A Stakeholder Analysis of Interoperable Data Architecture: The case of I-Choose

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ABSTRACT

This paper presents the challenges associated with developing a data architecture supporting information interoperability in the supply-chain for sustainable food products. We analyze information elicited from experts in the supply-chain for organic and fair trade coffee to identify relevant stakeholders and the issues and challenges connected with developing an interoperable data architecture. This study assesses the salience of individual stakeholder groups and the challenges based on the stakeholders' attributes in terms of power, legitimacy and urgency. The following five issues/challenges were found to be the most salient, requiring primary focus in developing interoperable data architecture: trust in data, cost to maintain the system, political resistance, oversight and governance, and the cost to consumers in terms of time and effort. In the conclusion we discuss potential future research and practical implications for designing an interoperable data architecture.

Categories and Subject Descriptors

H.4.2 [**Information Systems Applications**]:
Type of systems – interoperable data architecture for sustainable supply-chain.

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General Terms

Management, Economics, Human Factors, Theory.

Keywords

Interoperable data architecture, sustainable food product, stakeholder analysis.

1. INTRODUCTION

Technology advancement has the potential to reduce information asymmetry among multi-party relationships by eliminating the barriers to information sharing. Innovative use of technology such as Wi-Fi, social media, and Smartphones have the potential to create and facilitate interoperable relations among key actors in various fields, including the supply-chain. Until recently, internal workings of a supply-chain were opaque, creating information asymmetry among supply-chain actors and consumers [15]. Such information asymmetry results in consumers having to make purchasing decision with only limited and incomplete information, thus affecting their ability to choose among various products based on their personal preferences [24]. Enabling information sharing and integration across the supply-chain process could potentially reduce such information asymmetry among the supply-chain actors, resulting in better and trusted information to support consumers purchasing decision [15].

Using data collected as part of the I-Choose project, this paper provides preliminary understanding of the challenges in developing data architecture to support interoperable data and information sharing in a supply chain environment. The I-Choose project is a current project activity at the Center for Technology in Government (CTG) funded by the US National Science Foundation. The I-Choose project aims to develop and test a data

sharing architecture to provide a wide range of trusted product information to assist consumers in purchasing food products that reflect their environmental and social values. To narrow the scope of such undertaking, the project focuses on the development of interoperable data architecture for stakeholders involved in the supply-chain for coffee grown in Mexico and distributed and consumed in Canada and the US.

Given the multi-actor and multinational scope of the I-Choose project, the identification of primary stakeholders and their needs and challenges was viewed as a crucial element of the project. This is particularly true for projects exploring interconnectivity among different sets of stakeholders with potentially different values and interests in the project. This paper presents the results of this initial analysis, exploring the stakeholder approach to identifying issues and challenges related to the development of interoperable data architecture.

This research attempts to address the two questions proposed by Freeman [9] and extended by Mitchell, Agle & Wood [22] in the stakeholder theory, that are "who (or what) are the stakeholders [of the system]? And to whom (or what) do [developers] pay attention to? [9, 22]" in the development of interoperable data architecture. This paper presents the initial analysis of data from two data collection activities designed to 1) identify the stakeholders of the systems and their attributes, and 2) identify the challenges to developing an interoperable data architecture and their salience. Building on the identification of the stakeholders and their attributes, we can then predict the prominence of the challenges [22].

This paper is organized into six sections including the foregoing introduction. The second section provides an overview of the interoperability and the stakeholder theory and approach for system development. The third section briefly introduces the background of the I-Choose project. Section four highlights the methodology and data collection process. The fifth section provides the analysis and the discussion framed by the conceptualization of stakeholder theory by Mitchell et al [22]. The concluding section discusses potential future research and practical implications for designing an interoperable data architecture.

2. THEORETICAL OVERVIEW

2.1 The Benefits and Challenges of Interoperability

Referring to the definition of interoperability by ISO/IEC[1], interoperability entails the fulfillment of at least three conditions, 1) the ability to exchange data/information across different information system and organizational boundaries, 2) the exchangeable information through interoperable system is meaningful [7], and 3) it should not require from users to have profound knowledge of the system (ISO/IEC 2382-1: 1993)[2].

Interoperability has been related to various benefits, such as cost savings and increased efficiency. Interoperability is often associated with improvement of organization's economic standing such as increase in its profit margins, enhancement of its competitiveness and improved value proposition to its consumers [5]. Interoperability was also hailed for its potential to transform delivery of health care services by creating "a wide network of real-time life-critical data [3]" to enable widespread adoption of electronic medical records (EMR), which could potentially improve health-care efficiency, cost saving and safety [13]. Pardo & Burke [25] refer to interoperability as "key enabler" for transformation in public sector through information and knowledge sharing and integration among government, private sector and other actors, mainly through better coordination [25].

At the same time, the implementation of interoperability is accompanied with various challenges as such undertakings are inherently complex and difficult. Pardo & Burke [26] pointed out that implementing interoperability across different networks or organizational boundaries, particularly in government context, is challenged with complexity and layers of existing bureaucratic and political structures [26]. Such complexity increases proportionally to the level of organizational involvement [11], the diversity of the organizations involved, their size, and the complexity of institutional structures and political issues [26].

Likewise, creating interoperable information system among actors in a supply-chain is challenged with level of complexity due to the diversity of actors with distinct values and interests. One way to overcome this challenge is by creating architecture or environment that does not require each of the systems to "talk" directly to one another. The connection is facilitated through an abstraction of the databases by mapping the proprietary data architecture to an open schema-based standard supported by ontology of the supply-chain [15]. The development of common schema to link the different information systems can be done through ontology development [20]. Ontology enables the creation of "shared and common understanding of a domain that can be communicated between people and application systems" [6]. Ontology serves as a language to support data translation and queries from different system designs [20].

2.2 Stakeholder Theory and Analysis

The stakeholder theory approach for strategic management was introduced by Freeman in 1984. He conceptualized stakeholders as "any group of individual who is affected by or can affect the achievement of an organization's objectives" [9, p.46]. Freeman proposed three principles underlying the stakeholder theory to study organization: 1) the acknowledgement of stakeholders' interests, 2) the responsibility of the director or manager, and 3) power of stakeholders to influence the affairs of corporation [10, p.417]. These principles accentuated the significance of connecting the "stakeholders" with decision makers in the organization. In essence, stakeholder theory provides a framework for analyzing the internal and external relationships of an organization with its "stakeholders". Organizational outcomes are closely related to the adoption of specific interests [19].

The stakeholder theory is widely adopted as a framework for development of information systems [27]. In fact, the involvement of users and other stakeholders at various stages was regarded to improve the successful development and implementations of systems [29]. However, Pouloudi argued that most of the information system literature only considers internal stakeholders, overlooking the influence of external stakeholders to system development [27]. He further contended that focusing on internal relations is misleading considering that information systems might have wider strategic implications. As the information systems transcend organizational boundaries, integrating data

[1] The International Organization for Standardization/International Electrotechnical Commision (ISO/IEC)

[2] http://www.iso.org/iso/iso_catalogue/

exchange and business processes, the issue of stakeholders becomes more complex [14, 27].

One of the main aspects in creating interoperable systems is to clearly identify and assess the level of involvement of different stakeholders [22]. Bunn, Savage & Holloway [4] proposed a framework for stakeholders' analysis for multi-sector innovation for marketing development [4]. They recommended a five-step process for stakeholder analysis: 1) identify the key sectors and relevant stakeholders, 2) describe the stakeholder values and interests, 3) analyze and classify based on the stakeholder's attributes, 4) examine the dynamic relationships among stakeholders, and 5) evaluate their generic management strategies [4].

The demands and interests of the stakeholders in building interoperable systems might be diverse and often incompatible, reflecting the complexity of the interrelated systems. As a result, the process for stakeholder analysis for interoperable systems should incorporate a broad sense of the different interests, issues and needs, and account for their possible incompatibility. The diversity and incompatibility of interests among the stakeholders of interoperable systems is further magnified by three stakeholder attributes identified by Mitchell et al. [22] as power, legitimacy and urgency [22]. These stakeholder attributes can be used to classify stakeholders in interoperable information systems as well as the associated interests of those stakeholders. To account for the types and attributes of stakeholders, this paper will use the framework put forth by Mitchell et al. [22] and expanded by Bunn et al. [4] as depicted in Table 1.

Mitchell et al [22] conceptualize power as the level of influence of one social actor toward another based on coercive, normative, and utilitarian perspective [22]. Legitimacy is defined as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, beliefs, and definitions" [30, p.574].

Table 1. Stakeholder Attributes for Interoperable Systems

Stakeholder types	Stakeholder attributes			Stakeholder Salience
	Power	Legitimacy	Urgency	
Definitive	High	High	High	
Dominant	High	High	Low	
Dependent	Low	High	High	
Dangerous	High	Low	High	
Demanding	Low	Low	High	
Dormant	High	Low	Low	
Discretionary	Low	High	Low	

Source: *adapted from Mitchell et al. (1997) and Bunn et al. (2002)*

Urgency is characterized as the sensitivity of time and criticality of the stakeholder claims [22]. While defined individually, the three attributes are interrelated. For instance, the relationship of power and legitimacy will result in authority to influence the systems. Whether the authority is exercised or not largely depends on the urgency of the issue for the particular stakeholder [22]. As a result, the interrelationship of the three attributes determines the salience of the stakeholder and their claims. Based on the salience of the particular stakeholder, the system developers could assign appropriate strategy to addresses his or her concerns, interests, issues, and needs. Likewise, as elaborated by Bunn et al. [4], the stakeholder's interests and attributes are dynamic. For instance, a stakeholder could move from a dominant type to the definitive type during the system development process. In this way, stakeholder analysis is a reiterative process [4].

3. CASE BACKGROUND

This section describes the I-Choose system as an interoperable data architecture. The description is based on the project description by Jarman et al [15] at a recent APPAM conference[3] [15]. The I-Choose project is a current activity at the Center for Technology in Government funded by the US National Science Foundation. The project, known as "Building Information Sharing Networks to Support Consumer Choice (I-Choose)," focuses on the development of information architecture for interoperability among stakeholders to provide a wide range of trusted product information to assist consumer choices in purchasing sustainable food products, particularly sustainable coffee grown in Mexico and distributed and consumed in Canada and the United States. I-Choose will use emerging Semantic Web technologies to create a new generation of "linked data" mash ups connecting actors who have interests linked to the sustainable coffee product supply-chain. To achieve their vision, a collaborative network of international researchers from three countries in North America focuses on developing an interoperable data architecture for full product information necessary for a fair-trade coffee supply chain.

I-Choose system includes at least three different components: a set of data standards to share information across the supply chain, a set of Application Programming Interface (API) standards to make it possible for developers and other interested groups to create specific applications to make this information usable by regular consumers, and a governance system, which will be in charge of creating and modifying the standards over time.

In terms of the data standards for information sharing and interoperability, I-Choose envisions the development of an ontology-based set of standards to integrate information across the sustainable coffee supply chain. This ontology will integrate envisioned sustainable supply-chain ontology with the existing higher order ontologies, such as shipping or export/import ontology, accounting ontology and certification ontology. In the future, an organization's inventory, sales, and shipping information systems will need to comply with I-Choose information standards. The I-Choose architecture will enable the development of various future applications to help consumers make their ethical purchasing decisions.

One of the envisioned applications leveraging on the I-Choose architecture is illustrated in figure 1. This envisioned application allows consumer to trace back the origination of the product that the consumer is interested in purchasing. Let us assume a consumer named Ellen who is interested in fair-trade coffee. When Ellen wants to decide which product to buy to satisfy not only her needs but also her values for environment and social sustainability, all Ellen would need to do is scan the UPC (Universal Product Code) or QRC (Quick Response Code) with her mobile device. This code will enable the connection with the retailer databases to identify the origination and specification of the product. When Ellen run queries, the application based on the I-Choose architecture moves up the supply-chain using a

[3] For complete description, refers to Jarman et al. (2011)

sequence of "shipped to" and "received from" relationship to reconstruct the supply-chain.

If Ellen decides to run queries for the specification and origination of the product, the application moves up the supply chain to reconstruct the supply chain as depicted in the red line in figure 1. Enabling queries about product traceability requires information integration across the supply chain. The I-Choose system does not require the different information systems to "talk" directly to each other nor requires changes to the existing information systems. The connection is enabled through the online availability of some abstraction of the databases by mapping its proprietary data architecture to an open XML schema based on OWL-compliant ontology. Part of the I-Choose system are the special proprietary "patches" designed to map their regular information systems to the standards-based XML schema.

The goal of I-Choose system is to provide "trusted information" regarding sustainability to help consumers making purchasing decisions based on their environmental values. To achieve this, I-Choose needs to be able to present trusted certification and endorsement information in the system. Figure 1 also illustrates how these types of certification and endorsing relationships are handled by the I-Choose system. When Ellen runs queries about the fair-trade label on the coffee packaging by scanning the UPC/QRC with her mobile, the code would enable connection to the retailer databases and extract the origination of the product. I-Choose application will then move up the supply-chain to the wholesaler database of inventory movement and raw material requisition and extract the FLO-ID (Fairtrade ID) and the general ID of the importer (the green line in figure 1). Through this ID, the I-Choose application would identify the FLO-ID of the exporter and producer. The same FLO-ID will enable I-Choose to connect with the Flo-cert Databases and extract information regarding the certification status of producer, exporter and importer. All of this information will be presented to Ellen in aggregation or in detail providing her with more information she can trust regarding the sustainable impact of her purchase. The same process will be applicable for other sustainability ratings.

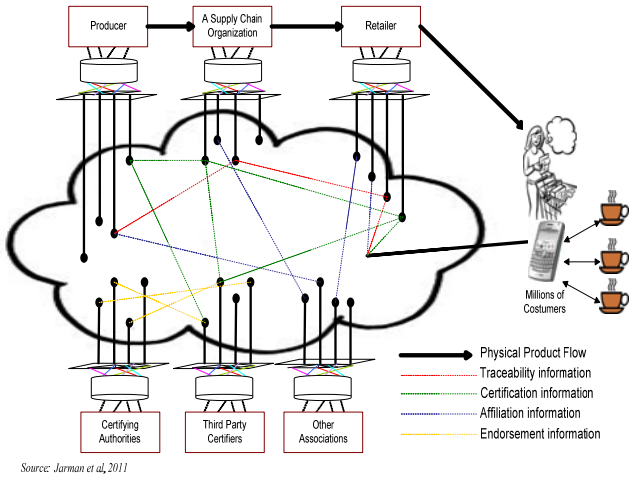


Figure 1. The Envision Application Leveraging on I-Choose Infrastructure

4. METHODOLOGY

4.1 Selection of Experts

The selection process to identify the experts as potential members of I-Choose network is based on the potential knowledge contribution of the expert to enter the study and their willingness to commit their time during the three-year project period. In this research project, the experts were selected to represent the stakeholders of sustainable coffee supply-chain. The experts consist of certifiers, government regulators, ICT specialists, non-for-profit organizations, retailers, consumer advocates, and academics. Given the multinational scope of the I-Choose project, experts were selected from three different countries, Canada, Mexico and the United States.

This wide range selection of experts was intended to mimic the interests of actual stakeholders in the sustainable coffee supply-chain. The search for experts was based on publications in the field, search through websites, as well as personal contact. A total of 23 experts expressed their willingness to join the research project and serve as member of the "I-Choose network". Considering the wide range of experts, the opinions expressed during the data collection could closely represent the opinions of sustainable supply-chain actors and reduce the potential of subjective biases.

4.2 Data Collection

The data collection process was conducted through a focus group discussion as part of a two-day meeting in August, 2011, at the Center for Technology in Government. In the beginning of the meeting, the attendees were given supply-chain exemplars and a case study to test the group understanding of current and potential I-Choose system. There were two exemplars. The first exemplar details the supply-chain process for fair-trade coffee procurement process that is produced by Tosepan Titataniske in Chiapas, Mexico and retailed by Rue-Champagneur in Canada. The second exemplar provide a highlight on the certification process for Fair-trade coffee produced in Mexico and consumed in Canada or/and United States. The case study outlined the policy implications of the I-Choose system in the current situation and in the future. In the larger group, the network members were given time to read and digest the materials and also to ask questions regarding the exemplar and case study.

Afterward, all members were randomly assigned into three different sub-groups where the focus group discussion was conducted. The focus group discussion in the sub-group was conducted in two stages. In the first stage of sub-group discussion, each sub-group was given 45 minutes to discuss "what do you consider as the essential issues and challenges of a system like I-Choose?" Each member in the sub-group was asked to write the issues/challenges on a piece of paper and share it with the rest of the group. In each sub-group they then discussed and selected most important issues/challenges. Subsequently, participants were asked to return to the large group. In this larger group meeting, through a round-robin style, facilitators asked each sub-group for the issues and challenges identified in the sub-group discussion. The facilitators then wrote the issue and challenge on the white board and clustered them into themes. Next, the members were given two different colors of sticky dots and asked to rank the issues based on the urgency, with red sticky dot representing present issues and blue sticky dot for future issues.

In the second stage of sub-group discussions, using similar techniques, the members were asked to identify the potential stakeholders of I-Choose system, ranked the stakeholders based on their power and interest and connected the ten most pressing issues/challenges to the five most relevant stakeholders. The random selection of sub-group and the combination of large group and sub-group discussions were intended to minimize the subjective biases and to avoid the impact of few respondents skewing the opinion of the group.

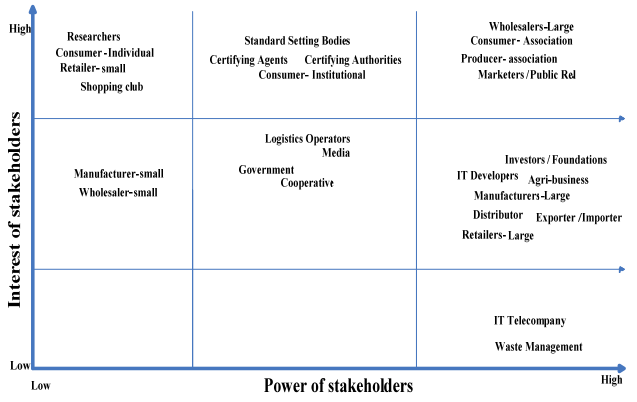
5. FINDINGS

5.1 Stakeholders and Their Attributes

Based on Freeman's [9] contention of stakeholder theory, Mitchell et al [22] propose two perspectives in the stakeholder theory, 1) to identify who or what are the stakeholders, and 2) to identify the issues that need to be considered. The first perspective deals with identification of stakeholders, separating the stakeholders from non-stakeholders. Mitchell et al [22] propose three attributes to assist in identifying and narrowing the stakeholders, namely: power, legitimacy and urgency [22].

This section will outline the stakeholders of the I-Choose system identified from the network meeting. In the first round, the network members were asked to identify the potential stakeholders that they assume could affect or be affected by interoperable data architecture such as I-Choose (figure 2). Among the identified stakeholders, the network members also classify and identify seven primary stakeholders of I-Choose system. These primary stakeholders are consumers, producers, certifiers, retailers, distributors, cooperatives and consumers association.

In the second round, the same network members were asked to classify the identified stakeholders based on two attributes, power and interest. Power in this study is defined following Mitchell et al category, which refers to the level of influence toward others [22]. Interest is defined as the objective concern over the I-Choose system based on participation or in using I-Choose system. The mapping of I-Choose potential stakeholders based on interest and power is depicted in figure 2 below.



Source: I- Choose focus group result

Figure 2. Potential Stakeholders of I-Choose

Based on figure 1, the I-Choose network members assigned all of the primary stakeholders of I-Choose into the high interest quadrant. Understandably, the primary stakeholders would have high concern over I-Choose due to their high potential involvement in using or participating in I-Choose. Interestingly, the network members correlated the power of stakeholders with membership in or association with an organization and the size of the organization. The right side of figure 2 depicting the quadrant of high power is populated with organizations. As an association with an organization is regarded as a proof of legitimacy, at the very least based on legal perspective [22], the results suggest that the network members were equating power with legitimacy.

In addition, the network members also seemed to correlate size of organization with power to influence the system. Larger organizations (e.g. larger wholesaler or retailer) are depicted to have higher power to influence the I-Choose system (figure.2). Larger size seems to be equated with the existence of slack resources, more accommodating organization structure and higher market share and power [12], which make them have higher ability to adopt new innovation [12, 18, 23]. On the other hand, the willingness to accept change in large organizations is also influenced by the relevance of the innovation to the current area of activity and interest [16]. Based on their power and resources, the acceptance or rejection of the new system by large organizations could potentially restrict or enable the adoption and diffusion of the I-Choose system.

Building from the identified stakeholders, their power and their interests (figure 2), we can generate the classification of stakeholders using the framework proposed by Mitchell et al [22] and extended by Bunn et al [4] as depicted in table 1. This framework uses three stakeholder's attributes: power, legitimacy and urgency. Following the logic of the network members, we equate power with the association to organization and size of the organization. In this sense, individuals have lower power than organizations, and larger organizations have higher power than smaller organization.

Following the assertion of Donaldson & Preston [8] on the normative aspect of stakeholders, interests of stakeholders can be used to justify the legitimacy of the stakeholders toward the system/organization. In addition, legitimacy is socially constructed value system based on norms and beliefs [30]. Following this argument, we contend that actors have high legitimacy when they have high interest in the I-Choose system. For instance, IT Telecompany might have high power due to the economic capital available at their disposal, but low legitimacy to I-Choose. The indirect representation of their interest in the I-Choose system contributes to the low legitimacy. Their interest lies on the usage of telecommunication infrastructure regardless, to some extent, of the existing application or system.

Lastly, this study defines urgency as the promptness of responses required by the stakeholders based on their respective interest. We argue that the producers, consumers, wholesalers, retailers and certifiers have higher urgency to have their interests acknowledged than other identified stakeholders. To use the same example, the IT Telecompany will have low urgency in the I-Choose system as compared to the individual consumers. The classification of the identified stakeholders based on the three attributes is presented in table 2.

Building on the classification of stakeholders and their attributes, we then categorized the salience of the stakeholders. In this research, we use two types of classification for the stakeholders' salience: priority and acknowledgement. Priority is assigned when at least two out of the three attributes are met. Acknowledgement is assigned when at least two out of the three attributes are not met. This exposition is based on Mitchell et al [22] argument that the salience depends on the interaction of attributes. For instance,

interaction of power and legitimacy result in authority and urgency provide ways to exercise the authority. The interaction of legitimacy and power will result in entitlements or privileges that are voiced through urgency [22, pp. 869-870].

The stakeholders who have high power, legitimacy and urgency need to have first prioritization by the system developers. The needs of these stakeholders should be prioritized first in the system development. These are the stakeholders who could create resistance and inhibit the proliferation of the system development if their needs are ignored. The stakeholders who have high level of at least two attributes need to be given second priority. In the sense that their needs and claims might be considered in the system development but the extent to which the system developers incorporate their needs is contingent on the time constraint and other resources or policy requirements.

The stakeholders who have only one attribute with high property need to be acknowledged by the system developers. However, the extent to which the system developers need to include their needs into the system is contingent on the availability of funding, time and other resources. The difference in the urgency between the stakeholders will also influence the timelines in addressing their needs and claims.

5.2 The Challenges of Interoperable Data Architecture

The network members of I-Choose were also asked to identify the issues/challenges/barriers that they foresee in the development of interoperable architecture like I-Choose. The network members were asked to rank the issues and after grouping them, assign themes to each group. We classified the challenges into three major categories: technology-related, economy-related, and policy-policy. The summary of the challenges is presented in table 3.

5.2.1 Technology Related Challenges

The technology related challenges consist of the following three major elements: the access challenge, the trust in the data, and the development approach challenge. First, internet access might pose huge challenge for certain actors in the supply-chain. For instance, the producer, particularly small plantation owners who are not part of a cooperative, might have a difficulty connecting to the internet. In addition, these producers might also not have the information systems that could comply with the I-Choose system. However, this challenge is related more to the implementation and not the development of the system.

This condition creates challenge for the system developers in choosing and integrating different technologies in creating the I-Choose system. Third challenge is related to the trustworthiness of the data. The core of I-Choose system is providing trustworthy information for the users/consumers to assist them with making purchasing decisions that reflect their environmental and social values.

The I-Choose system aims to gather the information from the existing data repositories along the supply chain and 3rd party certification. The quality of the data gathered from these data repositories will influence the level of trust in the information provided by I-Choose. This challenge poses the most significant issue for the system developers.

Table 2. Stakeholder Types based on the Attributes

Stakeholder types	Attributes			I-Choose Stakeholders	Stakeholder Salience
	Power	Legitimacy	Urgency		
Definitive	High	High	High	• Large wholesalers • Producers association • Consumers association	Prioritize
Dominant	High	High	Low	• Standard setting bodies • Certifying authorities • Distributor • Exporter/Importer • Large Retailers • Government • Agribusiness	Prioritize
Dependent	Low	High	High	• Certifying agents • Individual consumers • Small Retailers • Cooperative • Small wholesalers	Prioritize
Dormant	High	Low	Low	• Media • Marketers/Public Rel. • IT Telecompany • Waste Management • Investors / Foundations • Manufacturers	Acknowledge
Discretionary	Low	High	Low	• Researchers • Logistics operators • IT Developers	Acknowledge

5.2.2 *Economy Related Challenges*

Providing sustainability certification represents a big business. For instance, the reported fair-trade sales revenue by small farmer organizations during 2009-2010 was estimated to have reached 447 million Euros. The total income of the Fairtade International for the year 2010 was 13.7 million Euros[4]. This lucrative market could attract various interests, which could be affected by an information system that enables interoperability from consumers to the producers. The network members of I-Choose expressed their concerns about a potential negative impact on small businesses. The small farmer organizations lack expertise, have low competitive power, and have marginal technological capability. The new information system could create potential information manipulation by powerful, but irresponsible, actors in the supply-chain.

The I-Choose network members also expressed their concern about the cost of the system. The cost reflects the cost for the system and the cost for the consumers. The former relates to the incentives to maintain I-Choose and the business model of I-Choose.

Presumably, the operation of I-Choose will incur costs; hence there should be designated actors who have to bear these costs. The later relates to the costs incurred by the consumers in terms of loss of time and effort. An application developed using the data from an I-Choose system would represent an additional step that consumers would need to take while shopping for coffee. They would have to search and digest all of the information generated by the I-Choose system to help them make purchasing decisions. This challenge is closely related to the design of the I-Choose system. The extent to which a balance can be struck between the depth of information and simplicity of the system will significantly correlate with the users' satisfaction.

5.2.3 *Policy Related Challenges*

In the preceding section we had outlined the various interests that could be attracted to the lucrative sustainable products market. Consequently, creating policies to govern the operations of the I-Choose system would be crucial to avoid manipulation and other unlawful behavior. The I-Choose network members identified four major challenges in relation to policy: consumer privacy, political resistance, oversight and governance, and compatibility issue.

In relation to the negative impact of the proposed technology on the small farmers and small farmer organizations, the I-Choose network members emphasized the potential political resistance and need for appropriate governance and oversight mechanism.

The sustainable products market is attractive and information becomes strategic commodity for organizations in the supply-chain [33]. Wolf [33] pointed out that information signifies power in the supply-chain and the sharing of information involved game of power dependency among the supply-chain parties [33].

In this regards, information system that provides transparency and integration of information along the supply-chain could potential alter the power balance. There is a possibility that the new system would be met with political resistance or the supply-chain organizations would attempt to manipulate the system to reaffirm their powerful interests in the supply-chain.

Table 3. High Ranking Issues/Challenges by Categories and Themes

Category	Themes	Issues/Challenges
Technology	Development approach	• Seamless open technology • Technology exist but fragmented
	Trust in the Data	• Accuracy of information • Data Ownership
	Access	• Internet access in the location
Economy	Cost	• Cost to maintain the data system • The costs and benefits of the system
	Consumer time, cost and effort	• Cost to consumer • Information overload for consumer • Time, values, money, and interest of consumers • Consumers' awareness of the system
	Negative effect on small business	• Lack of expertise for SMEs • Competitive content • Training and technology differentials for marginal actors
Policy	Consumer privacy	• consumer privacy and accuracy of information
	Political resistance	• Limiting the powerful interest from manipulating the system • Unfair barriers to entry at all levels in supply-chain
	Oversight / Governance	• Oversight and assessment of the system • Appropriate governing mechanism
	Compatibility	• Lack of standard compatibility

[4] http://www.fairtrade.net/fileadmin/user_upload/content/2009/about_us/FLO_Annual-Financials-Sales_2010.pdf

The magnitude of the resistance can be high considering that the integration of information from various actors in the supply-chain and 3rd party certification organizations would involve various stakeholders with diverse interests, power and values.

The diversity of interests, power and values in the supply chain could also magnify the challenge of creating an oversight and assessment process supporting just and objective governing mechanism that accommodate the diversity, as pointed out by the network members. In addition to the diversity in the values and interest, the network members also highlighted the lack of compatibility in the existing standards for sustainable coffee. There are various 3rd party governing bodies using different indicators based on the different standards for sustainable coffee. For instance, each of the major independent monitoring and certification bodies – fair-trade, organic, rainforest alliance, and Utz certified – have different underlying principles in their certification and monitoring processes [17].

Lastly, the network members were also concerned with the possible consumer privacy intrusion. Any application built on the foundation of I-Choose envisions that consumers will be able to probe more information about a product background particularly related to the sustainable product. To do this, the consumers have to run the application through their mobile devices.

When scanning the product code, the consumer's device would connect to the retailer's servers and the cloud. Through this connection, the consumers may be subjected to intrusion on their personal data. Smartphones may carry expansive amount of personal information that could put the consumer at risk for identity theft and other online frauds.

5.3 Identifying the Salience of Challenges

During the network meeting, the network members were also asked to correlate the most pressing issues with the primary stakeholders. The results from this exercise enabled us to seek the connection between the salience of stakeholders with the pressing issues. Using this simple mechanism, we can identify the salient issues or challenges that system developers need to pay attention to. The identification of the salient issues or challenges is presented in table 4.

The issue/challenge of trust in the data emerged as the most salient issue that system developers need to prioritize. The salience of trust in the data is identified as important to four stakeholders, two definitive and two dominant stakeholders.

The next issue to prioritize is the cost to maintain the system. This issue relates to the creation of a feasible business model to support the sustainability of I-Choose system in the long term. This issue was identified as important to one definitive and two dominant stakeholders. As depicted in table 4, the stakeholders who vouched for the salience of this issue are the supply-chain actors (producer, retailer and distributor).

The profitability of these stakeholders might be affected by the potential costs resulting from the governance and sustainability model of I-Choose system. For instance, if the cost to maintain I-Choose is applied to the retailer, this cost will add to the cost of goods sold resulting in a reduced profit margin.

Table 4. Identifying Salience Issues/Challenges

Stakeholders	Trust in the Data	Cost (maintain the architecture)	Consumer time & efforts	Incentives	Consumer Privacy	Negative effects on small business	Political issues	Oversight / governance	Filtering	Compatibility of standards	Access	Development approach	Type	Salience
Consumer Association	X		X					X	X	X			Definitive	1st Priority
Producer Association	X	X		X		X	X				X		Definitive	1st Priority
Large Retailers	X	X			X		X	X					Dominant	1st Priority
Distributor	X	X	X										Dominant	1st Priority
Cooperative			X							X			Dependent	2st Priority
Consumer	X		X								X		Dependent	2st Priority
Certifiers	X						X			X			Dependent	2st Priority
Small Retailers		X		X							X	X	Dependent	2st Priority

The subsequent issues that are regarded as the salient issues are political resistance, oversight/governance, and consumer's time and effort. These issues are identified as important to two stakeholders, one definitive and one dominant stakeholder. The producers are more concerned with the political resistance than the issue of oversight mechanism. The producers might be concerned with the possible unfair manipulation of the system by irresponsible powerful interests. On the other hand, the consumers are more concerned with the oversight and assessment of the system and their expected level of involvement in the system in term of time and efforts.

6. CONCLUDING REMARKS

Building from the I-Choose project, this paper analyzes the challenges of developing data architecture to support interoperable sustainable supply-chain from the perspective of stakeholders. This study uses the proposition from Freeman [9] that is extended by Mitchell et al [22] as a frame of reference to 1) identify the stakeholders, and 2) identify the issues that the systems designer and organizations in the supply-chain need to pay attention to.

The identification of stakeholders and the issues and challenges was based on the expert input through a focus group discussion comprising of experts in the sustainable supply-chain. This paper connects the salient stakeholders to the identified challenges and issues to further identify and classify the most salient issues that a system developer needs to focus on in building interoperable data architecture. Using this mechanism, we identify five most salient issues/challenges that would require first priority in developing an interoperable data architecture: 1) trust in the data, 2) cost to maintain the system, 3) political resistance, 4) oversight and governance, and 5) costs to consumers in term of time and efforts. All of these issues entail significant research and practical implications, not only for the system developers but also for government and policy makers. This section will outline some of the potential research and practical implications for developing interoperable data architecture, such as I-Choose.

6.1 Research Implications

The issues of generating and measuring trustworthiness of data for the users of interoperable system are still very much open for investigation. Extant research examines trustworthiness of data from various lenses, such as: data integrity, data quality and data lineage and provenance [1]. There are different streams of research examining the trust in the data. Some research examines the meaning assigned to data quality [31, 32]. Other research examines the trustworthiness from the data lineage and provenance [1, 2, 28]. Yet, research on the trustworthiness of data in the context of supply-chain and interoperability has received less attention. More research is needed to understand the existing mechanisms to ensure data trustworthiness in supply-chain integration. Mapping of the existing data sharing mechanisms and data management practices in the supply-chain integration would be useful. The vision of I-Choose pointed at the importance of understanding the boundary in putting database abstractions without compromising security and privacy of proprietary data.

The analysis also highlights the significance of political resistance and the need for oversight and governance mechanisms to support interoperable architecture in supply-chain. More systematic research is needed to investigate the appropriate governing mechanisms that take into account all the complexities associated with interoperability in supply-chain. Jarman et al [15] pointed out three interrelated components for proper governance of system like I-Choose: "hard" regulation, partnership, and consumers participation in policy making. Research is needed to further understand each of the proposed elements. I-Choose envisioned data extraction from various data sources; some of them open to public and other are proprietary. Research is needed to investigate the policy governing the extraction and use of data from different data sources.

6.2 Practical Implications

In addition to the research elements, the development of interoperable data architecture entails various practical implications. The involvement of diverse organizations in the supply-chain necessitates practical investigation of the different capabilities required for supporting the creation of interoperable data architecture in supply-chain. Pardo & Burke [26] argues that understanding the different capabilities in the organizations involved in the interoperability system is one of the key success factors in the implementation of interoperable system [26].

The governing bodies of certification and monitoring of sustainable products use different standards and indicators. These differences in certification, monitoring and inspection standards create more complexity in the development of interoperable data architecture. Mapping of the existing 3rd party and government-based certification and monitoring is necessary to support the creation of the interoperable architecture. Creating a knowledge map that captures the overlaps and distinctions among these different standards could potentially ease the development and implementation of interoperable architecture.

Specifically to I-Choose, cost emerged as a major and salient issue to be considered in the development of the system. These questions relate to the sustainability models of I-Choose system; what are the source of funding and what would be the business model for such system. The investigation of this revenue and business model will lend understanding to the governance of I-Choose system.

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