing capacity of the logistic regression analysis allows us to overcome Turner's (1981) argument that the grounded theory approach is "least useful when dealing with large-scale structural features of social phenomena" and to apply this creative empirical approach in the field of public management for developing practical policy solutions.

4. Data

Data are collected from the Recall Case Archive at the Food Safety and Inspection Service (FSIS), USDA., a publicly accessible online database that compiles all press releases and notification reports issued by the FSIS regarding recalls of meat, poultry, and processed egg products from 1994 to the present. 415 recall cases were selected within the time frame between September 13, 2005 and April 20, 2012. The truncated sample is a necessary "compromise", because a key measure in the empirical study, "the quantity of product recovered", was included in the archive only after September 2005. Without such information, it would be difficult to evaluate recall performance objectively. Nevertheless, the selection of data would not significantly impact the research quality. In the empirical model, a dummy variable which measures structural changes in the food recall environment indicates no significant shift in the data structure along the chosen time frame. Further, as all meat and poultry plants are mandated to implement HACCP by January 25th, 2000, recall cases issued after 2005, 5 years after the initiation, would fully reflect the effect of this major change in the industry. Therefore, selected data were generated under comparable preventive control standards and relatively consistent for benchmarking recall performance. Moreover, although the empirical models were developed with the latest data available in the mid-2012, the archive has been updated since as more food recall incidents occurred. Suggested by the grounded theory approach, a practical empirical research is a constant comparison inquiry. The models thus can be viewed as the initial stage of an ongoing research project to construct a knowledge warehouse. Data not used in the current study present opportunities for evolutionary research in the future, investigating efficient mechanisms for effective management of dynamic food safety resources in the diverse food system.

In the archive, the unit of analysis is a recall case. Each recall case summaries key elements of recall operations, including food business (name, location); product (brand name, specification, data of production, traceability numbers); distribution (types of buyers, destinations of distribution); inspection (the party who discovered the hazard, the method used to discover the hazard); recall characteristics (recall class, types of hazard); recall performance (Announced recall quality, actual recall quantity). For example, on August 13th, 2009, the recall case number 042, Sterling Pacific Meat Co. announced a recall of 3516 pounds of ground beef products, branded as Fatburger and Cattleman's choice in various specifications and packaging. The company, a wholesaler, distributed products to restaurants in two states, California and Arizona. Products were contaminated by E coli O157:H7 and regarded as high risk, class I recall. The biological food hazard was detected by the FSIS during a regular record review. When the case was closed, 0 pound of the contaminated products was recovered. In another example, on July 14th, 2008, the recall case 023, Nestlé Prepared Foods Company announced a recall of chicken sandwich products, branded as "Lean Pockets". The products were distributed to retailing outlets nationwide. Some products contained pieces of plastic, a physical food hazard detected by consumers. The company recovered 41,555 pounds out of the 199,417 pounds of recall quantity. Although in general reporting data are qualitative (except for the announced and actual recall quantities are quantitative), rigorous documentation procedure and consistent format allow data transformation for further analysis.

Table 6 profiles the dataset with 5 characteristics, each of which was encoded into 3 categories based on consistent, observable patterns in the database.

Table 6. Characterizing and categorizing the database

	Characteristics	**Category**	**Definition**
1	Collaborative performance	High	Recovery rates greater than 75%
		Moderate	Recovery rates between 25% and 75%
		Low	Recovery rates less than 25%
2	Technical competence	Low	Recall cases involve physical hazards.
		Medium	Recall cases involve hazards which were identified by discrepancies under pre formulated managerial plans and standards.
		High	Recall cases involve biological hazards.
3	Social involvement	High	Food hazards were discovered by consumers.
		Medium	Food hazards were discovered by suppliers.
		Low	Food hazards were discovered by public agencies.
4	Industry type	Beef	Recall cases involve beef products.
		Pork	Recall cases involve pork products.
		Poultry	Recall cases involve poultry products.
5	Market scope	National	Recall products were distributed to more than 10 states.
		Regional	Recall products were distributed between 1 to 10 states.
		Local	Recall products were distributed within 1 state.

Collaborative performance is defined by the effectiveness of recall operations, measured by the percentage of announced recall quantity actually recovered. Operations with recovery rates greater than the third quartile (75%) are deemed as high performance. Operations with recovery rates less than the first quartile (25%) are treated as low performance. Those between the first and the third quartile are regarded as medium performance. According to table 7, in the dataset, almost half, 49.64%, of the recall cases falls into the category of low recall effectiveness. Less than one-fifth, 18.31%, of the cases attains relatively high performance. The situation indicates an urgent need for a performance strategy.

Table 7. Univariate analysis: collaborative performance

Measure	**Definition**	**Frequency**	**%**
High recall effectiveness	Recall ratio > 75%	76	18.31
Moderate recall effectiveness	Recall ratio < 75% but > 25%	133	32.05
Low recall effectiveness	Recall ratio < 25%	206	49.64

Technical competence describes technical capabilities of recall operations, defined by the required degree of search to identify food hazards. On the one hand, occurrences of physical hazards indicate high visibility, because hazards can be detected directly by sensory inspections. On the other hand, biological hazards indicate low visibility, because hazards, when latent, require special technology to identify and reveal them. In-between are the food hazards identified through the application of managerial plans, rules, and standards; for example, labeling discrepancy, violations in HACCP plan, documentary errors, etc. Although the hazards were not directly visible, the use of pre-formulated managerial tools enables the detection of potential hazards by visual inspections. Table 8 shows that more than half of the recall cases, 57.35%, involve high technical competence.

Interestingly, high technical competence does not directly translate into high recall performance.

Table 8. Univariate analysis: technical competence

Measure	Definition	Frequency	%
Low technical competence	Searchable hazards detected	35	8.43
Medium technical competence	Semi-searchable hazards detected	142	34.22
High technical competence	Biological hazards detected	238	57.35

Social involvement indicates the degree of stakeholder participation in recall operations. The social aspect is measured by different social roles of stakeholders performing collaborative hazard discovery in the food safety commons. On the one hand, when food hazards were detected by public agencies, recall operations are regarded as low involvement for the high degree of centralization. On the other hand, when food hazards were detected by consumers or buyers, recall operations are defined as high involvement for the high degree of decentralization. When food hazards were detected by suppliers and other third party service providers, recall operations are regarded as medium involvement.

Table 9 shows in most cases, 85.54%, hazards were detected by public agencies or suppliers. Inferring from the result, consumers may not have the competence to take initiatives and requires technical supports. Moreover, promoting social involvement would be a feasible strategy if the empirical study identifies a significant positive association between involvement and recall performance.

Table 9. Univariate analysis: social involvement

Measure	Definition	Frequency	%
High social involvement	Hazards detected by consumers	60	14.46
Medium social involvement	Hazards detected by suppliers	87	20.96
Low social involvement	Hazard detected by public agencies	268	64.58

Industry type summarizes a supply-side factor that impact recall performance. Food hazards emerge in different proportions, because each industry has unique manufacturing practices, products, supply chains, and critical control points. Table 10 shows more than half, 58.80%, of recall cases are related to beef industry. The higher percentage would suggest more attention on the beef industry according a risk-based rationale.

Table 10. Univariate analysis: industry type

Measure	Definition	Frequency	%
Beef industry	Hazards detected in beef related products	244	58.80
Pork industry	Hazards detected in pork related products	67	16.14
Poultry industry	Hazards detected in poultry related products	104	25.06

Market scope summarizes demand-side factors that influence recall performance. The scale of reverse logistics implies task difficulty of recall operations. Table 11 shows that 29% of recall cases appear in the national market; 37% in the regional market; 34% in the local market. A slightly lower percentage in the national market may indicate large companies are more capable to handle food safety problems. However, the trend of internet sales would obscure the measure.

Table 11. Univariate analysis: market scope

Measure	Definition	Frequency	%
National market	Products distributed to more than 10 states	120	28.92
Regional market	Products distributed between 1 state and 10 states	153	36.87
Local market	Products distributed within 1 state	142	34.22

Table 12 presents cross references between the four observed factors and their relationships to three different levels of recall performance, based on the distribution of recall cases. In the beef industry, operations at the regional and local markets would be an emphasis for system improvement. Although public agencies have already been heavily present in those markets, interventions only achieve moderate or low recall performance, suggesting the need for alternative strategies. Promoting social involvement may help. However, cases of consumer involvement are mostly related to physical hazards with search attributes and to moderate and low performance. Before delegating responsibility and authority, public agencies would need to spend efforts on consumer education. Moreover, transforming non-searchable attributes into search attributes (Caswell and Mojduszka, 1996, p1251) would provide necessary technical supports. In terms of supplier involvement, because small- and medium-sized producers and vendors are relatively incompetent, public agencies could consider strengthening supplier trainings, issuing more specific quality standards and practices, appointing channel captains, or promoting market mechanisms. In the pork and poultry industries, interestingly, more moderate- or low-performance cases involve the national or regional markets, indicating a different direction for quality improvement. Public agencies would need to emphasize on tightening industry standards and qualifying large companies in the industry.

Table 12. Distribution of recall cases

Recall Effectiveness = High

		Technical			Industry			Market		
		Low	Medium	High	Beef	Pork	Poultry	National	Regional	Local
Social	Consumer	1	4	4	6	1	2	4	3	2
	Supplier	2	7	13	13	6	3	7	6	9
	Agency	1	9	35	28	7	10	8	20	17
Technical	Low				2	1	1	2	1	1
	Medium				9	4	7	7	7	6
	High				36	9	7	10	21	21
Industry	Beef							8	18	21
	Pork							5	6	3
	Poultry							6	5	4

Recall Effectiveness = Moderate

		Technical			Industry			Market		
		Low	Medium	High	Beef	Pork	Poultry	National	Regional	Local
Social	Consumer	10	5	3	6	6	6	11	3	4
	Supplier	1	14	20	12	10	13	15	9	11
	Agency	2	36	42	55	8	17	14	30	36
Technical	Low				6	4	3	6	6	1
	Medium				26	8	21	19	17	19
	High				41	12	12	15	19	31
Industry	Beef							12	26	35
	Pork							15	6	3
	Poultry							13	10	13

Recall Effectiveness = Low

		Technical			Industry			Market		
		Low	Medium	High	Beef	Pork	Poultry	National	Regional	Local
Social	Consumer	16	11	6	12	9	12	20	10	3
	Supplier	2	13	15	19	5	6	8	15	7
	Agency	0	43	100	93	15	35	33	57	53
Technical	Low				5	6	7	13	5	0
	Medium				34	12	21	20	27	20
	High				85	11	25	28	50	43
Industry	Beef							28	49	47
	Pork							14	8	7
	Poultry							19	25	9

Chapter 3

Intelligence Platform

1. Strategic Food Safety Inspection

Inspection is critical to assuring food safety in the complex food system. The definition from the International Organization for Standardization (ISO), "examination of a product design, product, service, process or plant, and determination of their conformity with specific requirements" (ISO 17020:2012), suggests that food safety inspection is a control function with two main goals: identification of hidden food hazards and verification of food quality. In complexity, to meet various task conditions, effective inspection would require an integrated approach that combines multiple inspection methods. Table 1 re-categorizes types of inspection methods listed in Shingo (1986) according to alternative approaches and goals.

Table 1. Types of inspection methods

	Centralized control	**Decentralized control**
Identification	Judgment inspection	Self-inspection
Verification	Statistical quality control (SQC)	Successive inspection

Judgment inspection discriminates the status of an object under check into two states – defective or acceptable. The objective is to identify defects and to keep defective objects from moving to subsequent supply stages. Judgment inspection has the main advantage that it is easy to understand and implement, with one simple objective – to discover defects. However, due to its postmortem nature, it is often criticized as wasteful. Any operations involve costs. Identifying defects without further corrective and preventive actions would mean that the same defects could recur and incur more costs. Therefore, as the third of his 14 principles for transforming business effectiveness, Deming (1986, p23) asserted, "Cease dependence on inspection to achieve quality. Eliminate the need for massive inspection by building quality into the product in the first place."

Self-inspection requires each work unit to conduct inspection and be responsible for own work outcomes. By delegating the power of centralized control, it is the strategy to implement the ideal – building quality from the source. It has the advantage to improve system efficiency by removing redundant communication and unnecessary external control. However, the method is not without any concerns. As Shingo (1986, p77) argues, "it has long been held that there are two flaws to be reckoned with: workers are liable to make compromises when inspecting items that they themselves have worked on, and they are apt occasionally to forgot to perform checks on their own". While Shingo acclaims the benefits of self-inspection, establishing credibility is fundamental to the integrity of a system based on self-inspection. "If it were possible to guard against these flaws, then self-check system would be superior to a successive check system" (Shingo, 1986, p77).

The credibility of an inspection system can be verified in two ways. Technical-wise, statistical quality control (SQC) relieves the burden of costly mass inspections (i.e., continuous inspections) and provides science-based measures and risk-based analyses.

On the downside, SQC for inspection involves sampling. Its accuracy in a complex task environment raises a concern of "the pretense of knowledge" (Hayek, 1989). Moreover, the lagging effect can be a serious concern. When regularity or a structural trend is observable through data collection and analysis, the feedback may fail to capture the urgency of a problem and lose its value.

Social-wise, successive inspection amends the shortcomings of SQC with a non-statistical aspect of checks and balances. The operation is carried out at the nearest possible subsequent (ideally, the next) supply stages by different parties. In a production line setting, when a defect is discovered, it is required to shut down the production line right away and inform the work unit where the defect was generated. Proximity reduces the lead time of communication. However, as Shingo (1986, p78) points out, "there may be cases in which the actual circumstances of defect generation have already vanished by the time information is relayed back by a worker at the next process". Maintaining traceability along supply stages is hence desired.

Like "Shuai-jan", the agile snake living in the Ch'ang Mountain mentioned by Sun Tzu in *The Art of War*, with its head and tail fully coordinating to repulse assailants, an integrated inspection system forms a food safety community, which consists of consumers, suppliers, public agencies, and all other relevant parties such as academia and third-party service providers, all of whom are stakeholders, because food safety is a matter of everyone's health and benefit. Since all stakeholders share the responsibility of food safety management, each works on his or her power and discretion to detect, reduce, and eliminate food hazards from the community. Nevertheless, judgment, statistical quality control, and successive inspection are still located within the conceptual rut of double checking – the conventional sense of inspections — and thus are essentially wasteful in terms of Deming's rationale. Therefore, self-inspection should be the preferred method, and other methods exercise due diligence to safeguard the system. This conceptualization advances the meaning of inspection one step forward from a stand-alone centralized control activity into the realm of total quality management and organizational learning and redefines inspection as a strategic value-creating activity in collaborative partnerships. Strategic food safety inspection is thus defined as: the integration of multiple inspection methods with the goal to generate synergistic system performance.

The feasibility of this conceptualization is supported by the development of new information and communication technologies. Advancing technologies are changing the ways people communicate with one another and constructing expansive networks of interconnected resources through social media. Thus the strategic food safety inspection system uses both formal and informal communication to achieve its goal. In this light, food safety inspections are not the job only for public agencies or producers. Imagine the provision of public service without command and control; no principal-agent relationship; no cat-and-mouse game, and no mutually assured destruction. Imagine all stakeholders relinquishing myopic strategic behaviors and committing to collaborative innovation on better food quality and public health. Such a system would also be immune from moral hazard of the commons dilemma.

2. Food Safety Commons

Empowering consumers and suppliers promotes collaboration in the food safety community for achieving collective goals. Research shows that the empowerment of employees in public sector organizations would be expected to have positive results (Fernandez and Moldogaziev, 2011). However, food safety is a public good. The strategy to build a food safety community for strategic food safety inspection would encounter the so-called commons dilemma. In 1833, William Forster Lloyd raised the problem during the enclosure movement in England when he observed overgrazing on the shared pasture land, i.e., the commons. This occurred out of individual herders' selfish, but rational, pursuit of short-term economic benefits, resulting in the depletion of public pasture, a consequence detrimental to everybody in the community, including those individual perpetrators. In the market economy, self-interestedness is fundamental to entrepreneurship, which holds the key to innovation. That is, mediated by a competitive process, an individual's desire to fulfill wishes is supposed to drive a self-correcting spontaneous market order, guiding efficient and effective uses of resources, and achieving collective gains (Hayek, 1945). Paradoxically, the commons problem points out a situation contrary to the expectation -- short-term seemingly rational pursuit of individual goods could lead to long-term irrational collective bad, a paradoxical phenomenon called "the tragedy of freedom in a commons" (Hardin, 1968, p1244).

"Freedom in a commons brings ruin to all" is the essential takeaway from the lesson, argued by Hardin (1998, p682). Thus, it involves a philosophical debate baffling humanity for millennia – the free will problem: the tension between individualism and collectivism. Free will is defined as "the unique ability of persons to exercise control over their conduct in the fullest manner necessary for moral responsibility" (O'Connor, 2014). A "legitimate" free will, the beneficial kind of self-interestedness to the society, is inseparable from moral responsibility. Morality refers to "a code of conduct that, given specified conditions, would be put forward by all rational persons" (Gert, 2012). Responsibility refers to the burden of obligation, blameworthiness ascribed for causing harm (Smiley, 2011). Morally responsible people exercise their free will prudently without causing harm to others. Although negative externalities may still result from ignorance or accidents, justice is upheld through retribution. Moral responsibility is an invaluable asset to a society, because it keeps at bay those wasteful activities such as haggling and wrangling, allowing a focus on the positive aspects for a healthy societal evolution. In addition, it offers an efficient approach to deal with uncertainty, because it indicates a path for muddling through the grey area between self- and collective interestedness.

Hardin (1968) argues that the incompatibility between individual and collective interests "has no technical solution" (Hardin, 1968, p1243). The technological approach, "the techniques of the natural sciences" (Hardin, 1968, p1243), in his opinion, is a futile attempt, because the problem involves a dynamic game of human interactions that goes beyond the bounded rationality of mathematical exercises. Rather, the solution demands a change in human cognition on morality, induced by social arrangements that "produce responsibility … arrangements that create coercion … [while] mutually agreed upon by the majority of the people affected", suggested by Hardin (1968, p1247). However, the food safety community belongs to a different class of commons. While food safety is a public good, food safety inspection service is a second-order public good (Kollock, 1998, p206). The service intends to achieve adaptation through not only conformity but also innovation (Merton, 1938, p676). While coercion would be a practical argument in certain situations, in the long run, its efficacy is a concern. Since any form of coercion compromises and suppresses free flows of social energy, it risks its own undoing (Follett, 1919, p577).

Follett (1919) offered an alternative conceptualization. A community does not have static ends but rather has "a creative process of integrating" (Follett, 1919, p576). Self is not a "dign-an-sich" but is "always in flux weaving itself out of its relations" (Follett, 1919, p577). Collective value is attained through "the integrating of 'wishes' from individuals" (Follett, 1919, p576) in which "the greatest contribution a citizen can make to the state is to learn creative thinking, that is, to learn how to join his thought with that of others so that the issue shall be productive" (Follett, 1919, p581). As a functional whole, stakeholders are engaged in a common business – "they jointly assume the risks and share the burdens and the benefits of the enterprise. More than that, they share each other's frailties" (Follett, 2012). Kindled from this feeling of "an interweaving of obligations" (Follett, 2012), responsibility is jointly developed with self-respect and pride, leading to credible discretion and constructive empowerment – "if each of us exhausts his responsibility by bringing his own little piece of pretty colored glass, that would make a mere kaleidoscope of community" (Follett, 1919, p581).

Social networks bring Follett's ideal into reality. Interesting social phenomena go beyond the traditional Weberian mindset of mechanical and hierarchical organizational design (Weber, 1947) – small-world properties (Travers and Milgram, 1969), six degrees of separation (Watts, 2004), three degrees of influence (Christakis and Fowler, 2009), network externalities (i.e., demand-side economics of scale), etc. New technologies allow information to be communicated and knowledge to be shared in a more efficient and effective fashion and change the ways people socialize and interact with one another. For example, in 2005, the International Telecommunication Union (ITU) issued a report, envisioning the notion of an "Internet of Things" – "for anytime and anyplace, connectivity for anyone and anything". The ideal ubiquitous computing and communicating power is substantiated by the progress in radio-frequency identification technology, wireless sensors, and nanotechnology. Artificial intelligence is embedded in "smart things" which enable powerful social organizations. In recent years, the vision has begun to take shape. Mobile devices, such as smartphone, smartwatch, tablet, and head-mounted display, etc., create an augmented reality (AR) that unblocks barriers between people and unlocks value-creating opportunities from relationship-building activities. Increasingly connected social networks enhance interactivity and facilitate resource sharing within commons.

3. Intelligence Platform

An intelligence platform is essentially a virtual location that allows information processing and knowledge sharing. In other words, it is an information architecture that organizes knowledge stored in a system and allows users to share valuable knowledge with those in need. It is a fundamental performance strategy to manage intelligence generated by diverse stakeholders so as to improve the use and access of knowledge held at dispersed locations in an open food system. Through the platform, public agencies are able to tap into previously unused external resources – consumers, suppliers, and other public agencies – and collaborate to prevent food hazards from developing. The conceptualized food safety commons consists of diverse work groups (see Hackman, 1990 for the definition of a work group). For example, Johnson (2012) lists 14 public agencies which directly or indirectly share food safety responsibility in their operations. Many food suppliers develop HACCP plans and have proprietary quality control systems. Consumers, from direct consumption experiences, may have the street wisdom complementary to the technical knowledge equipped by public agencies and suppliers (Wang, Van Fleet, and Van Fleet, 2014). Last but not the least, consumer and third-party groups may have in-depth knowledge on specific topics of their interests. If strategic food safety inspections are collaboratively performed by multiple stakeholders in the food safety community, the risk of Type II errors in public operations would be greatly reduced.

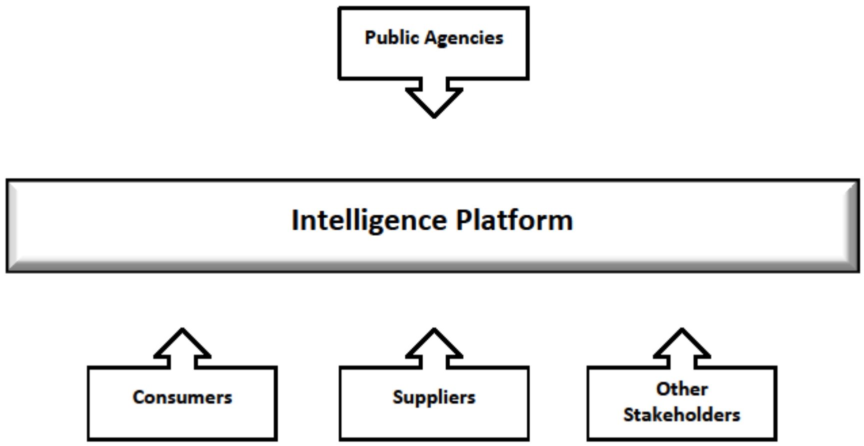
However, collaboration may not be taken for granted as a spontaneous behavior. Consumers may be occupied by daily errands and have limited spans of attention. Suppliers may not be willing to share their proprietary sources of competitive advantages. Public agencies may be driven by bureaucratic or political considerations. Self-interestedness is a powerful human behavioral driver – in general, stakeholders have the tendency to prioritize self-fulfillment before devoting to a collective good. Notwithstanding, self and collective agendas may not always be contradictory. When stakeholders share common interests, social gatherings in differential scales and forms – teams, groups, corporations, or communities – would be organized for the pursuit of self-interestedness while at the same time contributing to collectiveness, whether consciously or unconsciously. In the world full of diversity and complexity, fragmented but isolated organizations create a controversial social phenomenon, so called "knowledge silos", which, as a problem pointed out by Offsey (1997, p114), "provide adequate functionality for specific workgroups or business processes, but are unreachable by others in the organization". In essence, the question is a matter of resource sharing. The presence of knowledge silos greatly limits the efficacy of a food safety community, because erected barriers inhibit information flows, resulting in some counter-intuitive phenomena such as Infofamine (a user perceived lack of information) or infoglut (deluge of overloaded information). While tearing down the artificial walls between isolated knowledge silos is an intuitive reaction, the implementation is not as straightforward as it seems to be, as it may bring in unintended consequences. Resorting to centralized control and standardized operations would indiscriminately bulldoze everything -- the good, the bad and the ugly. Ironically, consequent weakened functionality of knowledge silos would contradict the original purpose of the strategy – knowledge integration for synergy. Therefore, collaboration needs a mechanism "to preserve the creation and processing functions inherent in knowledge silos, while offering all user access to the knowledge contained in the silos" (Offsey, 1997, p120).

Knowledge sharing for collaborative innovation is an alternative way of thinking to preserve diversity while promoting cooperation. In this approach, a collective agenda is identified that all members with diverse backgrounds share common interests and each, to each his own, contributes "two cents" for the betterment of a society. Food safety is one topic that provides the great opportunity to promote mutual understanding and resource sharing and to build communityship (Mintzberg, 2009), because safe and clean food is desired by everyone. The organizational design for such a food safety community corresponds to Hayek's prescription in the use of knowledge in society – a decentralized system with a rational economic order (Hayek, 1945). In Hayek's view, a communicative platform is a crucial element for the well-functioning of such a decentralized and rational system. Taking market and price mechanisms as an example (Hayek, 1945, p526 and p527), the platform facilitates system-wide information flows, creating and maintaining a self-organized order so as to achieve common goals. In the context of food safety management, an intelligence platform needs to be constructed to facilitate food hazard communications. It needs to be flexible enough so as to encompass all the value-creating potentials of diverse stakeholders. Moreover, it needs to be efficient enough so as to promote resource integration and to transmit intelligence in time. Furthermore, it needs to be rational enough so as to maintain public trust and confidence.

In a sense, an intelligence platform serves as an information hub "cross docking" knowledge stored at multiple stakeholders (Figure 1). Conceptually, an intelligence platform is similar to the notion of "value networks" based on the service-dominant logic.

Lusch, Vargo, and Tanniru (2010) define a value network as "a spontaneously sensing and responding spatial and temporal structure of largely loosely-coupled value proposing social and economic actors interacting through institutions and technology, to co-produce service offerings, exchange service offerings, and co-create value" (p20). Value creation, the main purpose of a value network, involves liquefying information resources and bundling and re-bundling resources (Lusch et al., 2010, p22 and p23) in order to identify value propositions that meet satisficing criteria (Simon, 1956, p136) – the synergy condition. Moreover, because knowledge is an operant resource (Vargo and Lusch, 2004), processes of value creation suggest learning, evolving and adapting to changing requirements as soon as an opportunity emerges – the efficiency condition. Therefore, on an intelligence platform, agility, i.e., quick adaptation for improved value proposition, is the core competence to realize the power of this creative setting; value is created and realized through two drivers – synergy and efficiency. However, the two value divers have some conflicting characteristics in nature. On the one hand, an effective use of relevant knowledge demands a structure flexible enough to accommodate diverse stakeholder requirements and meet their evolving needs. On the other hand, an efficient access to dispersed knowledge across society requires a structure stable enough to withstand disturbances arising from the fragmented knowledge landscape. Pursuing both synergy and efficiency at the same time would result in cognitive dissonance and create internal conflicts in an organization.

Figure 1 An Intelligence platform integrates stakeholders



A plural form of management that treats the two drivers separately and integrates them for actual value realization may be a practical approach to reconcile the two seemingly contradictory characteristics of an intelligence platform. In *Thinking, Fast and Slow*, Kahneman (2011) proposes two sub-systems related to human cognitions and decision-making behaviors. System 1, the fast thinking, represents an instinctive and emotional decision-making mode. The value-driven mechanism here is associative memory, the capability to link relevant knowledge stored in the system to interpret situations, to generate a coherent story, and to develop a positive feeling of confidence. In contrast, system 2, the slow thinking, corresponds to a deliberate and logical decision-making mode. The dominant mechanism here is the executive control of memory, the capability to conduct complex comparisons and computations and to make reasoned choices. System 1 operates automatically and effortlessly in making heuristic decisions, shaping the definition of situations, and filtering information cues in the decision-making environment. System 2 is mostly idle because it is costly to make deliberate decisions. While it is only activated when information cues enter the system drawing a focus of attention, system 2 carries composure and will power to verify performance outcomes of system 1 and to make conscious changes in decision rules. In Kahneman's conceptual framework, a human mind processes information in a much more dynamic manner than that described in Stigler's sequential search model (Stigler, 1961) – that information is more than a unified commodity, search is not just a standardized sampling process, and search efficiency is a way station rather than the destination to value creation, while a sequential search order is still prevalent in decision-making processes – that system 1 serves as the energy-conserving default mode and system 2 safeguards the system and only intervenes when situations require. The two systems reinforce each other in a fashion that offers opportunities to minimize decision-making effort while maximize performance.

In the food safety commons, when members of diverse backgrounds engage in strategic food safety inspections, some function as agents of system 1 and others serve as agents of system 2. The concept of transactive memory system can be a useful framework to conceptualize and operationalize this collaborative relationship as "a set of individual memory systems in combination with the communication that takes place between individuals" (Wegner, 1987, p186). In Wegner's construct, a group that "thinks" as a whole involves two functions: first, "the operation of the memory systems of the individuals" and second, "the processes of communication that occur within the group" (Wegner, 1987, p191). The first involves organizational memory – "[i]nformation is entered into memory at the encoding stage, it resides in memory during a storage stage, and it is brought back during the retrieval stage" (Wegner, 1987, p186); the second employs symbolic interactions – "[t]he transactive process may thus operate at retrieval to search for a label that can prompt access to the desired item in the internal or external storage of at least one group member" (Wegner, 1987, p191). Constructing systemic collaboration for value creation requires "an understanding of the manner in which groups process and structure information" (Wegner, 1987, p185). It involves two processes: first, a process of labeling – locating in the system where the relevant knowledge is; and second, a process of cephalization (Coase, 1937, p400) – communicating the knowledge to the foci of problem-solving. Further, the communication involves two kinds of information which indicate sources of knowledge: first, personal expertise, and second, circumstantial knowledge responsibility (Wegner, 1987, p192).

However, system 1 and system 2 are not perfect decision support systems, because lapses could happen between their coordination. System 1, according to the prospect theory, is subject to cognitive biases inherent in heuristic thinking under uncertainty (Kahneman and Tversky, 1979), and system 2 tends to neglect the significance of the psychodynamic unconscious, i.e., intuition and emotion (Epstein, 1994; Simon, 1987). Therefore, coordination between the two sub-systems is not always streamlined and seamless, as "gaps" exist between loosely-coupled interactions between the system-1 and system-2 agents. This concern in decision biases is also described in Shultz and Holbrook (2009, p125) in terms of the notion of vulnerability. On the one hand, "people are economically vulnerable if they know what is good for them but do not have the abilities, skills, funds, and other resources needed to acquire it." For example, many biological food hazards such as E. Coli, Salmonella or Norovirus are not subject to sensory inspections and require special laboratory testing to identify them. On the other hand, "people are culturally vulnerable if they have plenty of resources to acquire what they need but just do not know what is good for them" – for example, food hazards could result from insufficient cooking temperature, cross contamination, improper storage conditions, etc. – mishandling of food due to a lack of knowledge or due diligence. In a collaborative food safety environment, interactions and group dynamics could intensify the negative impact of decision biases and vulnerability. Resulting underperformance would demoralize group members, discourage cooperation, and threaten system integrity. Therefore, accountability is crucial. As Wegner (1987, p192) argues, "an effective transactive memory in a group should not leave the responsibility for information to chance. If a clear expert does not exist in a domain, a channel for the processing of that information should nevertheless be established, either explicitly or implicitly". In a dynamic and temporal sense, responsibility is anchored by accountability and reflected in traceability on an intelligence platform.

4. Structural Hazard Communication

Hazard communication, i.e., exchanges of hazard knowledge and information, provides opportunities to develop useful and traceable measures. According to the social comparison theory (Festinger, 1954), when facing unknown situations, people tend to communicate with peers to reduce feelings of uncertainty and insecurity. Effective hazard communication among diverse stakeholders in a complex environment requires an information framework, which explicitly organizes interactive elements so as to create a commonly understandable coherence for communicating knowledge claims (Egan, 1972, p66). Structural hazard communication thus can be conceptualized by four interrelated structural elements – resource, identity, structure, and knowledge – the RISK framework.

4.1 Resource (R):

The compilation of stored hazard information and knowledge forms the resource base (Barney, 1991) of a hazard communication system. In a sense, the collection of available resources represents organizational memory (Walsh and Ungson, 1991) which substantiates distinctive sensing capabilities (Day, 1994) and the path toward dynamic capabilities (Teece, Pisano, and Shuen, 1997). The four attributes of resources, valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1991, p106-p111), imply that the involvement of circumstantial knowledge possessed by diverse stakeholders is critical for generating competitive advantages and hence superior organizational performance.

4.2 Identity (I):

An identity serves as what Polanyi (1967) called the "subsidiary" (a pointing finger) for sense-giving and sense-reading, when decision making involves a complex phenomenon difficult to be articulated under time pressure. In a collaborative setting, an identity that functions as signals or symbols (Feldman and March, 1981) creates subsidiary awareness (Polanyi, 1967) and leads to symbolic interactions (Blumer, 1986), a mechanism to conserve cognitive resources and to facilitate efficient coordination, by providing a focus of attention (March and Simon, 1958), encouraging vicarious learning (Bandura, Ross, and Ross, 1963), and guiding heuristic information processing (Chaiken, 1980).

4.3 Structure (S):

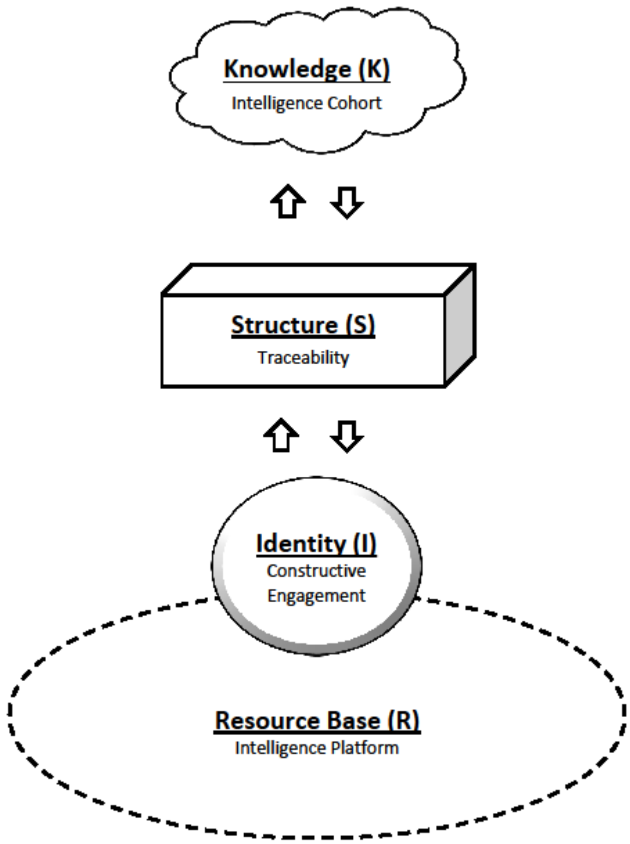
A hazard communication structure is an agreement that states objectives, tasks, and activities, and coordinates the overall hazard management system. The coordination is implemented by two kinds of information processing. First, coordination by plan disseminates pre-established information, and second, coordination by feedback involves transmission of new information (March and Simon, 1958, p160). The former represents the intention of the system, and the latter reflects the responsiveness of the stakeholders. While both can be products out of deliberate efforts, feedback always has, whether it is recognized or not, a voluntary and effortless element called intuition (Simon, 1987). Together "an arduous straining of the imagination is followed by a virtually spontaneous appearance of the solution" (Polanyi, 1967, p320), setting the path-goal (House, 1971; Evans, 1970) that addresses value propositions for implementing efficient hazard communication.

4.4 Knowledge (K):

Knowledge represents the practical use of resources, identities, and structure, ensuring the system not to be trapped in “red tape” or indulged in the status quo. In a collaborative context, collective cognitions are derived from organizational learning. Effective organizational learning requires “an understanding of the mechanisms that can be used to enable an organization to deviate from the culture in which it is embedded", which involves exploitation, enhancing existing knowledge, and exploration, acquiring new knowledge (March, 1991). While exploitation is fundamental to improve organizational efficiency, in the case of collaborative innovation, "the vulnerability of exploration" (March, 1991, p73) and "the nontraditional quality of organizational learning" (Weick, 1991) pose challenges to organizational effectiveness in terms of "motivation obstacles" and "cognitive boundaries" (Simon, 1991, p131). Nonetheless, the impact can be alleviated by lateral diffusion of knowledge enabled by shared understanding and ability to communicate (Simon, 1991, p131).

Figure 2 illustrates the RISK perspective of a strategic food safety inspection system. The system is composed of four modularized organizational functions. At the foundation lies the food safety community as the resources base (R). Multiple stakeholders such as consumers, producers, channel members, and public agencies, who possess various kinds of hazard relevant knowledge, commingle under a common vision to create cleaner, safer, healthier, and satisfying food choices. At the other end located an ad hoc food recall task force, which represents the knowledge (K) of the system. From a practical perspective that "form follows failure" (Petroski, 1992, p22), food recall can be viewed as learning opportunities to develop system safeguards and improve the system when ex ante efforts inevitably fail due to bounded rationality (Taylor, 2011, p9). The two organizational modules are connected by a communicative platform functioning as an open forum for stakeholders to negotiate mutually agreeable standards (S). Planned standards (for example, HACCP), observed standards (for example, TQM), and emergent standards (for example, voluntary compliance) – standards of three different kinds coordinate diverse stakeholders. The coordination is enabled by hazard communication, through which hazard knowledge is translated and summarized into various forms of identities (I), for example, food labels, brands, consumer reports, advertising, stories, or word of mouth. The identities serve as organizational symbols, with differential degree of information richness, assisting stakeholders of differential degree of competence in making appropriate decisions. An example of such structural communications is the Hazard Communication Program (HAZCOM) of the Occupational Safety and Health Administration (OSHA). In this interactive system for managing hazard information and knowledge, OSHA requires employers to disclose hazardous substances in workplaces, to provide employees and emergency personnel with access to resources (for example, a material safety data sheet (MSDS) or equivalent), and to support employees with appropriate training to understand health and safety risks. Elements of the RISK framework together create a system for managing strategic food safety inspection and hazard intelligence.

Figure 2. The RISK Framework for Structural Hazard Communication



5. Engagement

In the food system, the food market provides a naturally active platform that facilitates hazard communication and coordinates plural aspects of exchange behaviors: economic costs and social information processing. Economic costs are measureable and involve capital (e.g., computers, servers, smart phones, tablets, etc.) and exchange costs (e.g., carrier subscription fees, costs of information supply). Social information processing involves primarily the reliability of information obtained voluntarily from consumers and by regulation as well as voluntarily from suppliers and other stakeholders in the food system. As a result, two distinct effects and consequent market forces would drive how consumers and suppliers process information in the food system.

5.1 Informational effect and the force of differentiation:

Brynjolfsson and Hu (2001) argue for the prominence of the "Long Tail effect" in a networked environment. As market participants are better informed under new technologies, lower search costs enable a better fit between diverse attributes of demand and supply. If the pattern of transactions is conceptualized as a normal distribution, new information would level the concentration of transactions at the average and create "fat" or "long" tails. If this is the case, the conventional Pareto principle, or the 80/20 rule, may not anymore be the dominant heuristic to explain market behavior. Clemons (2008) describes this enriched state of knowledge as "informedness". On the one hand, consumers know what is available in the marketplace with precise attributes and at the precise price they need and want. On the other hand, suppliers respond to elaborated consumer demand with "hyper-differentiation" and "resonance marketing". It is believed that enhancing information availability for consumers provides suppliers with unlimited potentials to differentiate their offerings, explore underserved markets, and attain superior performance.

5.2 Social effect and the force of integration:

The interactive nature of the new technologies impact consumers and suppliers individually and collectively as well. In the traditional neoclassical economic paradigm, value is created and added unilaterally by suppliers through the combination and accumulation of supply activities. Demand is exogenous to supply, as consumers are passive recipients of products. The two separated entities of supply and demand are connected through exchanges and coordinated by prices. As social networks are reshaping the traditional hierarchical organization of markets, an individual consumer is no longer a faceless part of the aggregate silent representative consumer. Rather, consumers are empowered to let their voices be heard or even actively participate in value-co-creating activities to develop new market opportunities (Prahalad and Ramaswamy, 2004). Increasing needs for value co-creation in the market suggest that consumers and suppliers would build a collaborative relationship, which can be explained by the notion of "product market" through the lens of the socio-cognitive view of marketing. Rosa, Porac, Runser-Spanjol, & Saxon (1999) suggest that a product market is formed when consumers and suppliers co-create a product conceptual system through the enactment of product or channel attributes in consumption and other social interactions. A stabilized market results from a closer and stronger relationship with fewer endogenous and exogenous disturbances in the environment. At this stage, consumers and suppliers agree on common agenda and reach congruent goals, and the market is “domesticated” (Arndt, 1979).

The two market forces bring in mixed impacts on food safety management. Structuring communication on the intelligence platform would face a dilemma that Lawrence and Lorsch (1967) described in their empirical study on differentiation and integration in complex organizations – “Other things being equal, differentiation and integration are essentially antagonistic, and one can be obtained only at the expense of the other" (Lawrence and Lorsch, 1967, p47). Surprisingly, the research found that high performance organizations are both "highly differentiated and well integrated" (Lawrence and Lorsch, 1967, p1). To explain this counterintuitive phenomenon, Lawrence and Lorsch argued that certain conditions "seem able to make it possible to achieve high differentiation and high integration simultaneously" (p47) and that the key is the deployment of "integrative subsystems" (p31) that are "intermediate between those found in subsystems they were to coordinate" (p31), that initiate social influence (p33), and that provide behavioral standards (p37).

The RISK framework functions as an integrative subsystem to coordinate unorganized entropy of social energy in the food safety commons and transcend the creative diversity into a concentrated knowledge power in the recall task force to effectuate collaborative innovation. Since, in the dynamic processes, the platform is only a "way station", i.e., a mediating mechanism, when an engagement occurs on the platform, value is derived from the need for mobilization coordination (Warren et al., 1974) which represents "short-term, ad hoc efforts of coordination between pairs of organizations" (Van de Ven and Walker, 1984). At the micro-level, each interaction is a refreshing start, full of value-creating potentiality, an "embryonic stage in the development of inter-organizational relationships." These often involve interactions in an "unstructured form" and are "set in motion by a single organization that has a particular objective for which it must gain support, cooperation, or resources from a number of other organizations", in which "the agent of an organization mobilizes other pertinent organizations – or parts of them – around its own objectives." In other words, the boundary-spanning agent serves as entrepreneurs "who gathers together the resources and forges the ad hoc relationships needed to enable his or her organization to pursue its own objective" (Van and Ven and Walker, 1984: p598). At the macro-level, certain patterns of interactions would be observable if value creation is an ongoing need. This is especially the case in food safety management, when food hazards are mostly unexpected and thus vulnerability (Shultz and Holbrook, 2009) are constantly present. The structure is so important because it offers a continuing basis for relationship building. Without an organizational structure, interactions based on random walks could be costly.

Social exchange theory (Lawler, 2001; Emerson, 1976; Homans, 1958) provides a micro-macro linkage to explain how the structure of the dynamic phenomenon is formed. Homans (1958, p597) conceptualized social behavior as exchange and argued that "interactions between persons is an exchange of goods, materials and non-materials". Outcomes of social interactions thus explain "the variations in the values and costs of each man to his frequency distribution of behavior among alternatives, where the values (in the mathematical sense) taken by these variable for one man determine in part their values for the other" (Homans, 1958, p599). Essentially, social exchange is about how stakeholders jointly respond to uncertainties and ambiguities in collective value-creating processes (Lawler, 2001, p323). Given the conditions of irresolvable knowledge deficits, both cognitive and emotional reactions would be enhanced "when they succeed or fail at using exchange opportunities to deal with these uncertainties" (Lawler, 2001, p324). The role of value creation in the process of constructive engagement could be seen using

Homans' propositions (Emerson, 1976, p339), with their instrumental focus to develop actionable propositions for effective hazard communication and a guideline for collaborative food safety management.

P1. The Value Proposition: Participants in the food safety process are more likely to take actions that are more valuable to them.

P2. The Success Proposition: When a participant in the food safety process takes an action that is rewarding, that participant is likely to repeat that action.

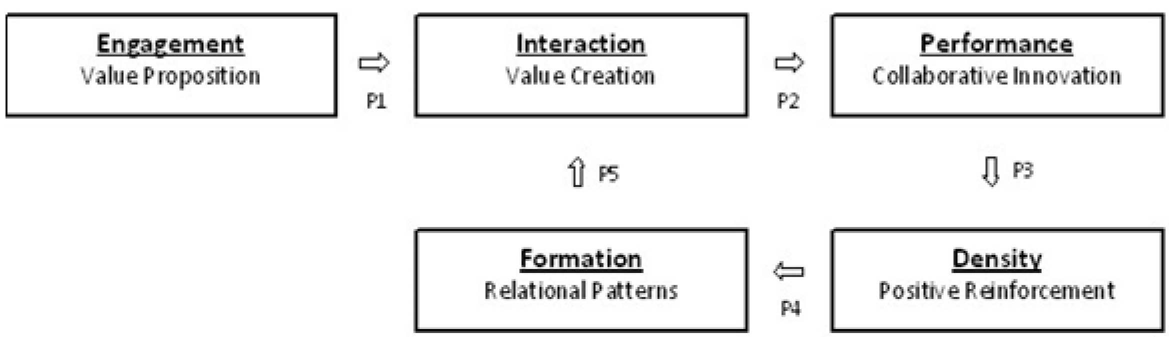
P3. The Stimulus Proposition: When a current situation is similar to one in the past in which a participant in the food safety process took an action that was rewarding, that participant is likely to repeat that action in the current situation.

P4. The Deprivation-Satiation Proposition: However, due to diminishing returns, the value of rewards to a participant in the food safety process for any action decreases with repetition.

P5. The Rationality Proposition: Participants in the food safety process are more likely to take actions that have greater perceived value, in terms of expected reward (formation) multiplied by the probability of receiving the reward (density).

In Figure 3, an EIPDF model with the five propositions indicated is proposed to explain dynamic processes leading to a social equilibrium which infers the structure of an intelligence platform. When one party engages in a social exchange, it offers a value proposition for all parties involved. Through interactions, the proposition is enacted and value is co-created. A higher level of value creation motivates organizational performance, which positively reinforces collaborative behaviors. Reinforced behaviors lead to more stable relationships, in terms of the concept of density (Lusch et al., 2010, p23). Anchored density forms the structure of relationships and set constraints for future interactions. From this sense, social exchange represents a frame of reference that facilitates the use of social power in influencing behaviors (Emerson, 1976, p335 and p338).

Figure 3 Social influence processes and platform structure



6. Discussion

Human beings feel good when they care about each other and build social bonding. This emotional side of human nature is so powerful that it is regarded by some scholars as the main driver for moral responsibility and collective actions (see Haidt, 2001). Feeling how others feel and thinking what others think enables people of different backgrounds to develop mutual understandings, establish closer relationships, and reach consensus in conflicts. Albanese and Van Fleet (1985a) recognize this "soft power" of social relations and emphasize the use of social information to generate positive group dynamics. In the context of work-groups, "social cues from respected co-workers or supervisors about task characteristics may cause a group member to perceive a task as unique. These social cues may serve to reduce the free-riding tendency if they enhance perception of task uniqueness and serve as a special incentive for public-good contributions. Social cues that deemphasize task uniqueness may have the opposite effect" (Albanese and Van Fleet, 1985a, p252-p253). Salancik and Pfeffer (1978, p226) explain the rationale of the social information approach – "individuals, as adaptive organisms, adapt attitudes, behavior, and beliefs to their social context and to the reality of their own past and present behavior and situation … as a function of the information available to them at the time they express the attitude or need"; an individual's "immediate social environment" is an important source of information and impacts "the relative saliency of information relevant to the person".

In 1759, 18 years before the release of the *Wealth of Nations*, Adam Smith published his first book, *The Theory of Moral Sentiments*, in which he expressed his "alternative" mindset antithetical to homo economicus. "How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it except the pleasure of seeing it" (Smith, 1759; quoted by Smith, 1998, p2). The act of sympathy is regarded by Adam Smith as the basis for cooperation because "nothing pleases us more than to observe in other men a fellow-feeling with all the emotions of our own breast" (Smith, 1759; quoted by Coase, 1976, p530).

While acknowledging the importance of human emotion, Smith held a rather composed stance toward its applications. "It is not the love of mankind which makes the 'man of humanity' willing to make this sacrifice, but because he sees himself through the eyes of an impartial spectator" (Coase, 1976, p531). In the complex food system, bounded rationality and associated cognitive and emotional biases suggests there is still a need for a leader who always has a clear and just mind, in Adam Smith's term, an "impartial spectator", focusing exclusively on the welfare of all members of the system and safeguarding the system from potential "psychopathic pursuit of grandiose sense of self-worth" (Hare, 1993). According to Van Fleet and Yukl (1986), effective leadership is situational, subject to the identification of leaders and the nature of social influence, which involve both epistemological and reciprocal influence processes. Although "all learning takes place inside individual human heads" (Simon, 1991, p125), leader-member exchange (LMX) theory (Dansereau, Graen, and Haga, 1975), multiple linkages model

(Yukl, 2006), and leader-environment-follower-interaction (LEFI) theory (Wofford, 1982) support the concept that leadership can be shared, i.e., performed by a variety of members in an organization. However, cognitive resources theory (Fiedler, 1986) implies that attributional biases inherent in organizational behaviors could negatively impact collaborative performance. Viewing the food system as a food safety community, the public agency empowers competent partners in the private sector and enacts servant leadership (Greenleaf, 1973), envisioning common goals, providing necessary technical and social support, and warehousing knowledge that facilitates "efficient cultures" (Wilkins and Ouchi, 1983). Together, the emergent leaders and the servant leader collaborate on (1) task objectives and strategies; (2) commitment and compliance in task behavior to achieve these objectives; (3) group maintenance and identification; and (4) the culture of an organization (Yukl and Van Fleet, 1992, p149). This comprehensive view of leadership based on self-managed autonomous work groups is the essence of involvement-oriented food safety management system – building an intelligence platform through social interactions, exerting social influence through constructive engagements, and achieving coordination and cooperation through strategic food safety inspections.

Chapter 4

Constructive Engagement

1. Spontaneous Order

To set up an intelligence platform, the public agency should refrain from arbitrarily exercising centralized authority and unilaterally imposing a fixed informational structure for stakeholder interactions. Inhibiting the spontaneous order of information flows reduces involvement, which is critical to the success of a knowledge warehouse. After all, an intelligence platform without involvement becomes an “information morgue”. A low density of participants, although easier for control, will limit the synergy the platform can create. Instead, a more appropriate strategy for the public agency is to take the role of a servant leader, learning, participating, and assisting the spontaneous order by managing traceability through the system. In this evolutionary approach of strategic formulating, involvement – stakeholders’ active participation in the food safety commons – enables the public agency to observe their behaviors and hence develop information structure which better reflects the spontaneous order and can practically facilitate the growth of the food system.

The food market provides a built-in platform for policy implementation. Catallaxy, "the order brought about by the mutual adjustment of many individual economies in a market" (Hayek, 2012, p108-109), is acclaimed as the “marvel”, “one of the greatest triumphs of the human mind” (Hayek, 1945, p527). The special kind of spontaneous order in a market coordinates diverse individual actions and utilizes knowledge and skills scattered all over society, without the necessity of a single plan, of a deliberate central authority, of perfect knowledge, or even of completely congruent goals and desires among all members. Although spontaneous, catallaxy is by no means an aggregation of thoughtless reflex. Rather, purposive actions are integral to its configuration, as Hayek pointed out, "its misfortune is the doubt one that it is not the product of human design and that the people guided by it usually do not know why they are made to do what they do" (Hayek, 1945). In his conception, entrepreneurs, who "constantly search for unexploited opportunities" (Hayek, 2002; translated by Snow), keep the spontaneity anew and alive.

In market exchange, if each participant is a social entrepreneur, by performing food safety inspection in his or her local niche, sharing circumstantial knowledge and market intelligence, and coordinating with others to remove hazardous products and services, the exchange becomes a constructive force which further transforms the market into an "organized complexity" (Hayek, 1989). In this light, prosocial activities reflect how innovative opportunities are contextualized (Garud, Gehman, and Giuliani, 2014). The envisioned collaborative partnerships (FSWG) are implemented by entrepreneurial teams (Harper, 2008, p622) developing more encompassing entrepreneurial cognitions, "the knowledge structures that people use to make assessments, judgments, or decisions involving opportunity evaluation, venture creation, and growth" (Mitchell, Busenitz, Lant, McDougall, Morse, and Smith, 2002, p97).

Entrepreneurial teamwork for the market-based, prosocial approach of food safety inspection is different from Harper's conceptualization that "team members are on an equal footing in the joint enterprise" (Harper, 2008, p623). While food safety is a common interest, members of market-based teams would not share comparable knowledge and motivation. They have heterogeneous competence - some enjoy more economic and cultural resources; others are handicapped. They have different motives - suppliers are driven by profit incentives and growth opportunities; consumers, by personal needs and wants; public agencies, by political and performance concerns. In this regard, efficacious collaborative partnerships need to shape and maintain opportunity structures (Merton, 1959) that can hold the entrepreneurial teamwork supportive and accountable.

In Hayek's (1945) view, the use of knowledge sets up three kinds of opportunity structures in markets: centralized, decentralized, and pluralistic. In a centralized structure, all relevant facts and intelligence are assumed to be acquired by a single command so as to formulate an optimal plan. In a decentralized structure, all facts and intelligence are assumed to be distributed and possessed by every member. While in an open and complex task environment, a centralized structure would limit the extent of innovation due to bounded rationality, a decentralized structure would render a system disintegrative and inefficient. In a pluralistic structure, centralized and decentralized structures co-exist in a market. On the centralized side, experts develop specialty knowledge; system administrators manage infrastructure, repair deficiencies, and resolve conflicts. On the decentralized side, each member possesses circumstantial knowledge as it is given.

Separately located knowledge is then integrated through communication and transferred to relevant decision makers.

Coordination in such processes of communication is a major concern, because a pluralistic structure would not be in a clean-cut, half-and-half formation. Rather, the spontaneous order has an amorphous structure which exhibits unbounded potentials and reflects the dynamics of "kaleidic interactions" (Shackle, 1974), however, "wherein it is impossible to fully coordinate activities …, [and] the process of entrepreneurial innovation is always in disequilibrium" (Garud et al., 2014, p1181). In other words, stability is not an inherent property of the pluralist structure. As "an entrepreneur's imagination continually changes based in part on new information generated by interactions with other entrepreneurs and stakeholders" (Garud et al., 2014, p1181), the spontaneous market order is an aggregation of contextual phenomena with its equilibrium to be maintained momently through communicating both physical evidence and socially derived interpretations and meanings (Salancik and Pfeffer, 1978, p228; Festinger, 1954).

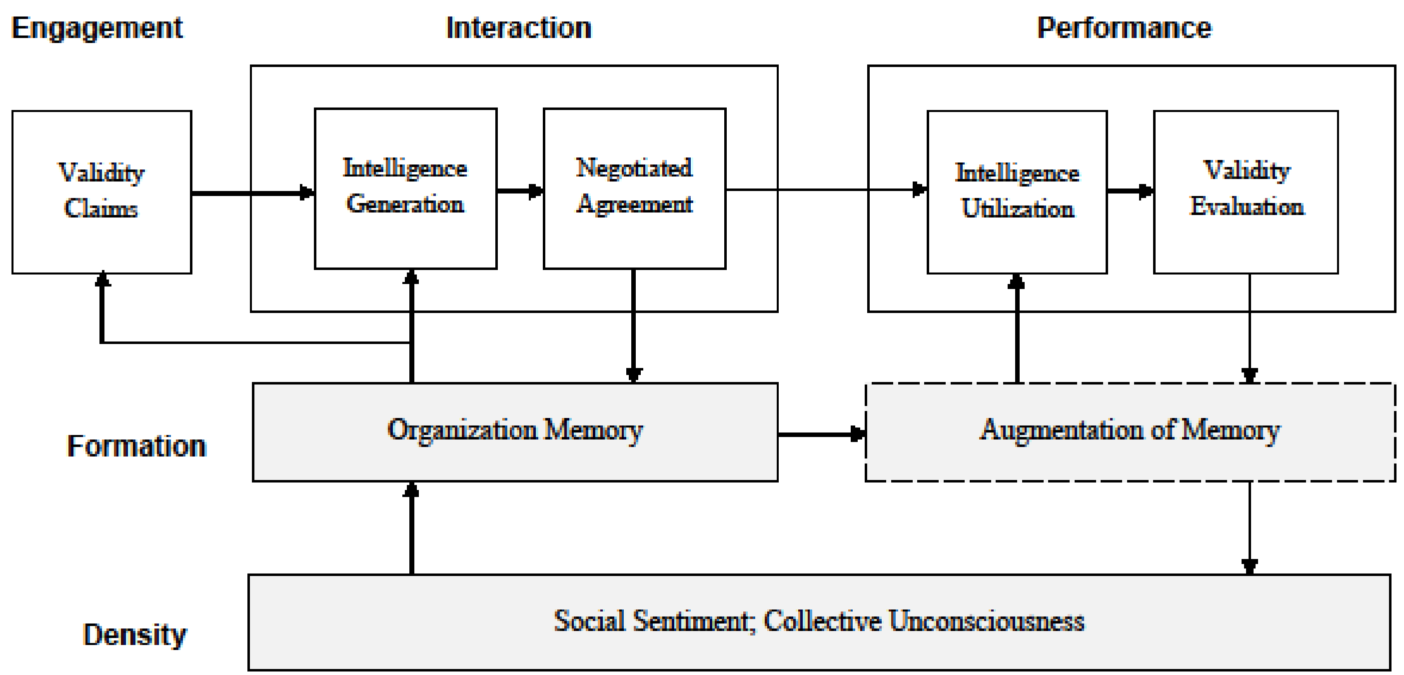
2. Communicative Actions

Jürgen Habermas' theory of communicative action explains how collaborative partnerships are achieved with both sense and sensitivity. Communicative action refers to "the interaction of at least two subjects capable of speech and action who establish interpersonal relations. The actors seek to reach an understanding about the action situation and their plans of action in order to coordinate their actions by way of agreement" (Habermas, 1984). Central to the theory is the concept of interpretation that multiple actors negotiate definitions of a complex situation which would consequently admit of consensus. Language is given a prominent role in this process of collective interpretation. Nevertheless, Habermas' concept on the use of linguistic expressions for coordination is by no means subject to Hardin's criticism on mass communication and his negative connotation of propaganda. Rather, it concurs with the notion of "performatives" in the theory of speech acts (Austin, 1962) and the collective acceptance theory of social institutions (Miller, 1984).

Performatives are "invoked" joint actions (Austin, 1962), "sayings which are also doings … speech acts which bring about an outcome in the external world … the outcome depends on collective acceptance" (Miller, 2012). In the theory of communicative action, the action specifically refers to symbolic expressions with which the actor engages certain kinds of interactive relations in the context of the objective world (identified by physical objectives and events). Rationality, defined as the acquisition and the use of knowledge by speaking and acting subjects (actors), is a critical element to be maintained throughout the process of realization from intent via communicative action to outcomes. Another crucial enabler, validity claims, defined as rational expressions which have "the character of meaningful actions, intelligible in their context, through which the actor relates to something in the objective world", anchor the elusive feeling of trust in the dynamic process. How do communicative actions drive the performance of collaborative partnerships? In short, in a communicative action, an actor proposes a claim which is open for objective appraisal in order to invite other actors to take a "rationally motivated position". As knowledge is embodied in symbolic expressions, rationality is extracted through argumentation, "continuing communicative action with reflective means". Whether that symbolic expression can lead to a motivated agreement and a joint action depends on how its validity claims are evaluated against the conditions of its validity, i.e., "background knowledge inter-subjectively shared by a communication community constituted of all participants".

While consensus is the focal intent of communicative actions, whether the internal coherence can lead to superior organizational performance is an empirical question and beyond the theoretical scope. In the context of strategic food safety inspection, entrepreneurial teams that function as market-driven organizations require a distinct ability to anticipate market events and trends ahead – market sensing capability (Day, 1994). Using concepts of Day (1994, p43) and the EIPDF model in the previous chapter, Figure 1 depicts the evaluation of validity claims in a stylized sequence. A negotiated agreement involves two interrelated processes in five sequential stages. On the one hand, the explicit process of information processing consists of five activities: symbolic expression, intelligence generation, collective interpretation, intelligence utilization, and performative evaluation. On the other hand, the latent process of knowledge sharing includes four elements: organization memory, its augmentation, social sentiment, and collective unconsciousness. In the dynamic processes, hazard information is first translated into a symbolic expression and used as a control signal to engage collaborative partners. Through social interactions, hazard intelligence is generated from two different sources regarding technical attributes and social responses. Collective interpretation of the hazard intelligence drives the imagination of entrepreneurial teamwork and guides the utilization of intelligence. The conceptual model further highlights the importance of collaborative performance, and its reinforcing effect through the process of feedback. Organization memory refers to “the stored information from an organization’s history that can be brought to bear on present decisions” (Walsh and Ungson, 1991, p61). Together with social sentiment and collective unconsciousness, the “non-regulatory supplements” to centralized governance, represent the tacit aspect of social processes that serve as a repository for collective insights, drive collective imagination, and set the course of ongoing inquiries. To the public agency, the social responses to information cues would be observed only indirectly through proxy measures. Therefore, observability of dynamic social behaviors raises another concern that, while “to manage is not to control” (Landau and Stout, 1979), “if you can’t measure it, how can you manage it” (Broadbent, 2007)?

Figure 1. Communicative actions of collaborative partnerships in food safety inspection



Adapted from Day (1994, p43), market sensing: processes for learning about markets

In communicative actions, social information processing does not naturally follow a top-down, hierarchical, or mechanical order and allow for exact control. Rather, free flows of social energy would more likely to reflect a bottom-up, organic pattern of “swarm intelligence”. Bonabeau and Meyer (2001) observed the collective behavior and swarm intelligence that emerges from a group of ants. "Individually, they have meager intelligence. And they work with no supervision ... for social insects teamwork is largely self-organized, coordinated primarily through the interactions of individual colony members ... Although these interactions might be primitive, taken together they result in efficient solutions to difficult problems (such as finding the shortest route to a food source among myriad possible pathways)" (Bonabeau and Meyer, 2001, p108 and 109). The emergent, self-organized, social behavior is not a product of chance and randomness. Rather, certain elements are antecedent to it. "Individual ants emit a chemical substance -- a pheromone -- which then attracts other ants. In a simple case, two ants leave the nest at the same time and take different paths to a food source, making their trails with pheromone. The ant that took the shorter path will return first, and this trail will now be marked with twice as much pheromone as the path taken by the second ant, which has yet to return. Their nest mates will be attracted to the shorter path because of its higher concentration of pheromone. As more and more ants take that route, they too lay pheromone, further amplifying the attractiveness of the shorter trail" (Bonabeau and Meyer, 2001, p108). Counterintuitively, the collective, efficient activity is not directed and controlled by any queens or generals, but determined by two simple rules of individual ants: first, lay pheromone; second, follow the trails of other ants with the most pheromone concentration. This is an example of Likert’s system 5 – managing without a boss (Likert and Araki, 1986; Likert and Likert, 1976, p33) that prosocial activities can drive to the performance of a working system.

3. Free-riding Tendency

Indeed, human society is much more complicated than an ant colony. While ant behaviors are directed by robotic and programmed reactions, it is argued that human behaviors are fundamentally driven by self-interestedness (Smith, 1937). If conflicts exist between individual sub-goals and the collective goal, individuals would not be motivated to participate in communicative actions. Collaborative partnerships would deviate from the intended policy goal due to the free-riding problem. The free riding tendency refers to the phenomenon that members of a group obtain benefits from group membership but do not bear a proportional share of the costs of providing the benefits (Albanese and Van Fleet, 1985a, p244). Albanese and Van Fleet argue that free riding behaviors, although not desirable, are “rational”, i.e., expectable, outcomes within group settings. The supply of a public good in this context will inevitably be “suboptimal” (assuming an optimal amount of such a good can be conjectured). Further, the shortage of the public good would be more severe as the group size increases.

Although counterintuitive, the free riding tendency has its psychological roots. According to March and Simon (1958), human beings are not omniscient, but have a general feature of “bounded rationality”, i.e., cognitive limits on rationality, under which decision makers are intended to be rational but it is so only in a limited sense, due to cognitive, behavioral, and emotional reasons. Cognitively, decision making would be influenced by selective attention when multiple alternatives are present. Due to capacity constraints of the brain and sense organs, human beings can only process a limited amount of environmental stimuli at a time. When multiple stimuli vie for attention, decision makers have to prioritize alternatives and ration cognitive resources to avoid sensory overload. Behaviorally, the focus of attention would be driven and reinforced by the pursuit of self-interestedness, which to an extreme extent is described as "selfish" interests (Albanese and Van Fleet, 1985a, p252), "solemnity of the remorseless working of things" (Hardin, 1968, p3), or opportunism (Williamson, 1998). Emotionally, the attentional processes would be further distorted by risk attitudes, perception of uncertainty, and feelings of stress. Hence, March and Simon (1958) described "satisficing" as the tendency of human beings under uncertainty to select not an unknown optimum but rather the first minimally acceptable alternative perceived. Consciously or unconsciously, bounded rationality sets the course of perception and expectation and shapes a decision maker's preference, i.e., "satisfactory standard" (March and Simon, 1958).

When collaborative partners hold different satisfactory standards, collaborative decision making would encounter the issue of conflicting sub-goals. When collaborative partners hold different satisfactory standards, conflicting sub-goals indicate a possibility that collaborative outcomes would not attain maximum public interest. March and Simon (1958, p154) explains the processes of conflict resolution through coordinating sub-goal formation with three critical factors: the focus of attention, the focus of information, and the span of attention. The essential task to align multiple sub-goals is to create a focus of attention within an organization. To do so involves a two-fold strategy. First, an informational strategy adjusts the focus of information that sets up a frame of reference, providing guidelines for organizational members to adjust individual definitions of situation and satisfactory standards. Second, a social strategy manages the span of attention that determines the capacity of organizational members and the magnitude of their efforts for alignment. The March and Simon's model represents a deliberate strategy crafted by a "chess master" (Simon, 1987). When a centralized command (acting as Simon's chess master) carefully manages information flows throughout an organization, including inflows, outflows, intra-vertical flows, and intra-horizontal flows, subjective to the responsiveness to the information supply, organizational members (chessmen) are expected to align their attention to the focus. The convergence of expectations (Malmgren, 1961) would lead to the attainment of collective goal.

Under the trend of Internet of Things (IOTs), bits and bytes generated from the use of information and communication technologies, consciously or unconsciously, influence how people interact with one another and frame their decisions. The so-called "digital pheromones" (Bonabeau and Meyer, 2001, p109) have become an increasingly prominent factor that drives decisions and shapes behaviors. In this brave new virtual reality, social networks open a creative avenue for the public agency to manage public attention. Engagement through Internet and social media allows coordination with more efficient regulatory interventions by the use of social information to drive motivation for cooperation. Real-time information service and word-of-mouth effects create a sense of direction and shape the structure of task environments. In two ways, social networks impact the structure of communication actions.

1) Decision framing:

A push-based strategy resorts to opinion leaders and vertical communications. Influentials with significant social power on others (Libai, Bolton, Bügel, de Ruyter, Götz, Risselada, and Stephen, 2010, p271) have the charismatic effects that a small number of individuals are able to leverage social media to mobilize a relatively large group of followers.

2) Community building:

A pull-based strategy relies on social capital and horizontal communications. Social capital, defined as advantages and opportunities accruing to people through membership in communities (Bourdieu, 1986), provides a basis for exerting behavioral influence through relational value enclosed in peer-to-peer bonds and socially-embedded exchanges (Laibai et al., 2010). Interestingly, social capital is most efficacious when a community involves members with internal locus of control. In this regard, a lively community by nature should be self-organized and driven by organic information flows.

The social orientation of market-based collaborative problem-solving, contrasting to the technical chess-master logic, generates a self-correcting counterforce to the free-riding tendency when intrinsic satisfaction is enhanced (Albanese and Van Fleet, 1985a, p252). Those who possess superior knowledge and higher motivation stand up as emergent leaders. They perceive innovative opportunities and conceive action plans. Their leadership behaviors are transformed into information cues for communicative actions. Followers respond to the calls and their following behaviors generate information traces. The responsiveness further provides references for social comparison. The self-organized symbolic interactions in the communicative actions represent “the dynamics of tacit knowing” (Polanyi, 1967, p319). Information cues and traces form a traceability structure of tacit knowing and create meaning through sense-giving (laying a digital pheromone; technical traceability) and sense-reading (responding to the trace; social traceability). The two activities, for integrating “signs of potentialities” (p321) and exerting “the power of anticipatory intuition” (p321), are “essential kinship of heuristics and verification” (p322) which enact “a body of anticipatory outline” (p322) that reflects rational processes of argumentation, “continuing communicative actions with reflective means”. Maintaining a coherent traceability structure is so important to efficacious collaborative partnerships because “random trial and error unguided by such a perspective will never add up to a skillful performance” (Polanyi, 1967, p322).

4. Constructive Engagement

In control theory, the control of a system is operated by two instruments: control signal and controller. A control signal provides reference that, when attached to the output of a plant, a controller can monitor and adjust the output by changing the value of the signal. In Hayek’s conceptual framework of catallaxy, prices exemplify a control signal that coordinates the access and the use of knowledge and provides traceability in the market system. While a succinct form, prices have limited capacity to extract, register, and convey full information from all market activities. Hence, self-correction based on prices is never meant to be "perfect" (Hayek, 1945, p527), and coordination solely through prices would result in market failures. As Hayek pointed out, the price system is "just one of those formations which man has learned to use" (Hayek, 1945, p528). Along with prices, a market would resort to other information systems, for example, word-of-mouth, labels, packages, advertisements, consumer reports, public information notices, etc. Various market signals visualize social responses and provide opportunities for the public agency to engage collaborative partners and to generate open-source intelligence (OSINT). Moreover, the public agency needs to actively engage collaborative partners so as to elicit responses and induce desired prosocial outcomes. According to Albanese and Van Fleet (1985a, p253), "the basic strategy for counting the free-riding tendency is to build various private goods that are contingent on the provision of the group's public good into the group member's incentive system". In the context of market-based communicative actions, the strategy of constructive engagement is implemented by bundling prosocial symbolic expressions with private goods to induce desirable social responses. An economic analysis demonstrates the feasibility of the strategy.

Referred to notations in Table 1, the bundling of a symbolic expression with a private good is expressed as:

$$\alpha + \beta M(x, e)$$

In the market, collaborative partners perceive a call for actions through salient information cues and reveal their behaviors. The relationship between information cues and the true task characteristic is not deterministic, subject to heterogeneous perception, expectation, and preference. Economic justification of the bundling is represented as benefits and costs of the supply of information regarding the differentiated attribute:

$$\alpha + \beta M(x, e) - c(x)$$

The economic value is maximized as the optimal level of x is chosen, under the first-order condition:

$$\beta M_x - c'(x) = 0$$

The optimal level of the task characteristic x* is implicitly defined as x* = x*(β, e). Comparative statics $\partial x^* / \partial \beta = -Mx / \beta M_{xx} - c''$ indicate positive definite. Assume collaborative partners are risk-neutral to the symbolic expression itself. Their risk attitudes are reflected in their responses (β). Collaborative partners perceive the symbolic expression and maximize their expected value from task characteristics. Collaborative partners expect benefits from processing the market signal, and therefore, let

$$E[B(x,e) - \alpha - \beta M(x,e)], \text{ subject to: (1) } E[\alpha + \beta M(x, e) - c(x)] = u_0; \text{ and (2) } x = x^*(\beta, e).$$

The first-order condition to maximize the constrained objective function equals to:

$$E[(B_x - C') \partial x^* / \partial \beta] = 0.$$

Substituting results from economic value maximization and taking a second-order Taylor approximation of M and C, one can derive an expression of β*.

$$\beta^* = E[(B_x)^*(M_x)] / E[(M_x)^*(M_x)] = Cov(B_x, M_x) / Var(M_x)$$

Table 1. List of notations

Symbol	Definition
α	A private good
M	A symbolic expression that elicits social responses
x	A task characteristic indicated in the symbolic expression (M)
e	A random noise, assuming $e \sim N(0, \sigma^2)$
β	A measure of the economic incentive that drives social responses to the symbolic expression (M)
C	Cost of provision of the symbolic expression (M)
B	Perceived benefits from the task in terms of the characteristic (x)
u_0	Reservation utility of collaborative partners

The analytical result indicates that, in communicative actions, economic incentives that induce social responses are driven by two factors. First, the covariance between perceived benefits and the symbolic expression indicates the degree of goal congruence. Second, the variance of the symbolic expression suggests the degree of situational ambiguity. On the one hand, a higher degree of goal congruence strengthens the economic incentive for social responses. On the other hand, a higher degree of situational ambiguity reduces the efficacy of the symbolic expression. The factors correspond to the two dimensions in communicative actions, knowledge sharing and information processing. The result also concurs with the notion of involvement as personal relevance in Celsi and Olson (1988) that the motivation of an individual to process information can be viewed from two aspects. The social aspect of knowledge sharing is determined by “a function of the personal relevant knowledge that is activated in memory in a particular situation” (p211). The technical aspect of information processing is determined by “the extent that relevant knowledge can be retrieved from memory in a given situation” (p210).

If properly designed and managed, the symbolic expressions can be sources of social influence because social cues from respected peers about task characteristics create a sense of task uniqueness and promote individual contributions (Albanese and Van Fleet, 1985a). However, the strategy is a double-edged sword. Social cues deemphasize uniqueness would cause opposite effects that result in free-riding or, even worse, selfish behaviors. Lest well-intended public operations adversely impact the prosocial spirit, prudent interventions are necessary in consideration of involvement from collaborative partners. As an alternative public strategy to direct interventions, Shultz and Holbrook (1999) argue for strategic application of communicative interactions and systematic deployment of explicit and measurable indicators in the task environment for prosocial outcomes. Ensuing accountability further allows the public agency to construct practical control signals, coordinate diverse interests, and drive system performance. Traceability throughout the course of communicative actions brings to the surface meaningful measures by creating a representation of tacit social dynamics that indicate conflict situations and promote self-organized checks and balances.

Chapter 5

Traceability

1. Traceability in Food Supply

The International Organization of Standardization (ISO 8402:1994) defines traceability as "the ability to trace the history, application or location of an entity by means of recorded identifications". The Food and Agriculture Organization of the United Nations (FAO) includes a dynamic aspect in the Codex Alimentarius (Latin for food code): "traceability/product tracing is the ability to follow the movement of food through specified stage(s) of production, processing and distribution". European Community Regulation 178/2002 offers a definition more pertinent to food and agribusiness in details: "the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution". Modern food and agribusiness supply involves interdependent actors and numerous inputs, processes, and outputs. In order to be effective, "traceability must be managed by setting up a traceability system" (Moe, 1998, p211), which constitutes a record keeping system designed to track the flow of product or product attributes through not only internal production processes but also external supply chains (Golan et al., 2004). In this context, the concept of traceability incorporates a supply chain view. Under which, transactions (i.e., exchange relationships between consumers and suppliers) are sustained by interactions of three activities – flows of physical products, flows of information, and flows of financial rewards – in a symbiotic cycle. Traceability systems along supply chains operationalize on the dimension of information, emphasizing on five factors – what (unit of analysis), who (actors), where (locations), when (events), and how (methods) of a subject under considerations.

Van Dorp (2002) defines a traceability system from the perspective of information management, including three layers: item coding (the physical layer), information architecture (information layer), and planning and control (the control layer). Item coding identifies products' unique properties, such as forms, fits, or functions, and embeds them in codes. This activity establishes a link between a product and associated information to increase the efficiency of the system. Information architecture manages the flow of information in terms of quantity and quality by setting up de-coupling points in the supply chain to determine the degree of aggregation of information, and assures information quality through quality audits and certification. The two levels build a foundation for the third, planning and control, which optimizes production activities with respect to feedback from tracking activities.

Traceability costs arise from activities of these three layers. First, costs of product differentiation relate to managing an item coding system that enables tacking units to be separated from one another and preserved their unique identities. Second, costs of recordkeeping relate to managing the information architecture that collects and maintains information on products and product attributes. Depending on the objectives of a system, these activities vary in the degree of sophistication, resulting in the characteristics which we can observe from a traceability system: the breadth, which describes the amount of information the system records; the depth, which defines how far back or forward the system tracks in a supply chain; and the precision, which reflects the degree of assurance a system can specify a particular product movement or characteristic.

Suppliers have three general objectives to develop and maintain traceability systems. First, a system is designed to improve supply management. By tracking production, inventory, and sales, a system provides information for finding the most efficient approach to coordinate logistics activities. Second, a system is designed to assure quality management. By tracking product movements, a system isolates the sources of potential hazards, clarifies liability, and limits the extent of risk associated with a food safety failure. Third, a system is designed to facilitate marketing management. By tracking product attributes desired by consumers, a system differentiates among products and creates new market opportunities. Suppliers are thus able to attain higher profits, cost-wise, from business environment with lower costs and less risk; and, revenue-wise, from a market position with better margins. An economically justifiable amount of investment on a traceability system is then determined by estimating and weighing the benefits that the system can bring to the company (Golan et al, 2004).

Food and agribusiness companies have spent substantial efforts in improving traceability technology. In the product identification technology, for example, the Universal Product Code (UPC), or the bar code, is a labeling scheme based on standards set up by the Uniform Code Council (UCC) of the U.S. and European Article Numbering (EAN) System. It contains a series of 12-digit or 14-digit numbers that represent certain attributes of a tracking unit. While it is a widely adopted industrial practice and the cost of application is low, it has very limited capacity for storing information. Moreover, retrieving data requires scanning the label with a bar code reader, which may not function well in a wet and cold environment. The radio frequency identification (RFID) is a newer technology without these two limitations. Based on the standard, Electronic Product Code (EPC) set up by the UCC and EAN, a RFID tag embeds a computer chip and its own power source so that it can actively and automatically receive and send a large amount of data. In addition, the tag can be recycled, reprogrammed, and reused for lowering costs. One potential drawback is that RFID tags can only be read by machines and cannot be processed manually by humans, and therefore makes the investment in a reliable RFID system utmost important (Thompson et al., 2005). Other technological development in quality and safety measurement, genetic analysis, environmental monitoring, geospatial positioning, and software for system integration are becoming practical industrial applications (Opara, 2003).

<u>Traceability Problem</u>

In the U.S., while private food and agribusiness companies have developed a significant capacity, they may not be motivated to improve traceability to a socially optimal level without incentives – a case of market failures (Golan et al., 2004). Extant economic literatures address causes of market failures from two aspects: information asymmetry and public goods. Taking the previously mentioned supply chain view, information can be transformed and incorporated as a part of product specifications. A market-based solution can then be devised by balancing product offerings and financial rewards, although the value of anonymity (Golan et al., 2004) raises an issue of moral hazard. While the principal agent model is applicable, the impact from monitoring costs would attenuate the effort and cause deviations from the status of optimal traceability supply. Further, traceability has a characteristic of public goods (Richards et al., 2009). Traceability supply may suffer from a free rider problem, resulting in reverse selection. A mandatory traceability system is a standard government response to this problem. However, it is criticized to be ineffective, failing to accommodate various use cases in different industrial sectors. In addition, the current public budget constraint does not welcome the development of a fully encompassing but costly system.

Modern food and agribusiness supply chains in the U.S. are characterized by their efficiency-driven trends. In general, food and agricultural products are income inelastic in nature. Consumer spending on such products has changed less proportionally as income rises. This phenomenon causes the so called "farm problem". In essence, farms and food companies are constantly facing declining profits, while an invisible price ceiling exists for their products but some of the input costs keep pace with income. Vertical integration, standardization in products, and global sourcing for low-cost inputs are then the three major approaches to secure margins. These three forces interact and result in consolidation in operations. Firms that are vertically integrated enjoy scale economies in unit fixed cost allocation, in marketing standardized products, and in global operations. However, as Coase (1937) prescribed, costs of errors outweigh the gains when firms over stretch their boundaries beyond management capacity.

Bovine Spongiform Encephalopathy (Beef), hoof-and-mouth disease (pork), microbial contamination of fresh produce (Spinach), poisons in animal feeds (Chinese pet food), unhealthy food additives (Chinese dairy products) and genetically modified organism (GMO) products are a few in the long list of food safety events that have drawn public attention. During a food safety outbreak, all companies in the industry can be impacted from a loss of sales. For example, the E Coli outbreak from fresh spinach in 2006 has caused a change in consumption preferences. Even after processors in California formed an industrial association, California Leafy Green Products Handler Marketing Association (LGMA) to control quality and boost public confidence, U.S. consumers have still purchased less spinach. In a worst scenario, public trust in the capability and integrity of the industry could be so low that a market collapse would result, leading to a deadweight loss of the whole industry.

While both private and public sectors in the U.S. are aware of the severity of the problem, and recognize that traceability is the first step of the food supply chain quality management (Roth el al., 2008), market failure becomes an obstacle in the supply of traceability. The public sector is not efficient in identifying and tracing all various use cases (Golan et al., 2004) but the private sector does not have sufficient incentive to cover the gaps (Richards et al., 2008). According to Arrow (1969), “market failure is not absolute; it is better to consider a broader category, that of transaction costs, which in general impede and in particular cases completely block the formation of markets”. Therefore, the problem of insufficient traceability supply can be examined from the lens of transaction costs economics for possible remedies.

2. Review on Transaction Cost Economics

<u>Transaction Costs</u>

A transaction occurs when a product or service is transferred through an interface between two separate parties. Ideally, the product or service moves smoothly with a constant full speed. The neoclassical economic theory portrays such a frictionless business environment. A firm is regarded as a production function that selects through alternatives to minimize input costs and maximize consumer utility. The invisible hand, the price mechanism, coordinates all consumers, firms, and economic activities moving toward an optimized status of equilibrium, so that the market is looked like "ocean of unconscious cooperation". However, this ideal is not always true. In reality, as Coase (1937) pondered the justification of "islands of conscious power", he argued that there are frictions – costs of using the price mechanism, named as transaction costs. In Coase's ideas, to organize production through the price mechanism, an actor needs to first discover relevant prices in the market, and then negotiate and conclude a contract with another actor for each exchange transaction. It is costly to conduct these two activities. Thus, a firm is formed to allow an authority to direct resources, saving the costs of marketing. However, organizing firms is not a panacea either. The expansion of a firm is subject to two forces. First, the size of a firm is constrained by diminishing returns of management, because costs of errors increase as a firm grows. Second, in a competitive environment, a firm takes over an activity from another firm only if the cost of running an operation internally is less than the cost of acquiring the same outcome of the operation from the market. The boundary of a firm thus is determined by a tradeoff between the two sources of transaction costs. In addition to cost comparisons, the presence of uncertainty, "the fact of ignorance and the necessity of acting upon opinion rather than knowledge", makes a firm more effective than the price mechanism. While Coase pointed out the needs for forecasting and an inevitable process of cephalization under uncertainty, he left the sources and implications of this effect for future researches.

<u>Transaction Cost Economics</u>

Following Coase's (1937) idea that a firm has coordinating potential to tradeoff transaction costs, Williamson (1998, 1981, 1979, 1971) developed a micro-level analytical structure for transaction cost economics and offers a more extensive understanding of the topic. The foundation of Williamson's framework is built on two behavioral assumptions, based on Herbert Simon's (1979) studies on human nature. (1) Bounded rationality describes the limited competence of human actors to formulate and solve complex problems and to process information. While bounded rationality is not necessarily hyperrationality, it does not mean irrationality either. Human agents are intended to be rational, farsighted, rather than myopic, although, in an economic sense, all complex contracts are still inevitably incomplete, containing gaps, errors, or omissions. (2) Opportunism is viewed by Williamson as the central concept in the study of transaction costs. Human actors are assumed to be self-seeking with guile, not only pursuing self-interest but also applying false or empty threats or promises to take advantage of others if an opportunity to gain more profits is present. Accordingly, a contract without a credible endorsement will not be self-fulfilled.

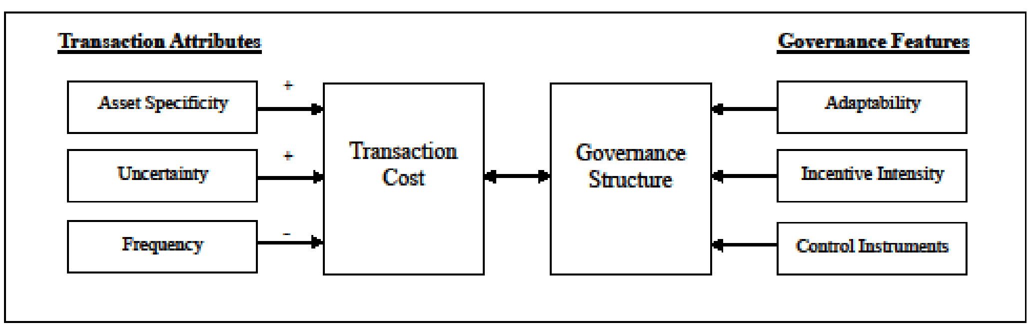
In this framework, the transaction is the basic unit of analysis. The operationalization of the transaction cost economics is based on principal dimensions, asset specificity, uncertainty, and frequency, the three key features of a transaction. *Uncertainty* signifies the disturbances to which transactions are subject. *Frequency* indicates whether and how transactions recur. *Asset specificity* represents the degree to which durable transaction-specific investments are incurred. The transaction-specific assets take various forms, such as physical assets, human assets, site specificity, and dedicated assets, etc. Under this analytical framework, a firm serves a role not only as a production function transforming inputs into outputs, but also as a structure governing transactions. Given bounded rationality and opportunism, a firm acts on the three transactional dimensions, with an objective to set up order in an exchange relationship, mitigate potential conflict threats, and thus realize mutual gains. This objective is achieved by selecting the appropriate governance mode from discrete structural alternatives – market, hybrid, or hierarchy. The governance modes differ in their competence, in terms of adaptability, incentive intensity, and control instruments (Table 1). Contingent to the institutional environment, the efficacious governance mode economizes transaction costs and better support exchanges.

Table 1. Features of alternative governance modes

Feature / Mode	**Market**	**Hybrid**	**Hierarchy**
Adaptability	Low	Medium	High
Incentive intensity	High	Medium	Low
Control instruments	Low	Medium	High

In sum, transaction costs measure frictions occurred in exchange relationships, for example, the cost of using price mechanisms (Coase, 1937). Under this framework, an economic organization is not conceptualized as a neoclassical production function which transforms inputs into outputs in a streamline. Rather, it is a governance structure that conditions behaviors from agents with different preferences, needs, and capabilities and trying to solve economic problems of each's own. Given bounded rationality and opportunism (Williamson, 1998, p31), with the objective to develop private orderings that resolve conflicts and thus realizes mutual gains, agents interact on three transactional attributes that define the property of the "technologically separable interface" (Williamson, 1981) - uncertainty, asset specificity, and frequency. The exercise of the "discriminating alignment hypothesis" (Williamson, 1998, p37) identifies the right governance structure that economizes transaction costs, by aligning governance structures (for example, market, hybrid, hierarchy) with transactional attributes (Figure 1).

Figure 1. A transaction cost analytical framework



Uncertainty

Uncertainty is a multidimensional construct and arises from different sources and perspectives. For example, Koopmans (1957) distinguished between primary and secondary uncertainty while Milliken (1987) defined a typology of uncertainty dimensions as state, effect, and response uncertainty. Additionally, Sutcliffe and Zaheer (1998) tested three sources of uncertainty in a transaction, primary, competitive, and supplier uncertainty. Although empirical studies from John and Weitz (1988) and Heide and John (1990) found that other types of uncertainty, such as volume, or technological uncertainty, have effects on firms' vertical integration decisions, in the context of a transactional relationship, Williamson (1998) contends that the behavioral uncertainty is the relevant form, as it is human actors' behaviors, including how they initiate or respond to different types of changes, that impact transaction costs. While bounded rationality causes all contracts to be incomplete, opportunism subjects them to hazardous results. The effects of these two characteristics may come from all human actors involved in the transaction; for example, both suppliers and customers, or even other suppliers and customers who are currently not involved but have the potential to influence the transaction. Sources of uncertainty are explained by situational ambiguity in the task environment and goal conflict among collaborative partners. Derived from the economic analysis in the previous chapter, the two dimensions imply root causes of high transaction costs.

1) Situational ambiguity:

Referred to classification schemes of Nelson (1970) and Darby and Karni (1973), common food and agribusiness products can be categorized into three types according to their *search*, *experience*, or *credence* attributes. While consumers can examine a product's search attributes before purchase or experience attributes after consumption, it is impossible for them to discern credence attributes, because they simply do not have the necessary capacity and capability to monitor production processes or to detect properties in the product content. Differences between the three product attributes suggest the intensity of hidden information, implying the degree of information asymmetry and thus potential hazards to which transactions are exposed (Table 2).

Table 2. Relationships of product/service attributes and uncertainty

Characteristics	**Attribute saliency**	**Hazard potential**
Search	High	Low
Experience	Medium	Medium
Credence	Low	High

2) Goal congruence:

Goal congruence indicates whether consumers and suppliers are like-minded. Collaborative partnerships are only feasible when congruent goals lead to equal and mutually beneficial agreement. Therefore, a critical question is whether consumers and suppliers maximize their joint utility, or pursue their own sub-goals at the expense of the other party. Conflicts between the goals of two parties can arise for several reasons (Table 3). In terms of morality, consumers and suppliers may hold different moral and value standards and exhibit Williamson’s (1998) behavioral assumption, opportunism as self-seeking with guile, pursuing own interests at the expense of other parties. In terms of information, information asymmetry may exist and thus cause transaction parties unable to acquire necessary information for making correct decisions. In terms of competency, suppliers fail to fulfill their promises to consumers, or even worse, are not capable of meeting customer requirements. Consumers may not be equipped with the necessary knowledge or skills to perceive or process market signals sent by suppliers. In terms of market structure, competitive conditions and market power may also explain conflicts between suppliers and consumers. For example, suppliers under an over-crowding market may deviate from consumers' benefits in order to survive cut throat competitions. Moreover, suppliers or consumers with market power may exercise their power to achieve better trade terms.

Table 3. Causes of goal incongruence

Aspect \ Party	**Supplier**	**Consumer**
Ethics	Myopia Suppliers only concern own goals (production, sales, or profit).	Egocentrics Consumers only concern own goals (satisfaction).
Information	Information disclosure Suppliers remain anonymity in key information.	Information asymmetry Consumers do not access full product or process information.
Competency	Quality Suppliers are not capable of fulfilling promises or demand.	Vulnerability Consumers are not capable of perceiving or interpreting market signals
Market	The Hunger Game Overly crowding and overly competitive market conditions	The Power Game Power imbalance between stakeholders

Asset specificity

The notion of asset is conceptually identical to that of capital (Bourdieu, 1986). Transaction specific assets take various forms, for example, economic, cultural, and social capital. Traceability supply creates value through conversions of the forms of capital. Thus, investment in transaction-specific assets reduces uncertainty through two ways.

1) Information effects on situational ambiguity:

Information effects indicate conversions between economic capital and cultural capital. Efficient processing of information is an important and related concept in transaction cost economics (Williamson, 1979), because human actors make decisions – assessing situations, forming expectations, selecting choices, and evaluating outcomes, based on their perceived information, information available to them at the time of decision making and their interpretation of the available information. On the one hand, bounded rationality constrains human actors' abilities to receive, store, retrieve, and process data. When they encounter complex and uncertain transactional conditions, this limitation causes an effect of "information impactedness". Information sticks to the source and does not transmit freely, because information receivers are unable to process it. Moreover, observational economics show that "the acquisition of information often involves a set-up cost" (Radner, 1970), a fixed cost in nature. This minimum cost threshold represents the costs of information search, which is independent of the scale of demand, often causing the acquisition of information less economically justifiable and intensifying the problem of bounded rationality. Furthermore, it takes efforts and costs to coordinate different human actors, a problem Williamson termed as "convergence of expectations". Especially in a highly variable and uncertain environment, in terms of higher levels of bounded rationality and opportunism, it may require constant communications and negotiations. High coordination costs would make information processing prohibitive. On the other hand, bounded rationality can be countered by investing in "unsticking" information (von Hippel, 1994), such as expert system or a user-friendly computer database. Although the human nature of bounded rationality still makes all contracts incomplete, the investment in information assets enables human actors to be more farsighted, alleviating the degree of cognitive limitation. As information is less costly and information processing is more convenient, more information is available and increases the probability to detect opportunistic behaviors.

2) Social effects on goal congruence:

Social effects indicate conversions between economic capital and social capital. A transaction involving specific assets is referred as an idiosyncratic transaction. In idiosyncratic transactions, investment in assets only for certain customers' usages incurs non-marketable expenses and cost-bearing consequences. The degree of asset specificity impacts the relationships between transactional parties, specifically, increasing the degree of interdependency. Therefore, asset specificity locks both parties in the transaction. On the one hand, interdependency breeds potential hazards in the transaction. Bounded rationality makes it prohibitive to devise an inclusive contract to cover all possible scenarios. Hence, both parties can only agree on general terms of trade first and negotiate for contingent adjustments in the future. However, opportunism may urge transactional parties to exploit economic surplus from other parties, when there is an opportunity, until the perceived marginal net benefits of other parties are reduced to zero. This effect from opportunism under conditions of contract incompleteness would result in constant bargaining and haggling between transactional parties as they are tied in the transaction and cannot walk away, increasing transaction costs. On the other hand, by definition of "transaction-specific", suppliers cannot apply the assets for other purposes. Customers cannot either switch to other suppliers for a favorable deal with products or services in the same specifications, because production by using non-specific assets generates higher costs. Therefore, when the degree of asset specificity is high, both transactional parties may be willing to commit to the continuity of their exchange relationships, decreasing transaction costs. From this perspective, specific assets act as "hostages" of transaction parties, bringing in credible commitments to support transactions. The efficacy of government interventions in correcting market failures therefore lies in the economics to transform specific asset investment from threats to commitments of parties under transactions. As Williamson (1983) comments, "failure to recognize the economic purposes served by hostages has been responsible for repeated policy error".

Frequency

The notion of frequency indicates the degree of hazard communication. Traceability supply generates relational value through relationship building. Thus, frequency of transactions implies two ways to mitigate uncertainty.

1) Information effects on situational ambiguity:

Information effects correspond to "linking" between collaborative partners. Familiarity brings communication economics. When contractual parties transact frequently, more interactions can generate learning effects in information processing. Example of this include, developing specialized languages and codes, being more efficient in normal operation procedures, or reducing the degree of impactedness and coordination costs. Further, as the costs of information collection are a fixed cost in nature, allocated unit cost is lower in a recurrent transaction, resulting in transaction specific savings in observational economics.

2) Social effects on goal congruence:

Social effects correspond to “bonding” between collaborative partners. Recurrent transactions are a necessary condition for an interdependent contractual relationship. Without assurance of continuing transactions, a supplier would not be willing to invest in or develop transaction specific assets, unless the expenses can be fully covered by customers in limited transactions, not a usual case. Higher frequency of transactions brings familiarity to contractual parties at the interfaces in which human actors in charge of operations interact with one another more often, and thus can build personal trust in relationships. As the level of trust increases, personal integrity may suppress opportunism and then reduce the degree of uncertainty. Moreover, recurrent transactions act as infinite repeated games in the game theory. Each contractual party is motivated to maintain goodwill in hope for future profits, because the probability for opportunistic behaviors to be detected is higher in repeated games than that in one-shot games. Therefore, opportunism and potential moral hazards are curbed. Contractual parties can form more constructive engagements, avoiding suboptimal bargaining and haggling and resulting in effective adaptations.

3. Social Traceability

The food and agribusiness industry is a complex system that encompasses interdependent actors and numerous inputs, processes, and outputs. As a result, collaborative partnerships for strategic food safety inspection consist of interactions of multiple identities, for example, different types of food hazards, actors, products, supply chains, etc. The complexity of the system would make the identification of hidden food hazards economically unjustifiable if traceability needs to be provided solely by the public agency or any single agency alone. Nevertheless, the social aspect of transactional attributes points out an opportunity to bypass the unsolvable economic trade-off. The hysteresis of insufficient traceability supply can be alleviated by a social remedy through voluntary, prosocial behaviors.

Recent developments in information and communication technologies have profound implications for the traceability problem. The Internet of Things (IOTs) and cloud computing exhibit both evolving and converging properties, which could greatly enhance connectivity and interoperability of the networked society. The systemic nature of traceability opens an opportunity to organize social networks as food safety commons and apply Hayek's concept on the use of knowledge from dispersed and unknown sources. As suggested by Shultz and Holbrook (1999, p221), "more feasible strategies involve approaches that actually increase group size but with an emphasis on the collective pursuit of self-interest", as "the more globally integrated those systems, the greater the probability that consumer vulnerability will decrease" (Shultz and Holbrook, 2009, p127). However, technologies can be a double-edged sword to effective organizations. On the one hand, ”technological advances will facilitate dissemination of information, enhancement of communication, education of all stakeholders, and verification” (Shultz and Holbrook, 1999, p224). On the other hand, “complex real-world dilemma of global propositions can adversely affect communication, transparency, and trust” (Shultz, 2014, p11). More specifically, Farrell and Saloner (1985) point out a possibility of the dark side of social networking that “non-binding communication of preferences and intentions … exacerbates the problem of asymmetric inertia” (p72) which escalates bandwagon effects and results in “excess momentum” or “excess inertia” (p81). The paradox poses challenge to the public agency when engaging collaborative partners in communicative actions. “There must be economic and cultural solutions, including systemic and societal approaches to problem solving”, as suggested by Shultz and Holbrook (2009, p126).

Shultz (2014) categorizes diverse actors in commons into two types of stakeholders. Type I endogenous stakeholders, who are familiar with the local task environment, possess the power of circumstantial knowledge. Type II exogenous stakeholders, who are equipped with a broader scope and well-supplied of resources, hold the power of expert knowledge. Traceability supply in a self-organized food safety commons thus can be described was an agent perspective by the social cognitive theory (Bandura, 2001). Personal agency represents the grass-root efforts from Type I stakeholders that generate and disseminate field intelligence in the commons. Proxy agency consists of the Type II stakeholders who provide direct intelligence generation and supporting activities which are not able to be carried out by individual Type I stakeholders, for example, testing services from the public agencies and third-party laboratories, information services from practitioners, education services from consumer groups, etc. Collaboratively, a collective agency of food safety intelligence provides a more encompassing traceability in the food system.

The social aspect of traceability also explains in the collective agency the “socially coordinative and independent effort” (Bandura, 2001, p1). With respect to the coordinative effort, in communicative actions, knowledge is embodied in symbols as information and communicated to all stakeholders. Stakeholders share knowledge and seek to reach an understanding about the action situation and their plans of actions. The collaboration consequently determine how situational ambiguity is reduced and whether goal congruence is attained. In order to form validity claims, traceability is the necessary temporal and spatial mechanism to facilitate objective appraisal, continuing communicative actions with reflective means, and meaningful, intelligent actions, because it enables stakeholders to communicate past experiences and learn from performative outcomes. With respect to the independent effort, traceability is a necessary “fact-finding” mechanism (Lewin, 1947, p13) in a complex task environment. Individuals play an initiative role to define new decision premises and then encrypt them into organizational knowledge. “It was learning by an individual that had consequences for an organizational decision … all learning takes place inside individual human heads” (Simon, 1991, p125). Therefore, the notion of “self-regulation of motivation and action”

(Wood and Bandura, 1989, p366) is an important consideration in the provision of traceability.

Based on the above discussion, traceability is a critical factor dealing with situational ambiguity and goal congruence. The agentic perspective suggests that, in addition to a technical aspect of attributes, the ability to trace and track an identity can be traced and tracked from a social aspect of roles. In communicative actions, stakeholders freely respond to symbols. In order to recognize the processes of self-identification and self-verification (Burke and Stets, 1999), it is necessary to discriminate between social traceability and technical traceability. Table 4 summarizes the extended definitions of traceability.

Table 4. Extended definitions of traceability in the context of communicative actions

Traceability	The organizational capability to verify the history, application, and location of any entity by means of <u>recorded identifications</u>.
Technical traceability	The organizational capability to verify the history, application, and location of any entity by means of <u>identified attributes</u>.
Social traceability	The organizational capability to verify the history, application, and location of any entity by means of <u>identified roles</u>.

Although traceability is initiated by individual stakeholders and realized as an organizational capability, the transition between individual and organizational learning is not an automatic, spontaneous, and streamlined process. Driven by self-interestedness, it won’t be a surprise that agents would fail to perform their due diligence, because of the free-riding tendency (Albanese and Van Fleet, 1985a). Moreover, agents would exhibit selective moral disengagement (Bandura, 2002) and misuse their expert power for selfserving purposes. Levitt and March (1988) observe three distinct features of learning as an organizational behavior. First, organizations are oriented to targets (Simon, 1955). People organize themselves into groups for purposes stated explicitly or implicitly in means-ends. Second, organizational actions are history-dependent (Lindblom, 1959). Organizational development can be traced by paths-goals. Third, individual behavior within an organization is based on routines (Cyert and March, 1963). The routines serve as behavioral norms to set the paths. Therefore, Levitt and March (1988, p320) conjecture, "organizations are seen as learning by encoding inferences from history into routines that guide behavior". Therefore, in the empirical study, we investigate the significance of social traceability in the organizational context, how it relates to organizational performance, and whether it is supplemental to the conventionally-defined, technical aspect of traceability.

Hypothesis:

1. Technical traceability is positively associated with collaborative performance.
2. Social traceability is positively associated with collaborative performance.
3. Social traceability is positively associated with technical traceability.

Traceability allows the system to build organizational memory by remembering the trail of activities involved in complex social interactions - who, what, where, when, how much, and how often. Moreover, the intelligence generated by traceability enables the deduction of "why" these activities were happening so as to examine relationships of means-ends sequentially, spatially, and in time. Consequently, a more transparent task environment facilitates precise interventions when/if those activities were dysfunctional, inefficient, and/or harmful, which otherwise would further intensify the threat from food hazards.

4. Empirical Exploration

Measures

Table 5 summarizes the definitions of measures, and corresponding descriptive statistics and category generation. Recall effectiveness is measured by the percentage of announced recall quantity which is actually recovered. To conduct a comparative analysis, recall ratios are categorized into 3 levels of performance, high, moderate, and low. Recall cases are assigned into three cohorts according to levels of performance.

"Social traceability" is measured by stakeholder roles that detected food hazards. The 3 role identities, consumers, suppliers, and public agencies, signify various scopes of social networks, corresponding to Williamson's notion of governance structure, i.e., market, hierarchy, and public bureau, respectively. Voluntary hazard detection by consumers indicates high stakeholder involvement and thus a high level of social traceability. Suppliers, driven by their profit motive, represent a medium level of social traceability, while public agencies, centralized operations with limited participation, imply a low level.

"Technical traceability" is measured by the type of food hazards detected. A low level of technical traceability is indicated by physical hazards whose search attributes (Nelson, 1974) require the least level of asset specificity. A medium level of technical traceability in the archive is represented by the procedural hazards, for example, labeling discrepancies, misbranding, or HACCP violations, whose "semi-search" attributes are created by preset managerial intelligence systems. A high level of technical traceability is marked by biological hazards, for example, Salmonella, Listeria, E Coli, and other microorganisms or toxins, etc. which are mostly invisible and require investment in special technologies to make them "searchable".

Four contextual factors define the traceability environment. On the supply side, "industry type" measures the effect of different industrial practices in the beef, pork, and poultry industries. On the demand side, "market scope" measures 3 different scales of distribution (national, regional, or local). A larger scale would imply dispersion and increase the difficulty for effective recall. In addition, 2 dummy variables measure effects of the new information and communication technologies. The use of internet and social media for hazard communications would strengthen informational linking and social bonding, and thus improve recall performance.

Table 5. Definitions, Descriptive Statistics, and Coding

Recall Effectiveness (Y):

Category	Definition	Count	%	Code
High performance	Recall ratio > 75%	76	18.31	1
Moderate performance	Recall ratio < 75% but > 25%	133	32.05	2
Low performance	Recall ratio < 25%	206	49.64	3

Remarks: recall ratio = actual recovered recall quantity / announced recall quantity

Technical Traceability (X_1):

Category	Definition	Count	%	Code
Low technical traceability	Physical hazards of search attributes	35	8.43	1
Medium technical traceability	Procedural hazards of semi-search attributes	142	34.22	2
High technical traceability	Biological hazards of non-searchable attributes	238	57.35	3

Social Traceability (X_2):

Category	Definition	Count	%	Code
High social traceability	Hazards detected by consumers	60	14.46	1
Medium social traceability	Hazards detected by suppliers	87	20.96	2
Low social traceability	Hazards detected by public agencies	268	64.58	3

Interaction (X_3): Interaction term between social traceability and technical traceability

Industry Type (X_4):

Category	Definition	Count	%	Code
Beef industry	Hazards detected from beef related products	244	58.80	1
Pork industry	Hazards detected from pork related products	67	16.14	2
Poultry industry	Hazards detected from poultry related products	104	25.06	3

Market Scope (X_5):

Category	Definition	Count	%	Code
National market	Product distribution to more than 10 states	120	28.92	1
Regional market	Product distribution between 1 and 10 states	153	36.87	2
Local market	Product distribution within 1 state	142	34.22	3

Table 5. Definitions, Descriptive Statistics, and Coding (continued)

Social Media (X_6):

Category	Definition	Count	%	Code
Not available	Do not use Twitter for communication	238	57.35	0
Available	Use Twitter for communication	177	42.65	1

Webpage (X_7):

Category	Definition	Count	%	Code
Not available	Do not use "Ask Karen" for communication	51	12.29	0
Available	Use "Ask Karen" for communication	364	87.71	1

Model

Multinomial logistic regression is applied to model the 3-category response variable of recall effectiveness. Cohort dynamics are explored by two types of models. First, a generalized logit model compares performance outcomes between cohorts, as the response variable is regarded as nominal, specified as follows, with j = 1 or 2; i = 1,…, 7.

$$\log (\pi_j / \pi_3) = \alpha_j + \beta_{ij}X_{ij}$$

The model consists of 2 equations. Because the baseline category is set as the cohort with low recall effectiveness (J), the first equation compares the odds of the high performance cohort (j=1) vs. the odds of the low performance cohort (J), and the second equation does the odds of the medium performance cohort (j=2) vs. the odds of the low performance cohort (J). The log of odds (π) of the response variable (Y) is modeled as a linear combination of the predictor variables (X_1 to X_7).

Second, in a cumulative logit model, a cumulative probability, $P(Y \leq j)$, represents that Y falls at or below a particular point of j. Since j = 3, $P(Y \leq 1) = \pi_1$; $P(Y \leq 2) = \pi_1 + \pi_2$; P(Y

$\leq 3) = \pi_1 + \pi_2 + \pi_3$. The cumulative probabilities reflect the ordering as $P(Y \leq 1) \leq P(Y \leq 2) \leq P(Y \leq 3) = 1$. $P(Y \leq 3)$ is not utilized for modeling, because it equals to 1. Thus, the model has two functions, specified as follows, with j = 1, 2, or 3; i = 1,…, 7.

$$\text{Logit}\ [P(Y \leq j)] = \alpha_j + \beta_i X_i$$

When j = 1, the logit of the cumulative probabilities is expressed as:

$$\text{Logit}\ [P(Y \leq 1)] = \log \{P(Y \leq 1) / [1- P(Y \leq 1)]\} = \log [\pi_1 / (\pi_2 + \pi_3)]$$

When j = 2, the logit of the cumulative probabilities is expressed as:

$$\text{Logit}\ [P(Y \leq 2)] = \log \{P(Y \leq 2) / [1- P(Y \leq 2)]\} = \log [(\pi_1 + \pi_{2)} / \pi_3)]$$

The cumulative logit model allows the two functions to differ in their intercepts, while restricting and assuming the predictor coefficients to be the same. The score test for proportional odds evaluates true or false the null hypothesis that this proportional odds assumption is valid. With a p-value greater than 0.1, the null hypothesis is not rejected.

By utilizing information from the ordering of response categories, the model is equipped with the proportional odds property that the same parameter estimate (β) applies for each cumulative probability, invariant to the choice of response categories. In other words, the effect of a predictor X_i is regarded as identical for the (J-1) cumulative logits. When the model fits, it has advantages of simpler interpretations and potentially greater power (Agresti, 1996, p180). Further, the proportional structure of the model can be used to explore an underlying continuous variable, if the relationship between the assumed variable and predictors are plausible (Agresti, 1996, p188). In the present context, the latent variable refers to transaction costs of traceability.

Results

Table 6 summarizes the model results. The likelihood ratio test on the global null hypothesis shows no evidence of lack of fit in both models. P-values, 0.1247 for the baseline-category logit model and 0.1881 for the cumulative logit model, are greater than 0.05, the chosen level of statistical significance. Moreover, a score test of the proportional odds assumption has a p-value 0.1205 greater than 0.1. It is valid to argue that the cumulative logit model exhibits the proportional odds property.

Table 6. Summary of Model Results

Recall Effectiveness		Baseline-category Logit Model: High vs. Low	Baseline-category Logit Model: Moderate vs. Low	Cumulative Logit Model: High vs. (Moderate and Low)	Cumulative Logit Model: (High and Moderate) vs. Low
Intercept		-3.8231 **	-2.1870 *	-3.5405 ***	-1.9949 *
Technical Traceability		1.5251 **	1.0229 *	1.1667 ***	1.1667 ***
Social Traceability		0.8943	1.2675 **	0.8940 **	0.8940 **
Interaction		-0.4958	-0.5932 ***	-0.4831 ***	-0.4831 ***
Industry Type	Beef vs. Poultry	0.2288	0.5965	0.0856	0.0856
	Pork vs. Poultry	-0.1461	0.2153	0.3928	0.3928
Market Scope	National vs. Local	-0.2872	-0.1678	-0.2822	-0.2822
	Regional vs. Local	-0.3476	-0.5034	-0.2523	-0.2523
Social Media		0.0213	0.3189	0.1146	0.1146
Webpage		-0.3267	-0.1276	-0.2432	-0.2432
Likelihood Ratio		0.1247		0.1881	
Score Test for Proportional Odds				0.1205	

Note:

1. Regression coefficients marked with asterisk(s) were statistically significant (*** = $p < .001$; ** = $p < .05$; * = $p < .1$).
2. Numeric values in social traceability, technical traceability, and interaction represent a subjective measure of transaction costs; a higher value indicates higher transaction costs.
3. Parameter estimates of both models are computed by the computer software SAS under the PROC LOGISTIC procedure.

Statistically, contextual factors in both models are not significantly associated with recall effectiveness. Although counterintuitive, the results are consistent with research in closed-loop supply chain management that distinct operational patterns exist between forward and reverse information flows (Tibbon-Lembke and Rogers, 2002). Because food recall involves reverse logistics, directly applying measures of forward supply chains does not explain changes in recall performance. However, the insignificance of social media and webpage, both of which are related to communication, would suggest a need for more sensitive measures other than dummy variables.

In the cumulative logit model, technical traceability, with a p-value 0.0079, is statistically significant at the 0.01 level. Since the coefficient refers to the difference in the log of odds, a positive value, 1.1667, indicates higher performance improvement with the increase of technical traceability. Therefore, hypothesis 1 is supported. Social traceability, with a p-value 0.0467, is statistically significant at the 0.05 level. The positive coefficient value, 0.8940, also indicates a positive association between social traceability and performance improvement. Therefore, hypothesis 2 is also supported. The interaction term, with a p-value 0.0098, is statistically significant at the 0.01 level. Table 7 displays the log odds when technical traceability interacts with three different levels of social traceability. The positive correlation between coefficients of technical traceability and the levels of social traceability suggests hypothesis 3 is supported.

Table 7. How social traceability impacts technical traceability, cumulative logit model

	Low social traceability (X_2=3)	Medium social traceability (X_2=2)	High social traceability (X_2=1)
Technical traceability (X_1, Base = 1.1667)	-0.2826	0.2005	0.6836

However, in Table 8, the positive correlation does not hold vice versa. Social traceability is negatively associated with the change of technical traceability. Counterintuitively, higher social traceability, when interacting with technical traceability, would not contribute to better performance improvement. Therefore, managing traceability requires an integrative strategy.

Table 8. How technical traceability impacts social traceability, cumulative logit model

	Low technical traceability (X_1=1)	Medium technical traceability (X_1=2)	High technical traceability (X_1=3)
Social traceability (X_2, Base = 0.8940)	0.4109	-0.0722	-0.5553

The baseline-category logit model further examines the dynamic relationships between social and technical traceability from the "path" of performance improvement. Table 9, corresponding to the table 7, indicates that technical traceability, with the coefficient 1.0229, contributes slightly less to moderate performance improvement, while the result, with the level of significance 0.1, is not strongly significant. Social traceability is still a positive supplement to the technical solution.

Table 9. How social traceability impacts technical traceability, Baseline-category logit model

	Low social traceability (X_2=3)	Medium social traceability (X_2=2)	High social traceability (X_2=1)
Technical traceability (X_1, Base = 1.0229)	-0.7567	-0.1635	0.4297

Table 10, compared to the table 8, shows that social traceability, with the coefficient 1.2675, has stronger impact to moderate performance improvement, while technical competence, indicated by levels of technical traceability, still sets up hurdles for social involvement.

Table 10. How technical traceability impacts social traceability, Baseline-category logit model

	Low technical traceability (X_1=1)	Medium technical traceability (X_1=2)	High technical traceability (X_1=3)
Social traceability (X_2, Base = 1.2675)	0.6743	0.0811	-0.5121

While significantly associated with moderate performance improvement, social traceability does not lead to high performance improvement. Moreover, social traceability of moderate performance more frequently involves suppliers and public agencies, and thus incurs higher transaction costs. Technical traceability is a significant factor in both performance categories, and, especially, a sole determinant to high performance improvement. Thus, the application of social remedy would be contingent, but rather the more the better. While high technical competence is directly associated with high-performance cohort, relatively lower but more “popular” technologies are associated with moderate performance cohort that promotes low-cost social traceability and enables low performance cohort to “take-off”.

5. Policy Implications

According to the results, on the path from low to high performance, the public agency has a leadership role to guide the system and to empower collaborative partners. Table 11 proposes a typology of an intelligence cohort for efficacious public interventions. Contingencies in the food safety commons are characterized by two performance drivers – social traceability and technical traceability. The integrative framework corresponds to the concept of governance in transaction cost economics that efficient governance structures vary depending on environments in which transactions are embedded. Through proper alignment between transactional contexts and organizational mechanisms of control and coordination – specifically, social and informational underpinnings (Ouchi, 1979), public agencies can alleviate or remove obstacles on market incentives and promote traceability.

Table 11. Intelligence cohort: alternative governance structures for traceability management

		Technical Traceability	
		High	Low
Social Traceability	High	Scenario 1 Spontaneous Order Remedy: Self correcting Measure: Price Function: Sense-articulating	Scenario 3 Organizational Socialization Remedy: Social Measure: Outcome Function: Sense-giving
	Low	Scenario 2 Organizational Symbolism Remedy: Informational Measure: Process Function: Sense-reading	Scenario 4 Organizational Learning Remedy: Social informational Measure: Identity Function: Sense-making

Scenario 1 characterizes a situation of high technical traceability and high social traceability. Stakeholders are able to not only verify task environment through search attributes but also reach converged expectations. Under these conditions, price mechanisms can function well and the market is the most efficient governance structure. Public intervention is not required, wasteful, and would disturb the spontaneous market order.

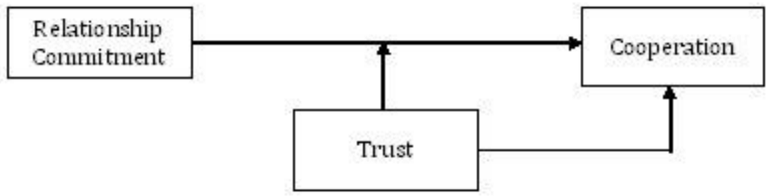
Scenario 2 describes a situation of high technical traceability with low social traceability. The high level of technical traceability implies that stakeholders are able to acquire sufficient scientific information for their decision making. Ceteris paribus, it would not be difficult to verify transactions through search attributes. However, evaluating experience (Nelson, 1974) or credence attributes (Darby and Karni, 1973) would face artificial obstacles due to opportunism, self-interest seeking with guile (Williamson, 1998). Thus, traceability activities should leverage technical capabilities and develop feasible process measures. Polanyi (1967) suggested that these measures, whether they are accurate or not, serve as "subsidiary", i.e., the "pointing finger", which facilitates sense-reading in ambiguous situations. Effective public agency can improve social traceability through qualification by providing protocols and incentives that facilitate organizational symbolism (Dandridge, Mitroff, and Joyce, 1980) and symbolic interactions (Estes and Edmonds, 1981).

Scenario 3 indicates situations with high social traceability but low technical traceability. Interestingly, although stakeholders have similar goals, high uncertainty and costs of search in the environment hinders mutual understanding. In this case, an informational remedy is the focus. High technical uncertainty implies that extensive monitoring processes can be costly. High social traceability implies outcome measures, which are generally more efficient than process measures, can be effectively enforced. Effective public strategy should leverage social capabilities for remedies – socialization tactics (Ashforth, Sluss, Saks, 2007) that emphasizes on sense-giving (Polanyi, 1967) and induces behavioral changes – for example, defining rules, standards, and regulations, promoting training and education, etc.

Scenario 4 is characterized by both low technical traceability and low social traceability. The complex situation requires sense-making (Weick, Sutcliffe, and Obstfeld, 2005) before the implementation of any effective strategy. Developing public strategies would need to "engineer" choices under ambiguity and bounded rationality (March, 1978). Public agencies would collaborate with competent and trustworthy partners, for example, recruiting private contractors or appointing "channel captains". Utilizing social cues and tapping into social informational processing would create salient and unique identities (cf. the notion of competitive cohort in Flint and Van Fleet, 2011) and an identifiable task environment (Albanese and Van Fleet, 1985a).

Empirical findings suggest a synergistic or "plural" strategy that involves both the social and informational approach, when a rational economic order is developed from chaos (scenario 4) to equilibrium (scenario 1). In commitment and trust theory, Morgan and Hunt (1994) also point out two paths that lead to cooperative outcomes. First, relationship benefits and termination costs, mediated by relationship commitment, are positively associated with cooperation and relational stability. As an alternative path, communication and restraint on opportunistic behaviors, mediated by trust, effectuate cooperation, constructive conflicts, and transparency. While sending a message of cooperative intent can be achieved by either way of commitment or trust, without commitment, communication remain to be "cheap talk" (Farrell and Rabin, 1996); without trust, credible commitment requires costly "hostage" (Williamson, 1983). Nevertheless, trust, cultivated through validity claims in communicative actions, could transform relationship commitment from costly economic capital to less expensive social capital (Bourdieu, 1986) and achieve an economic order which is both rational and efficient (Figure 2).

Figure 2 Commitment, trust, and cooperation



In the real world, the 4 scenarios in the conceptualized intelligence cohort are often interrelated in a loosely coupled structure – clear-cut boundaries may not exist between scenarios and multiple scenarios would be present simultaneously. According to Habermas (1984, p95), building trust in such complex situations requires a “cocktail therapy”: teleological actions which serve as an objective base of proposition (scenario 1), normative actions which anchor and instill cultural value (scenario 2), dramaturgical actions which allow self-expression of subjective experiences (scenario 3), and communicative actions which encourage dialogues and admit of consensus (scenario 4). As previously indicated, fundamental to these efforts is the establishment of the traceability environment, which, nevertheless, is not arbitrary but evolutionary. Therefore, the concept of intelligence cohort needs to be more fully explained and analyzed.

Chapter 6

Intelligence Cohort

1. Validity Evaluation

Information and communication technologies open avenues to leverage connective and interactive social networks for a prosocial approach to food safety management. A pilot study shows that social networking can be a strategy for improving hazard communication (Wang, Van Fleet, and Van Fleet, 2014). Individuals in a market could function as emergent leaders, known as social media influencers (SMIs) (Freberg, Graham, McGaughey, and Freberg, 2011), and, through communication, exercise informational social influence for the public good. However, the opportunities bring forth both blessings and curses. Spreading the word about negative events through social media alone would not solve, and would intensify, the problem, because social media users may create noise in the system (Gorry and Westbrook, 2009) and their credibility sometimes questioned due to distortions or misinformation (Wright and Hinson, 2012; Carlson and Peake, 2013).

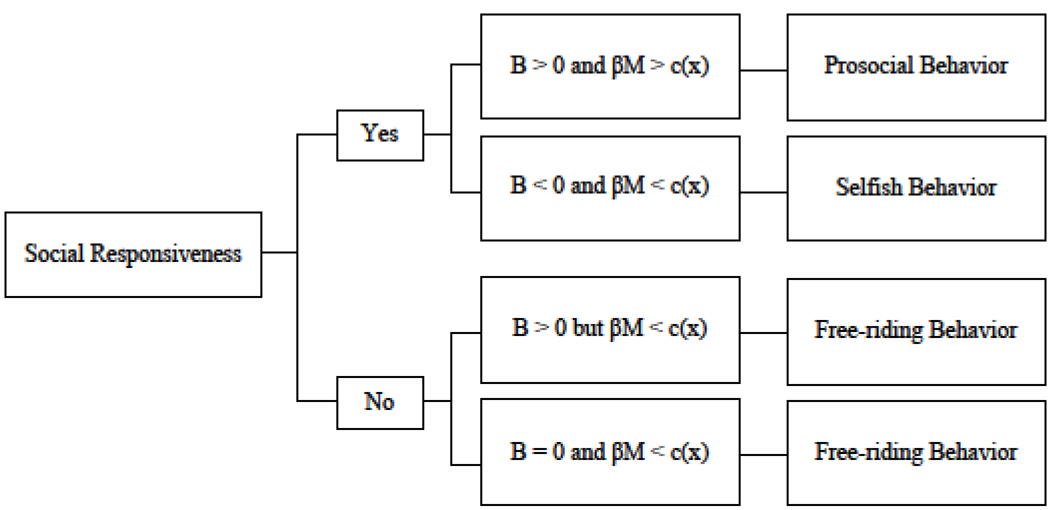
The dark side of social networking can be explained by a psychological phenomenon, named, framing effects. According to the prospect theory (Tversky and Kahneman, 1992), framing effects occur when decision makers, under uncertainty, alter their preferences in processing different, but logically equivalent, information cues. Such effects show evidence of decision biases, which suggest citizen incompetence

(Druckman, 2001b), casting doubt on the democratic basis of the envisioned collaborative partnerships (FSWG). Whereas, Druckman (2001a) argues the framing effects in the literature are overstated. In real-world settings, social context provides other references for non-rational minds to follow collective rational choices. Specifically, deploying issue frames counterbalances the negative impacts of equivalency frames (Druckman, 2004). Nevertheless, issue framing is not without any concerns. Social frames and social traps are two sides of the same coin. Phenomena such as the commons dilemma (Shultz and Holbrook, 1998) and free-riding tendency (Albanese and Van Fleet, 1985a) indicate that collective rational choices would not lead to long-term, sustainable prosocial outcomes. Paradoxically, social networks as social frames could both reduce and contribute to the complexity.

In the theory of communicative action, coordinating diverse collaborative partners is implemented through symbolic interactions. In the communicative processes to reach a negotiated agreement, opinion leaders propose claims which are open for objective appraisal in order to invite followers to take rationally motivated stances. Whether a validity claim in the form of symbolic expression can lead to a motivated agreement and a joint action depends on self-verification (Burke and Stets, 1999) – 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”. In this regard, stakeholders of food safety commons use social information to validate claims of safety. In doing so, they seek out others who are using the same or similar information. As a result, food safety commons evolve as collaborative relationships develop.

While collaborating with stakeholders would be expected to have positive results as has the empowerment of employees in public sector organizations (Fernandez and Moldogaziev, 2011), organizing the food safety commons requires more than laissez-faire. 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. Based on the economic analysis in Chapter 4, Figure 1 indicates that valid and rational decisions would result in three different kinds of behavioral outcomes, i.e., prosocial, selfish, and free-riding, due to goal incongruence, which corresponds to B, and situational ambiguity, which is indicated by $\beta M(x, e) - c(x)$. Therefore, coordination by the public agency is still necessary to maintain the integrity of the food system even with additional intelligence from consumers and suppliers.

Figure 1. Different rationally motivated positions in communicative actions



In the stakeholder negotiated and compliance model, Shultz and Holbrook (1999) posit that verification emanated from communicative interactions among all stakeholders should be integral to commons management. Specifically, a multistep verification schema is built in the system to validate “a step-series of agreed-on, incremental, and measurable results at specific periods, while the process is moving toward the final, ideal outcome” (Shultz and Holbrook, 1999, p224). Three considerations are especially important when designing such an expansive element for integrative commons management.

1) Situation awareness:

A monitoring function informs and alerts stakeholders to the unfolding processes that result from the negotiated agreement.

2) Non-regulatory supplements:

Participating parties must look “outside the box”, beyond the opinions of centrally located set of principal stakeholders, to resolve their commons dilemma.

3) Systemic approach:

A broader and integrative approach determines the extent to which the negotiated agreement affects multiple commons.

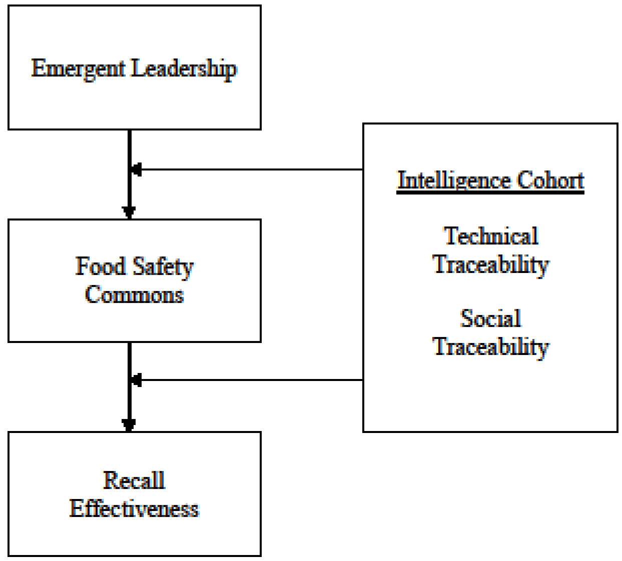
Shultz and Holbrook (1999, p225) call for empirical investigations on “systemic factors and integrative forces relevant to administrating the integrative effects”. In the food safety commons, operational requirements of both collaboration and coordination for cooperation suggest plural governance to regulate activities of contrast natures. With stakeholders of diverse knowledge, motivational backgrounds, and evolving needs, effective leadership from the public agency requires the design of a platform to manage information processing and to engage different types of interactions so as to induce social influence while preserving prosocial ethos in collaborative partnerships. This chapter introduces the concept of intelligence cohort, tests it in the context of food recall, and examines its efficacy for managing the dynamic processes of validity evaluation.

2. Intelligence Cohort

An intelligence cohort is a managerial tool to collect and transform diverse traces of information in the system so as to generate useful intelligence and benchmark organizational performance. Derived from the notion of competitive cohort (Flint and Van Fleet, 2011, p105), intelligence cohort is defined as the set of identities that define and exemplify the relevant standards against which subsequent performance should be measured and compared. Compared with the notion of benchmarking (Watson, 1993), intelligence cohort goes beyond the conventional way of identifying fixed and formalized performance standards. Compared with the notion of competitive cohort, intelligence cohort considers not only salient but also non-salient entities. Moreover, the sources of behavioral influence consists 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 a more encompassing approach to implement traceability strategies, by providing a schematization on complex task environments and organizing diverse technical and social identities into a subgroup formation.

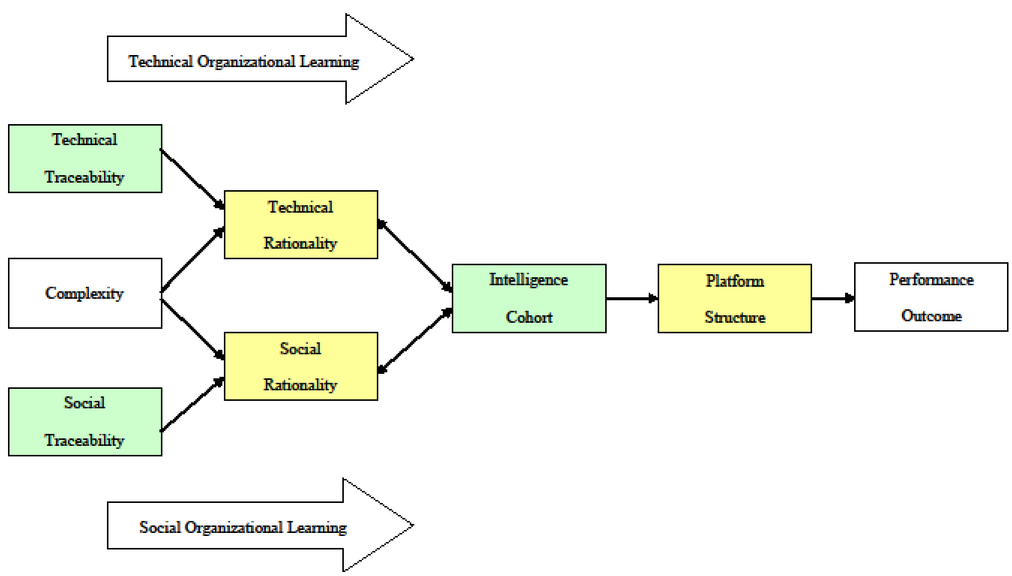
To empirically test the concept, a general framework encompasses the "path-goal, multiple linkage model of organizational leadership" (Van Fleet and Yukl, 1986), which addresses situational effects on leadership performance, and transaction cost economics. As diverse stakeholders are self-organized into a food safety community, group dynamics function as the "intervening variables", on the one hand, receiving negative impacts from contingencies such as food hazards, and on the other hand, influencing organizational effectiveness. In food recalls, consumers and suppliers act as emergent leaders to detect and correct food hazards in the market. An intelligence cohort functions as a "situational filter" (Dunnette, 1963, p318) and structures the complex linkages between multiple stakeholders and collaborative community performance. As shown in Figure 2, the public agency takes a role of a servant leader, by constructing an intelligence cohort, to cultivate a food safety commons that encourages constructive engagement, mutual support, and resource sharing among consumers and suppliers, as well as monitoring symbolic interactions in the commons so as to identify vulnerable situations when they emerge and take timely actions to neutralize them.

Figure 2 Intelligence cohort safeguards food safety commons



Traceability is the "eyes" of an organization, crucial to the quality of decision making in collaborative but complex task conditions. Figure 3 illustrates how traceability as an organizational learning mechanism determines collaborative performance. Dispersed intelligence in the system is first consolidated into collective rationality. The two streams of social forces then are molded into interactive structure. The solidified social energies further set the course of organizational performance. The linkage between the formation of collective rationality and the density of interactive structure, and its performance implications, presents a strategic concern (referring to the concept of strategic choice in Child, 1972). In the food safety commons, symbolic interactions form the structure of the hazard communication, which consists of two dimensions. The technical dimension characterizes the generation of hazard intelligence and various information cues for coordinating purposes. The social dimension describes the responsiveness of stakeholders to these information cues. While information could be actively "fed", 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, 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 3. 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. Within the public agency, a recall committee is formed 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” (Likert and Likert, 1976, p184) 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 oftentimes 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 practices, 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, and 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 will be fully provided as private goods by the market mechanism. In Scenario 2, task identifiability intends to evaluate individual performance, making 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 of recognition to promote self-identification. Experiments show that feeling worthwhile and facing challenging tasks would encourage individuals to exert a higher level of contribution in a public task (Harkins and 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", before a feasible remedy comes to light. Additive tasks, for which total organizational performance is the sum of individual sub-group contributions, modularize the task environment and enhance operational agility. The creation of an additive task structure thus enables resource sharing and social influence and facilitates the capability of contingency planning and effective responses.

Table 1. Additive task structure for traceability

		Technical dimension	
		Traceable	Non-traceable
Social dimension	Traceable	Scenario 1 Market mechanism	Scenario 3 Task uniqueness Pull-based social strategy
	Non-traceable	Scenario 2 Task identifiability Push-based technical strategy	Scenario 4 "Black box" Competitive mechanism

3. 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 and Strauss, 1967). Table 2 lists the 7 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 needs. Besides the technical dimension, multiple stakeholders collaborate in food recalls, creating the needs for social traceability as an alternative type of identification. Additional information is available in the Archive and might be useful. 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 Internet-based communicative platform, for example, AskKaren.gov, would promote the access and the use of intelligence in the system. After the encoded qualitative data are organized into three cohorts according to different levels of performance outcomes, categorical data analysis is applied for the purposes of discovering hidden information and useful intelligence and for improving 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 by a recall operation	1) Recall rate = Actual recovered recall quantity ÷ Announced recall quantity 2) Criteria: - High performance: recall rate > 75% - Medium performance: recall rate between 25% and 75% - Low performance: recall rate < 25% or indeterminable	1) rrate = 1: High performance cohort 2) rrate = 2: Medium performance cohort 3) rrate = 3: Low performance cohort
X_1	Technical Traceability	Independent; Binary Variable	Whether decision making is determined by fixed rules and procedures	Detecting biological hazards requires a high degree of technical traceability supply; Non-biological hazards indicates a low degree of technical traceability supply.	1) Technical = 1: Low degree of technical traceability. 2) Technical = 2: High degree of technical traceability.
X_2	Social Traceability	Independent; Binary Variable	Whether decision making power is concentrated to an authority.	When a hazard is detected by public agencies, centralized operations indicate a low degree of social traceability. When a hazard is detected by a supplier or a consumer, high involvement indicates a high degree of social traceability.	1) Social = 1: High degree of social traceability 2) Social = 2: Low degree of social traceability
X_3	Industry	Independent; Categorical Variable	Type of recalled product	Type of recalled product, in terms of beef, pork, or poultry (including processed eggs). If a product consists of mixed ingredients, an industry type is determined by its major ingredient.	1) Industry = 1: beef industry 2) Industry = 2: pork industry 3) Industry = 3: poultry industry
X_4	Market	Independent; Categorical Variable	Scope of product distribution	National market: product distributed to more than 10 states. Regional market: product distributed between 1 and 10 states. Local market: a product distributed within 1 state.	1) Market = 1: National market 2) Market = 2: Regional market 3) Market = 3: Local market
X_5	Internet	Independent; Binary Variable	The use of internet in recall operations	Whether internet information service (AskKaren.gov) is available, measured by a dummy variable.	1) Internet = 0: Not available 2) Internet = 1: Available
X_6	Structural Change	Independent; Continuous Variable	Structural change in the environment of recall operations	A continuous variable, set by recall case number from 1 (the first data point) to 415 (the last data point). The variable indicates whether a significant structural change is observable in the recall data.	

Table 3 summarizes the analytical model settings and results. The 3 models are structurally varied to examine the effects of different organizational strategies, while sharing the same 7 variables listed in the Table 2. Cohort performance is compared and evaluated by two levels of performance improvement - 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, the use of Internet-based platform. In addition to the 5 performance drivers, a structural parameter is included to detect whether significant structural changes were present in the food system. The likelihood ratio 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, and Van Wassenhove (2003) argue, factors of regular forward supply chains would not predict behaviors in reverse supply chains. The use of Internet-based communicative platform is insignificant. Although in theory communication is antecedent to trust, which further leads to higher commitment and lower uncertainty (Morgan and Hunt, 1994), a dummy variable may not be sensitive enough to capture this effect in the data. Lastly, no significant structural change is observed in the recall environment. Therefore, it is not a concern in the model validity.

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 to the performance differential. With the logit 0.8937, a high degree of social traceability is associated with the improvement of 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 a low degree of technical traceability supply and a high degree of social traceability are associated with better cohort performance, while social traceability is a more powerful performance driver to 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 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, p1227) and Albanese and Van Fleet (1985a, p248). Interactions, when conflicting, would decrease the efficacy of the strategies. Therefore, task structure matters.

Table 3. Comparison of 3 models

	Model 1 Unstructured Tasks: Full interaction		Model 2 Additive Tasks: Technical-oriented		Model 3 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	-0.9556	-0.0432	-0.9556	-0.0432
Technical 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 Technical)	-0.4608	-1.1976**				
High Social Traceability, given Low Technical Traceability			0.4329	-0.2204		
High Social Traceability, given High Technical Traceability			0.8937**	0.9772***		
Low Technical Traceability, given High Social Traceability					-0.8126*	-0.3648
Low Technical 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 platform						
Not-available vs. Available	-0.4851	-0.4777	-0.4851	-0.4777	-0.4851	-0.4777
Structural changes	-0.00057	-0.00226	-0.00057	-0.00226	-0.00057	-0.00226
Likelihood Ratio	0.3882					

Remarks: the asterisk indicates statistical significance at the level of 10% (*), 5% (**), and 1% (***)

In Models 2 and 3, a nested arrangement between the technical traceability and social traceability represents the use of additive task structures that facilitate orderly organizational changes. Interestingly, statistical evidences show 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 level of social traceability does not provide significant conclusions in both high and medium cohort performance changes. Whereas, given a high level of technical traceability, a high level of social traceability 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 has a negative impact, 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, 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 level of social traceability. If the technical traceability is decreased to the 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 level of technical traceability. If social traceability is decreased to the 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 Perforamnce	Strategic Orientation			
	Technical Traceability		Social Traceability	
High Improvement (High vs. Low)	Situation 1		Situation 3	
	Given Technical Traceability = High		Given Social Traceability = High	
	Social Traceability = High	41.67% *	Technical Traceability = High	49.16% *
	Socail Traceability = Low	17.04% *	Technical Traceability = Low	21.81% *
	Situation 2		Situation 4	
	Given Technical Traceability = Low		Given Social Traceability = Low	
	Social Traceability = High	25.05%	Technical Traceability = High	17.04%
	Socail Traceability = Low	16.24%	Technical Traceability = Low	11.99%
Moderate Improvement (Medium vs. Low)	Situation 1		Situation 3	
	Given Technical Traceability = High		Given Social Traceability = High	
	Social Traceability = High	22.02% *	Technical Traceability = High	42.83%
	Socail Traceability = Low	8.29% *	Technical Traceability = Low	29.83%
	Situation 2		Situation 4	
	Given Technical Traceability = Low		Given Social Traceability = Low	
	Social Traceability = High	31.02%	Technical Traceability = High	8.29% *
	Socail Traceability = Low	38.67%	Technical Traceability = Low	19.05% *

* Statistically significant

First, regarding social orientation, focusing on the social orientation in Situation 3 and Situation 4, significant results were observed at both high and low levels of social traceability. 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 role of the public agency. 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 still 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, a path conceptually similar to Likert's management systems 1 to 4 (Likert, 1967). 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, the 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.

1. Social significance: taking high social traceability as an orientation, supported by high technical traceability, results in the highest performance improvement.
2. Cocktail therapy: Performance improvement can be attained through integrating high social traceability and high technical traceability.
3. Servant leadership: the public agency should exercise limited authority and perform a supporting role to promote social and technical traceability in the system.

Table 5 identifies the deficiencies of the system and presents “learning opportunities” through a survey on the FSIS Recall Case Archive. By using the same variables and coding categories in the empirical model, 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 in specific contexts, 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 and Mojduszka, 1996, p1251). Regarding the industry, private participation is relative 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 needs to improve the capabilities of small, local suppliers. In addition, social media would offer new opportunities to implement a pull-based strategy that organize and mobilize local consumers and supplier from the grass roots.

Table 5. Exploring opportunities for performance improvement

Scenario	Group		Performance						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	20.96%
	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%	20	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	1.96%	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	2	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%

4. Discussion

Identity Visibility

A food safety commons accommodates dispersed sources of intelligence, and an intelligence cohort creates an additive task structure to organize diverse intelligence generating processes. While in an intelligence cohort traceability is the key to self-organization and collaborative performance improvement, the saliency of identities is mutually determined by both technical and social information processing. In this regard, it is not simply a grass-roots movement lacking of a strategic focus, nor solely a deliberate strategic plan subject to the “pitfalls of strategic planning” (Mintzberg, 1994). Rather, it represents “deliberately emergent” or the “process strategy” that “management controls 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, p71). Therefore, it 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 in food safety management. Therefore, effective strategic food safety management needs to consider multiple perspectives regarding determinants of organizational performance (Table 6). As Flint and Van Fleet (2011, p113) 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 grass-roots), facilitating organizational learning (technical and social) so as to reduce complexity in task environments and identify feasible strategies.

Table 6. Perspectives of organizational performance

		Technical Traceability	
		High	Low
Social Traceability	High	Perspective 1 Industrial/Organizational Economics Perspective	Perspective 3 Social Cognition Perspective
	Low	Perspective 2 Resource Base View Perspective	Perspective 4 Competitive Cohort Perspective

* Adapted from Flint and Van Fleet (2011, p105)

While facilitating knowledge and resource sharing, multiplying identities derived from frequent symbolic interactions, would cause sensory overload, exhaust cognitive resource, and result in counterproductive outcomes. Engulfing by waves of information cues, individuals would instead look for sources of information that is visible and trustful, with the intent 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 symbolic interactions on the virtual network of hazard communication could be challenging. In Chapter 4, the economic analysis on social exchange, with the purpose to decipher the complex processes, 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 ambiguous task environment would weaken the efficacy of differentiated attributes and hence the coordinating power of market signals. On the other hand, such a pessimistic outlook would not be necessary. Referred to the social identity theory (Hogg, 2001), market stability is attainable if diverse stakeholders would voluntarily affiliate themselves to certain social structure. 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", argued by Hogg (2001, p189).

The phenomenon of prototypicality describes group dynamics in symbolic interactions. According to Hogg and Terry (2000, p125), the responsiveness of social identity to immediate social context is the secret behind the magic of private ordering with positive performance outcomes. As Ouchi argues, "evaluating organization according to an efficiency criterion would make it possible to predict the form organizations will take under certain conditions" (Ouchi, 1980, p129); "in order to mediate transactions efficiently, any organizational form must reduce either the ambiguity of performance evaluation or the goal incongruence between parties" (Ouchi, 1980, p135), categorizing these "situationally attractive individual characteristics" (Hogg, 2001, p186) involves two dimensions: (1) an informational process of attribution, and (2) a social process of attraction (Hogg, 2001, p190).

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 and Van Fleet, 2011, p104). Salient entities are the key enablers of performance outcomes of a competitive cohort, as they form the foundation of a meaningful frame of reference for guiding desired behaviors. The notion conceptually corresponds to that of prominence (McCall and Simmons, 1978) or salience (Stryker, 1980) in identity theories of sociology. McCall and Simmons (1978, p65) define a 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 one is supported by others for an identity, commits to an identity, and receives extrinsic and intrinsic rewards from an identity (McCall and Simmons, 1978; Stets and 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, determines the significance of social information. The two perspectives inspire further thoughts. Stets and Burke (2003, p12) argue that McCall and Simmons address "what an individual values" (the cognitive aspect) while Stryker emphases on "how an individual will likely behave in a situation" (the behavioral aspect). It is a self-affirming mechanism of "identity verification" (Burke and Stets, 1999) that bridges the cognitive and behavioral aspects and constructs the integrity of multiple identities enacted by an individual. In Burke and Stets' thesis (1999, p347), 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 and recognizes the important role of emotions to induce social influence and initiate behavioral changes (Flint and Van Fleet, 2011, p100).

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. According to Williamson (1998), a viable hybrid governance structure is critically determined by the deployment of safeguards, i.e., organizational design to mitigate system disturbances, which suggest the function of an intelligence cohort. In general, three leading styles of safeguards mediate exchange interfaces for hybrid transactions (Williamson, 2008, p10).

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 myopic and inefficient fashion. Thus, transactions are not conducted under informed and prudent decisions. Oftentimes, decisions are driven by short-term orientation and interests of the muscular stakeholders. In a world of asymmetric information and knowledge, this approach invites the escalation of strategic behaviors and zero-sum games.

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. 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 a 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 instruments of organizational design are often required to maintain cooperation. As Williamson (2008, p10) points out, reputation effects deter defections, but they still need safeguards to which mutual benefits can be confidently ascribed.

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, p10). Credible commitments can take flexible forms. Different contracting practices can be interpreted in 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, p11). However, economic considerations of safeguards at the same time raise a concern on "excesses of calculativeness" (Williamson, 2008, p13), which, when perceived negatively, would decrease the credibility of a safeguard and increase transaction costs instead.

Dynamics of transactions as Williamson prescribed, the move from market to hierarchy is always 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 convergence of expectations (Malmgren, 1961). 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 (Williamson, 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 in Chapter 3).

Involvement

Push-based strategies are often perceived as cold, hard, unpleasant measures without any concern or sentiments. In fact, a push-based strategy also involves subjective feelings. Simon (1987) recognized the role of emotion in making management decisions, and it may not always be negative, as he also mentioned that "stress interacts with cognition to elicit counterproductive behavior" as "the pathologies of organizational decision making" (Simon, 1987, p62). However, it should be cautious when negative feelings are involved, such as fear, guilt, or other forms of aggression, if sustainable, high productivity is the desired outcome. Although resorting to the fear factor is sometimes seductive for its seemingly efficiency and effectiveness on manipulating human instincts, the impact is only short-term and subject to diminishing marginal returns. Moreover, unintended consequences are always a concern. Furthermore, voluntary behaviors would be suppressed. Kurt Lewin's legendary experimental studies in 1939, on the social climates of groups and behaviors of children in response to three different styles of leadership (autocratic, democratic, and Laissez Faire), offers substantial evidence for the arguments (Lewin et al., 1939).

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 and Olson, 1988, p211). The attitude of personal relevance to goal attainment is reflected in the behavior of felt involvement. Felt involvement, "a [organizational member's] overall subjective feeling of personal relevance" (Celsi and Olson, 1988) is the central concept to explain the "fundamental processes of attention and comprehension by which [organizational members] attend to salient aspects of their environment and comprehend or make sense of that information" (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 the behavioral intentions. When individuals are self-identified to certain identities, in the processes individual goals and the collective goal are aligned. In this case, implementing a push-based strategy may be additional, generate waste, or, to be 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 and Van Fleet, 1985b, p127).

Chapter 7

Conclusion

1. Summary and Findings

The Food Safety Modernization Act shifts the direction of food safety management from reaction to prevention. In the complex food system, due to bounded rationality, preventive control would face the threat of TYPE II errors and be ineffective. The advance of information and communication technologies enables creative strategies for public agencies to tap into previously unused external resources through collaborative partnerships in the food market. However, food safety is a public good. Empowering consumers and suppliers would encounter the free-riding problem. For that reason, coordination by public agencies is still required. Plural aspects of both collaboration and coordination present two forces, differentiation and integration, challenging effective system governance. Deploying a hazard intelligence platform is necessary to organize diversity. For public agencies as platform leaders to maintain the integrity of the system while preserving the prosocial ethos, understanding the dynamics of “non-regulatory supplements” to central governance is crucial.

This dissertation consists of two parts. Part one is a conceptualization of the hazard intelligence platform. In the chapter 3, the concept of platform and related topics are discussed.

1) Strategic food safety inspection: it is a strategy to integrate multiple inspection methods with the goal to generate synergistic system performance. The conceptualization broadens the conventional definition of judgment inspection and centralized control.
2) Food safety commons: an ideal organization for collaboration is a community as a functional whole. To overcome the commons dilemma, stakeholders jointly develop moral responsibility with self-respect and pride, leading to credible discretion and constructive empowerment.
3) Intelligence platform: it is a virtual location that facilitates joint efforts of information processing and knowledge sharing. Gaps and lapses exist on the platform, especially in a dynamic and temporal sense, and would negatively impact collaborative performance. Therefore, collaboration requires accountability and traceability.
4) Structural hazard communication: hazard communication forms a self-organized structure on the platform through four elements: resource, identity, structure, and knowledge. The RISK framework provides a conceptual ground for public agencies to influence platform behaviors.
5) Engagement: public agencies can actively shape platform behaviors without coercion through the EIPDF model of social influence: engagement, interaction, performance, density, and formation.

In the chapter 4, the EIPDF model is further elaborated into communicative actions. Public agencies coordinate collaborative partners by way of negotiated agreement, which is a shared interpretation of negotiated definitions of a complex situation. Reaching a consensus requires proposing and evaluating validity claims. A brief economic analysis shows that social responses to the symbolic expression are driven by the social aspect of goal congruence and the technical aspect of situational ambiguity.

Part two is an empirical testing of the conceptualized platform. In chapter 5, traceability represents behaviors of information processing and knowledge sharing on the platform. The free-riding problem of lacking social responsiveness is viewed as the traceability problem. A review on transaction cost economics provides a theoretical ground. The definition of traceability is distinguished into two kinds: technical and social traceability. Empirical findings are summarized as follows.

1) Social traceability is statistically significant and positively associated with the improvement of collaborative performance.
2) Social traceability positively contributes to the efficacy of technical traceability, but not vice versa.
3) Technical traceability significantly contributes to both moderate and high performance improvement; while social traceability is only significant for moderate performance improvement. Therefore, the social effect is limited and contingent.

In chapter 6, a managerial tool of an intelligence cohort is proposed to analyze the dynamic platform structure. By using technical and social traceability, an intelligence cohort is constructed to create an additive learning structure in complex, crisis situation. The empirical results indicate three strategic considerations:

1) Social significance: social traceability is the fundamental consideration to high cohort performance.
2) Cocktail therapy: an integrative strategy with high social traceability and high technical traceability attains high cohort performance.
3) Servant leadership: public agencies should exercise limited authority and perform a supporting role in the provision of appropriate technical traceability, while actively promoting social traceability in the system.

2. Inferences

<u>System</u>

New policy initiatives shift the focus of food safety management from reaction to prevention and envision a strategic role for food safety inspections. Systematic meat inspections in the U.S. food supply originated a century ago when the "Jungle" conditions in the Chicago meatpacking industry, which were unsanitary, inhumane, corrupt, and filthy, revealed by Upton Sinclair, urged President Theodore Roosevelt to take actions on federal inspections. The Federal Meat Inspection Act enacted in 1906 mandated that every carcass passing through slaughterhouses being physically examined by inspectors appointed by the federal agency. A food safety inspection system of extensive command-and-control regulation and intervention has since been put into effect. The radical innovation exemplifies social entrepreneurship as a self-correcting mechanism of the food system – initiated by a journalist who generated intelligence, driven by the general public who disseminated the intelligence, and implemented by the public agency who responded to the public voice.

In the collaborative innovation approach, a rather passive role played by the private sector is somewhat a misfortune. An inspection is not an independent task. It is a quality function that supports the main production activities – to assure everything goes well according to the plan. Therefore, a comprehensive food safety management system encompasses both ex ante production system and ex post hazard inspections (Table 1). The two system components are interdependent to each other in a nested governance structure that is succinctly described by Williamson's contractual reasoning: "differences in technology [ex ante production] give rise to different contractual hazards which in turn elicit safeguards [ex post inspection]" (Williamson, 1998, p37).

Table 1. Comparison of different food safety management approaches

	Production	**Inspection**
Traditional approach	Control-oriented	Reactive
Current policy focus	Control-oriented	Preventive
Alternative approach	Involvement-oriented	Preventive / Reactive

When the traditional approach of food safety management was developed in the early twentieth century, the food system was less complex. The system design followed close-system logic that ex ante system optimization would turn random food hazards into controllables which can be subsequently handled by a certain level of system reserves. In this situation, a controlled-oriented production system with a reactive system safeguard sufficed. However, the modern food system is characterized by its complexity. Imagine a food system simultaneously shaped by the interplay of hundred millions of consumers and suppliers, to each his or her own preferences and actions. As increasing complexity renders control ineffective, it is not an easy task to maintain the close-system logic and predict how this system would change. Under bounded rationality (March and Simon, 1958), a single incidence of food hazards, although initially deemed statistically insignificant, may amplify its negative effects through network interactions and trigger an outbreak that greatly impacts the food system.

Taking preventive inspections is the first step to recognize the more practical open-system logic. Ouchi (1980) identifies two ways toward improving organizational control -- by reducing either performance ambiguity or goal incongruence. Implementing more rules and tighter standards may stabilize the food system and achieve the goal. Moreover, a stabilized food system would be more predictable and facilitates preventive hazard safeguards in terms of quick response -- early detection, containment, and reduction of food hazards from the sources. Following this rationale, the Hazard Analysis Critical Control Point (HACCP) and other science-based measures serve as a dominant logic (Prahalad and Bettis, 1986) to reduce the complexity and expand the technical rationality of the food supply system. Nevertheless, across the farm-to-table spectrum of the food system, many critical control points are in fact located beyond the reach of supply control or science-based analytical measures. A food system under preventive control is still subject to error-based disruptions (i.e., Type I and Type II errors due to the limited capacity and capability of the control methods in use). Failing to recognize the nature of imperfect knowledge in complex networks and imposing control measures give rise to premature programming (March and Simon, 1958) and unintended consequences (Williamson, 2002), “an attempt to control a problem that should be managed” (Landau and Stout, 1979).

In an involvement-oriented food safety management system, the ideal food system resembles a high-performance work system. A high-performance work system (HPWS) is an organizational design that intends to achieve high organizational performance through motivating people, by adopting managerial practices with an emphasis on employee empowerment, involvement, and commitment, rather than control (Tomer, 2001; Lawler, 1992). The market is transformed into a food safety community which accommodates consumers, suppliers, and public agencies, all of whom are stakeholders because food safety is a matter of everyone’s health and benefit. In this light, the responsibility of hazard prevention does not lie solely on the public agencies. The food safety community serves as a built-in safeguard to correct potential food hazards from the source. Imagine the provision of public service without public agencies’ command and control; no principal-agent relationship, and no moral hazard; no cat-and-mouse game, and no lock-in mutual destruction. Imagine all stakeholders relinquishing myopic strategic behaviors and devoting to collaborative innovation on better public health. This would be Likert’s visionary System 5 comes true – what a wonderful food system!

Likert (1967) posited that a highly participative system, which he termed System 4, resulted in greater efficiency and effectiveness than did alternatives. System 4 employs a high use of participative methods involving all members of the organizational system. Hall and Leidecker (1981) characterized Likert's System 4 as emphasizing trust, freedom to talk to superiors about the job, rewards as incentives, group involvement, responsibility of individuals towards organizational goals, co-operative teamwork, vertical and lateral information flows, and accurate communication. Wilson (2010, p40) suggests that "The proliferation of participative organizations, technological advances, and preferences towards collaboration in 21st-century organizations may at last be conducive for Likert's visionary theory to succeed".

Designing and organizing a strategic food safety management system in complex food networks is challenging – multiple social relations and relational governance mechanisms are intertwined with contingencies of performance ambiguity and goal conflict. The challenge is exactly the problem Hayek (1945, p524) described in "The Use of Knowledge in Society":

"The economic problem of society is mainly one of rapid adaptation to changes in the particular circumstances of time and space … the ultimate decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them … We cannot expect that this problem will be solved by first communicating all this knowledge to a central

board which, after integrating all knowledge, issues its orders. We must solve it by some form of decentralization".

Nevertheless, decentralization through empowerment is not a panacea.

"We need decentralization because only thus can we ensure that the knowledge of the particular circumstances of time and place will be promptly used. But the 'man on the spot' cannot decide solely on the basis of his limited but intimate knowledge of the facts of his immediate surroundings. There still remains the problem of communicating to him such further information as he needs to fit his decisions into the whole pattern of changes of the larger economic system" (p524).

The problem of systemic communication echoes the first question Hayek asked in his seminal work: "What is the problem we wish to solve when we try to construct a rational economic order" (Hayek, 1945, p519), and moreover, under time pressure, in "rapid adaptation to changes"? Hayek never expected a closed-system solution of a procrustean style (see Procrustes in Greek mythology) which amputates free flows of social energy as do sufferers of body integrity identity disorder (BIID). Rather, a spontaneous order with confidence is desired. The rational economic order consists of complex decision-making processes with a rationale (articulated reasons) and feelings (unarticulated reasons) of assurance that, although complicated means-ends relationships are not fully comprehensible, everything will be all right, onward, upward, and beyond.

The rational order of a market is reflected in its structure, which can be perceived from a two-dimensional conceptualization of centralization/formalization framework (Aiken and Hage, 1967). Systems are designated as being centralized when information and decision making are concentrated in the hands of a few individuals (Hage & Aiken, 1970). Decentralization, on the other hand, refers to the extent to which decision-making power is moved outward (and downward). Decentralized systems in which members establish exchange linkages with others having dissimilar asset profiles should lead to a greater variety of resources, thus, increasing information available to all members (Arya & Lin, 2007). The empirical study in this dissertation supports this view with the evidence on social traceability. However, the results also indicate that technical traceability is significant, reinforcing social traceability, and necessary to higher performance. Formalization, defined as job codification and rule observation (Hage and Aiken, 1967), is the extent to which formal rules and policies are used to regulate behaviors and decision making in a system. Developing the two seemingly conflicting structural characteristics in a system would be problematic.

Burns and Stalker (1961) presented a conceptualization of structure that involved one of two forms. The mechanistic form relies on standardization, centralization, and hierarchy and focuses on efficiency. The organic form relies on high levels of decentralization and autonomy and focuses on flexibility. Rather than be seen as distinct alternatives, some studies have claimed that aspects of each can be combined (Jansen et al., 2006; Raisch & Birkinshaw, 2008). So the organic form can be thought of as a relational form in which there are lateral communications between people of different ranks, resembling consultation rather than command (Hoffer Gittell & Douglass, 2012). Hence, the organic form is conceptually similar to Williamson's hybrid governance structure, whose viability relies crucially on the efficacy of system safeguards (Williamson, 2008, p8).

System Safeguard

Safeguards according to Williamson's view are implemented through two ways: either vertical integration or credible commitments (Williamson, 1998, p38). Vertical integration organizes activities under a centralized authority to effect control and coordination through fiat, while credible commitments resort to crafting contract supporting devices for dealing with unforeseen contingencies during contract implementation, for example, "penalties for premature termination, information-disclosure and verification mechanisms, specialized dispute settlement, and the like" (Williamson, 2005, p7). As Homans (1958, p604) argued that "a stable and differentiated social structure in a real-life group might arise out of a process of exchange between members", the form of system safeguards is determined by exchange relationships. Williamson (2008, p10) distinguishes three leading styles of exchange relationships that mediate interactions within a governance structure: naïve trust, power, and credible. As Williamson (2008, p10) argues, a credible relationship is "hardheaded" compared to the naïve trust while "not mean spirited" compared to the power. From Likert's system perspective, Williamson's categorization of safeguards and exchange relationships corresponds to two kinds of organizations -- authoritative and participative (Likert, 1967, p14) (Table 2).

Table 2. Williamson's safeguards and Likert's systems

Relationship \ Safeguard	**Vertical integration** (Unified ownership)	**Credible commitment** (Contract supports)
Naïve trust	System 0 Laissez Faire	N/A Absence of credibility
Power	System 1 Exploitive authoritative	System 3 Consultative
Credible	System 2 Benevolent authoritative	System 4 Participative

While Williamson and Likert would agree on a general direction of organizational design, Williamson praises the advantages of credible commitments relative to unified ownership; Likert advocates the movement toward more participation in an organization, a guideline for implementation remains inconclusive. In Williamson's transaction cost economies, how to balance cost-effectiveness and over-calculativeness when deploying credible commitments is still an unsolved problem (Williamson, 2008, p13). In Likert's management systems, how to muddle through system 3, the overlap between two distinct management styles (authoritative and participative), is subject to a mysterious force that initiates the transformation. Likert's system 5 represents a creative goal to integrate the two views. From a managerial perspective, through a process of delegation, members of a system enjoy a higher degree of discretion and incentives, while in return taking responsibility and meeting accountability. This is the rationale behind social traceability, technical traceability, and their high performance implications. Moreover, traceability creates a necessary structure that links collaboration to intended performance outcomes. Although both are managing without a boss, system 5 is quite different from system 0. In system 5, freedom from dictatorship leads to creativity and collective value, while in system 0, the same organizational feature results in random walks and chaos. The difference lies in those stabilizing forces that maintain the system integrity – emergent leadership (Hollander, 1959), servant leadership (Greenleaf, 1973), followership (Burns, 1978), organizational citizenship (Smith et al., 1983), social capital (Bourdieu, 1986), and communityship (Mintzberg, 2009).

The development of social capital is closely related to the structure of the embedded social environment. Social capital is defined as advantages and opportunities accruing to people through membership in certain communities (Bourdieu, 1986). Coleman (1988) argues that social capital arises through changes in the relationships among members that facilitate interactions, manifested in three aspects of social structures: trustworthiness of the social environment, information channels, and social norms. Putnam (1993) points out that "social capital refers to features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated action". Therefore, underlying network structures are a conduit for information flows which enables collaboration and coordination through social effects.

However, the structure of social exchange only partially explains performance outcomes. According to Nahapiet and Ghoshal (1998), at the cognitive dimension, social norms represent a shared value which motivates members to forgo opportunism and act in the interests of collectivity. At the structural dimension, information indicates patterns of communications and provides a basis for interactions and relationship development. At the relational dimension, trust constitutes cohesion of relationships, developed through interactions among members. The commitment-trust theory (Morgan and Hunt, 1994) describes how the three attributes of social capital are associated with relational performance. Shared value and communication, mediated by trust, lead to relationship commitment and cooperation. With relationship commitment, interactive parties recognize the importance of an ongoing relationship with one another and exert maximum efforts at maintaining it. With cooperation, interactive parties work together to achieve mutual gains or, even during disagreements, to resolve conflicts and avoid relationship dissolution. Stability and predictability are hence promoted and enables economics of scale, specialization, and experience in the relationship. All these benefits are based on the key mediator -- trust, suggesting that the creation of social value leads to economic value.

In social network theories, the value of social capital is explained by two distinct network mechanisms. On the one hand, network closure theory (Coleman, 1988) focuses on the strong ties and argues that inward-oriented, dense networks with strongly interconnected members are the source of social capital. Closure is regarded as a property to form effective social norms, because corresponding network density is associated with strong social relations, which are a necessary condition to establish reliable communication channels and effective sanctions against opportunistic behaviors. Without network closure, reputation cannot be built. Collective sanctions cannot be applied. The consequent ineffective social norms and lack of trust encourage free riding behaviors, as people seek for protection from being exploited by others, initiating a vicious cycle of tension and conflicts. Social capital from this perspective adds value through uncertainty mitigation. On the other hand, structural hole theory (Burt, 1992) emphasizes on the strength of the weak ties (Granovetter, 1973) and argues that outward-oriented, loose-coupled (Weick, 1979) networks with disconnected segments, named structural holes, are the source of social capital. Structural holes appear when people concentrate on activities within networks to which they belong and do not attend other networks. The disconnectedness between networks provides opportunities for boundary-spanning agents to bridge discrepancies, extend current network scope, and update network resources. Social capital from this perspective adds value through its function in brokering opportunities across structural holes.

To reconcile the two arguments, Burt (1997) proposes a contingent view of social capital. The closure argument explains how dense or hierarchical network structures consolidate current networks and reduce risks, while the structural-hole argument explains how loose and organic network structures expand current networks and develop new opportunities. Alternative network structures are driven by two forces: competition and legitimacy. Competition refers to a frame of reference that leads to innovation. Legitimacy refers to mutual coercion which is established by congruent behaviors observed by the majority. The two mechanisms correspond to the two exchange characteristics of asset specificity and frequency in transaction cost economics. An intelligence cohort represents an integrative strategy to create a network structure that governs the dual properties and initiates high performance in the context of collaboration on complex tasks in crisis situations. Although the structure is dynamic, it intends to be manageable, because it is modularized and additive; and practical, because it is both technically and socially traceable.

3. Recommendations

An intelligence cohort is a dynamic process to construct a flexible grand routine on an intelligence platform. For its inward mindset and repetitive nature, the notion of "routine" is sometimes associated with negative aspects of bureaucracy – insensitive, rigid, and dehumanized mechanical operations. The so called fixed routine specifies a situation in which an invariable environmental stimulus calls for deterministic operations. The repetition has its important economic rationale, as repetitive application of the same set of knowledge is a key source for gaining experience and improving performance – no matter it is regarding economies of scale or economies of specialization. Paradoxically, in an open system, in which ever-changing task conditions and uncontrollable inputs are common, a fixed response is less likely to be ideal.

A performance strategy to resolve the dilemma is to employ multiple fixed routines and integrate them into a "grand" routine that is flexible to meet contingencies. In this sense, a flexible routine is conceptually similar to March and Simon's (1958, p141) notion of performance program. Its performance outcome is contingent upon interactions between a program and its surroundings – in terms of performance outcomes, how the task environment impacts a program and how a program shapes its task environment; in terms of organizational learning, how unexpected disturbances surprise a program and how a program mitigates the disturbances. The contingent capacity - capability to adapt to current situations - is thus a crucial differentiating feature between a fixed routine and a flexible one.

Organizations perceive visible events as experiences and translate memorable experiences into routines. On the platform, updated routines set organizational goals, which further coordinate member behaviors. Ouchi (1980, p135) argues that organizational coordinating processes involve two mechanisms – "any organizational form must reduce either the ambiguity of performance evaluation or the goal incongruence between parties". In this regard, performance outcomes of modularized platform can be interpreted by two dimensions: on the technical dimension, programmability of tasks; on the social dimension, predictability of responses. Accordingly, heterogeneous social interactions are categorized into 4 modules.

Table 3 summarizes the four strategies, VSQC, that enhance traceability, create a rational order on the platform, and improve system performance, referred to the conceptualization schemes in chapter 5 (table 7) and chapter 6 (table 1 and 6), and an empirical testing of the strategies and their performance implications in the table 4 of chapter 6. First, the verification strategy applies when both high technical and social traceability. At the module 1, although the same situation recurs in a predictable manner and the same response performs in a repetitive fashion, output variations may still occur due to differential quality of production resources or random errors. Optimization would enable the intelligence cohort to utilize traceability outcomes and articulate its sensing capabilities. A feasible strategy is to set up a verification scheme that continuously improves operations toward standardization. Second, the socialization strategy applies with high social traceability but low technical traceability. At the module 2, the task is not programmable while the response is predictable. Social underpinnings suggest an effective strategy should rely on social remedies to compensate for technical deficiencies. Ironically, validity issues could result from predictable social responses due to behavioral biases, for example, the Asch effect, halo effect, or scapegoating, etc. In order to encourage "think[ing] outside of the box" (Baker and Sinkula, 1999, p413) and provides the "qualitative engine behind market orientation that prevents rigidity" (Baker and Sinkula, 1999, p416), socialization should have a higher order goal to improve technical traceability on the non-programmed tasks and lead to desired performance outcomes. Third, the qualification strategy is effective with high technical traceability but low social traceability. At the module 3, the task is programmable while the response is unpredictable. Free riding behaviors would arise due to insufficient social information processing. Since a programmable task environment allows operant conditioning, a feasible strategic goal is to leverage technical information and qualify prosocial stakeholders – by creating science-based measures to coordinate stakeholder behaviors, enhance information flows, and reach internal reliability. Fourth, introducing competition is an inevitable strategy when both technical and social traceability are low. At the module 4, the task is not programmable and the response is not predictable. Uncertainty and equivocality (Daft and Lengel, 1986) would require competition as a discovery procedure (Hayek, 2002) to create necessary conditions for effective management. However, as Hayek pointed out, competition is double-edged – an organizational learning mechanism that could result in unintended social consequences. Therefore, it should be a way station in the intelligence cohort. Once sufficient technical or social intelligence are generated, other strategies (V, S, or Q) take over and relay for the pursuit of high cohort performance.

On the intelligence platform, operational requirements of both collaboration and coordination for cooperation suggest plural governance, which involves both push- and pull-based strategies and alternative technical and social task conditions. An intelligence cohort can be viewed as a dynamic, self-organized platform structure that encompasses multiple aspects of social exchange. A modularized and additive task structure enables actionable strategies in complex crisis situations. Traceability strategies of the VSQC framework create and shape a rational order that leads to high performance in collaborative partnerships.

Table 3. VQSC performance strategies for the intelligence cohort

		Technical Attribute	
		Programmable	**Not programmable**
Social Response	**Predictable**	Module 1 (V) Verification	Module 3 (S) Socialization
	Not Predictable	Module 2 (Q) Qualification	Module 4 (C) Competition

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