Influence of Information Sharing Behavior on Trust in Collaborative Logistics

Morice Daudi, Jannicke Hauge, Klaus-Dieter Thoben

Influence of Information Sharing Behavior on Trust in Collaborative Logistics

Morice Daudi[1], Jannicke Baalsrud Hauge[2, 3] and Klaus-Dieter Thoben[1,2]

[1] International Graduate School for Dynamics in Logistics (IGS), University of Bremen, Germany (mdaudi@uni-bremen.de)

[2] Bremer Institut für Produktion und Logistik at the University of Bremen, Germany {baa, tho}@biba.uni-bremen.de

[3] School of Engineering, Technology and Health, KTH, Royal Institute of Technology, Sweden

Abstract. Collaborations are based on mutual trust to strengthen confidence in the sharing of various resources such as information. Particularly in logistics, collaborations benefit emerged rich-data environments to successfully manage demand fluctuation and visibility of in-store logistics; as well as the sharing of physical assets. Shared information is gathered from various sources and manipulated by specific partner to match or maximize individual payoff. Such information may become vulnerable to information sharing behavior of the partner to henceforth affect trust. This paper investigates the influence of the information sharing behavior on trust. It focuses on a dimension of information accuracy to answer a research question: how do information sharing behaviors of partner affect trust in logistics collaboration? A framework of information behavior is established, and subsequently a trust model specified. Afterwards, simulation experiments are conducted to observe resulting impacts. Results unveil that both, the positively and negatively manipulated information influence trust in similar magnitudes. It is further argued that partner's deceitful behavior underlying information sharing can be reduced although it might be difficult to eliminate.

Keywords: Trust, logistics collaboration, rich-data environments, information behavior, information uncertainty, veracity information.

1 Introduction

Logistics collaboration advocates an efficient use of shareable resources to mitigate underlying and encountered inefficiencies. Through collaboration, partners can reduce logistics costs, improve the quality of service, gain market position, and reduce harms to the environment [1]; as well as increase the utilization of physical and non-physical assets. Although beneficial, logistics collaboration is challenged by a lack of trust amongst collaborating partners. One key area contributing to this challenge are

uncertainties which stem from the information sharing behavior of partners. The sharing of information enables the implementation of planning and control of chain operations [2]. Information sharing is one of the key determinants of trust in logistics collaboration, on the one hand. On the other hand, it is a construct from which both the certain and uncertain behavioral elements of an enforcing partner emerge. Uncertain information lacks quality, and may negatively affect chain operations and trust. For example, the sharing of untimely, irrelevant, inaccurate and incomplete information may escalate uncertainties due to unreliable variations in an actual belief of the world. Notwithstanding with this, sharing of quality data may be impeded with the perceived (or existing) opportunism; fear of exposing private business models to competitors, and; misuse of proprietary information. This problem may even be large in the present era where supply chain and logistics operate in data-rich environments where veracity information is largely featured.

Information behavior in logistics and supply chain is normally conceptualized in qualitative and/or quantitative forms. The literature [3, 4, 5] conceive the qualitative form using constructs such as "*no information sharing*", "*limited information sharing*", and "*full information sharing*". Such constructs have been used in [3], [6], [7]. The no information sharing, according to [8] means sharing only actual orders and excluding tiers of width and distance of sharing. The full information sharing construct implies that all information is visible to the entire chain without any barrier. This implication is however contradicted because collaboration occurs in a world which is neither totally invisible nor completely visible. In addition, the full information sharing is even exaggerated because the world cannot be made risky-free. The no information sharing construct denies prediction and implies that transactions are risky and untrustworthy. To this end, the limited information sharing remains the potential and practical belief that surrounds daily living of humans. It is the world in which humans, organizations, and objects interact and collaborate. Therefore, this paper advances on the limited information sharing that is featured by the information sharing behaviors of collaborating partners. It concentrates on a dimension of information accuracy to investigate how information sharing behavior of partners impact trust. It particularly answers the following Research Question (RQ): *how do information sharing behavior of the partner affect trust in logistics collaboration?* Besides this RQ, the paper contributes also by establishing a trust framework of information behavior that may potentially be applicable in logistics collaboration and related areas.

The remainder of the paper is organized into 7 sections. Section 2 presents discussions of data-rich environments, trust in logistics collaboration, and information behavior. Section 3 describes a methodology this study has employed while section 4 presents a framework of information behavior. Whereas section 5 presents the trust model and hypotheses, section 6 presents the design and setups of the experiments. Section 7 presents results and discussions while section 8 provides conclusion and outlook.

2 Information Sharing: A Trust-based Perspective

This section presents discussions of data-rich environments in logistics and it highlights the current and future benefits of such environments to collaboration. In addition, it reviews literature which addresses trust in a standpoint of information sharing. A primary goal of such review is to recognize previous contributions and identify a resulting knowledge gap. Final discussion is focused on building a foundation of information and information-seeking behavior. This foundation supports the establishment of a corresponding trust-based framework that guides a trust model.

2.1 Data-Rich Environment in Logistics Collaboration

Emerging information and communication technologies enrich the world with more data. Such data enables efficient distribution goods, services, and as well as mobility of humans. It further facilitates visibility of logistics features such as the size, weight, content, location, condition, and the state of usage of asset. Rich-data has enabled customers to gain more control in the delivery of tangible goods thereby supporting a direct customer interaction especially at pickup and delivery [9]. Other improvements are such as the: prediction of consumer demands; production planning, and; distribution and storage of goods. In the matter of feedbacks the manufacturers and retailers can nowadays obtain consumers' reviews about products and services they offer. Nevertheless, it is now relatively quite easy to figure out an optimum delivery route that leads into saving the cost of fuel.

However, data-rich environments are challenged to deceitful behaviors. The deceitful behaviors emerge from many sources such as actors (partners). Partner may purposely distort Information Quality (InfQ) either for just malicious purpose or individual interests. The accuracy of exchanged data, for example, may intentionally be manipulated to maximize individual payoffs. This challenge may be referred to as veracity data in logistics collaboration. It is the challenge encountered when opportunistic partners generate rich but inaccurate data that in the end offer a high chance to deteriorate trust.

2.2 Trust in the Context of Information Sharing in Logistics

Trust is generally understood as an extent to which an object will behave in an expected manner. It is a critical ingredient of humans' everyday life and plays a profound role in networked collaborations. Although a plethora of definitions exists, in this paper, trust is defined in accordance to [10]. Trust is a level of confidence developed by trustor in trustee based on the expectation that trustee will perform a particular action necessary to the trustor, irrespective of the ability to monitor or control trustee.

Literature has addressed trust in a standpoint of information sharing. In the [11] authors investigate the role of information sharing and quality in the development of

trust. In [3] authors explore how trust impacts the level of shared information. Using the supplier and manufacturer as subjects, authors in [6] investigate the role of trust in supply forecast. Moreover, in [7] authors study supply chain coordination with the trust-embedded cost-sharing contract. In the overall, previous studies tend to address the role and impact of information sharing on trust. Such studies lack to take into account sufficient consideration of information sharing behavior exhibited by partners.

In a standpoint of trust in logistics collaboration, information sharing is more than a degree to which information can be exchanged. One crucial step ahead, for example, is to understand how information sharing behaviors of partners lead to the growth or deterioration of trust. This understanding strengthens previous contributions and subsequently updates both the academic and practitioner communities. In essence, collaborating partners exhibit multiple information sharing behaviors which may be valuable or harmful. Valuable behavioral practices entail information exchange that conforms to a purpose of collaboration, while harmful ones lack this conformity. Both behaviors can be described or represented using the InfQ dimensions such as those belonging to data use in the process. A critical analysis of the literature on logistics collaboration characterizes the data use in process to consist of various attributes (see in [12], [13]) such as the information accuracy. Information accuracy means that every set of data represents a real world situation [13]. If partners exchange data that do not represent a factual belief of the world causes low chain visibility as well as trust deterioration.

2.3 Information Behavior in Logistics Collaboration

Information and information-seeking behavior are becoming more imperative in this era of information age. These multidisciplinary constructs are drawn from disciplines of the information science, psychology, and decision-making. The literature [14] define the: information behavior as the totality of human behavior in relation to sources and channels of information, whereas; information-seeking behavior is the purposive seeking for information as a consequence of a need to satisfy some goal.
Partners source (capture) and exchange (share) information amongst them to satisfy goals of collaborating. For this to be possible partners have to possess cognitive ability for sensing [15]: information that reflects the state of their environments (beliefs); state of the environment they prefers (desire), and; state of the environment they try to achieve. Since captured information is not only meant for internal consumption, it has to be shared to peers for a specific purpose. In view of this, author [8] emphasizes that information sharing is typically a: *collaborative/collective behavior* since it does not only involve an individual behavior, but a collective and collaborative effort occurring in a sharing community; *mutual-benefit behavior* because partners expect to respectively gain values out of it, and; *relationship-based behavior* because it is supported and facilitated by relationships that connect partners. In spite of a fact that partners work to attain common goals they may still differ in decision-making. This difference is largely brought about by uncertainties in states of their environments as well as intrinsic and incongruent behaviors of partners. Partners may correspondingly be deceitful and manipulate (distort) captured information

before sharing it. Consistent with the principle of sense-making, such shared information may be subjective because its production is internally guided by partners [16].

The information sharing behavior can be described and represented using the Wilson's revised model of information behavior [17] and Dervin's sense-making framework [16]. These model and framework are potentials for establishing the linkage and dependency among the information behavior, sense-making, expectation and trust. Author in [18] builds from [16] to clarify that sense-making is implemented:

- *In situation of time and space* (context in which information problems arise);
- *In a gap* (difference between the contextual and desired situation);
- *An outcome* (consequences of the sense-making process), and;
- *A bridge* (means of closing the gap).

This implementation correlates strongly to human trusting process and the structure of belief-desire-intention. To briefly explain, trust has a meaning in a situation of dependency featured by a fact that trustor cannot accomplish its task without relying on trustee. In this dependency the trustor is uncertain (gap) if a trustee can accomplish a task to be delegated in a manner the trustor expects. In this endeavor, the trustor collects and assesses information about the trustee to close the uncertainty it has in the trustee. Once satisfied, the trustor accepts to be vulnerable to consequences of the trustee and executes an action to trusting.

3 Research Methodology

This study builds up on social behavior of human agents in computer controlled settings. It uses the Multi-Agent Systems (MAS) simulation to observe impact that results from the bottom-up interactions of individual human-representatives. The MAS complements the case study and/or action research due to difficulties of obtaining industrial testbed platform. The remaining part of the methodology is described as follows. Firstly, a framework is built to link the concepts of logistics collaboration, information behavior, and trust. In this framework, key collaborating partners are identified and modeled using the agent-based modeling approach. Secondly, a trust simulation model that draws largely from [19] is formalized and corresponding hypotheses derived. Thirdly, simulation experiment is designed and necessary settings specified to run experiments. The simulation uses the randomly generated data (*model*) and system data (*system*). The system data has been validated in [20]. For model inputs, independence of data is established using linear-congruential generators. Additionally, the chi-square test is carried to ensure data is uniformly distributed.

The internal validity technique is used to ensure that conceptualization as well as assumption, and representation of the information sharing behavior is reasonably accurate and credible. It is worthy to note that the trust mechanism behaves stochastically due to individual agent's actions. For this reason, the internal validity is attained by running several replications to determine the amount of (internal)

stochastic variability [21]. Moreover, two aspects are involved to ensure that results are not only reliable but also bear an operational level of accuracy. Firstly, the output behaviors of the component of Interaction Trust (IT) of the FIRE [22] model and trust model (*trust mechanism*) are compared. The second aspect entails comparing outputs behavior of model data to that of the system data. Mixed techniques, namely: statistical tests and graphical displays are employed to provide the subjective and objective decision in judging results of the aforementioned comparison.

4 A Framework of Information Behavior

In this section a trust-based framework of information behavior is proposed. The framework provides loose connectedness among concepts used in this study. The framework is built up by integrating the revised model of information behavior in [17], and the concepts of information sharing, partner behavior, logistics collaboration, and trust (Fig. 1). This framework depicts logistics collaboration as a context by which partners desire to improve information visibility. It is further described as follows. Shippers, carriers, and receivers desire information (world beliefs) to achieve an ideal full information visibility. This desire may be satisfied or not. Struggling to achieve this desire partners activate their information seeking behaviors to obtain needed information. Such information relates to logistics functions such as the capacities, demands, forecasts, inventories, and backorders.

However, during this struggle partners encounter stresses in respect underlying uncertainties in information they are looking for (sensing). To master such stresses partners need to be cognitive. Such kind of ability help partners to reduce or mitigate encountered uncertainties thereby collecting needed information from all sources they are able to sense. While attempting to manage uncertainties, partners face barriers related to the economy, environment, and source characteristics.

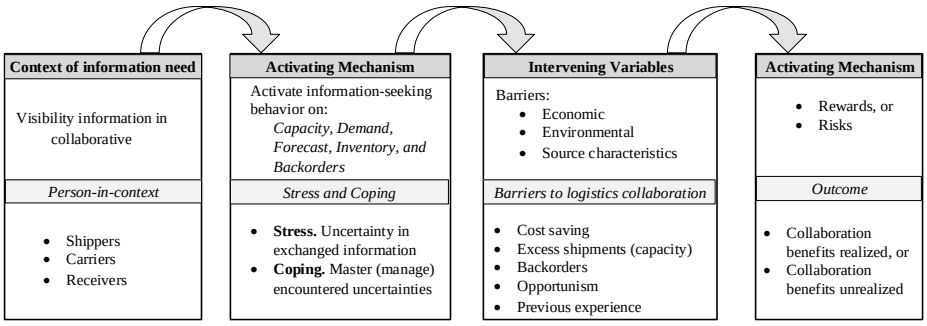

Fig. 1. A framework of information behavior in the context of logistics collaboration

To emphasize this, barriers partners face are such as: how much cost they can save by collaborating; costs emerging from excess capacity they provide, and; back orders. Other barrier is a possibility that some partners want to benefit more on the cost of others (opportunism) by providing misleading information. Additionally, previous experience may become a barrier especially when benefits to collaboration were least

than it was expected. On the whole, depending on the information sensed (captured) and individual cognitive reasoning, partner chooses how to behave when providing (exchanging) information to its logistics network. In the end, logistics function becomes executed and outcomes (reward or risks) observed. Depending on the states of outcome and prior expectation partners may maintain a trust or distrust in the network they are involved. Moreover, obtained trustworthy forms part of an experience to future engagements where partner may adjust its information sharing behavior to suit the forthcoming context (stress, barriers, and outcome).

5 Trust Model and Hypotheses

This section proposes the trust model that is used to investigate the impact of information sharing behavior on trust. Conception proceeds as follows. A decision partner undertakes is largely influenced by prevailing circumstances (collaborative situations) and is guided by individual ability of the partner to reason. The collaborative situation and individual ability account for a degree of the certainty and uncertainty in information partners can share or exchange. Partners can exchange uncertain (manipulated or distorted) information in an attempt to recover from previous bad outcome or to purposely maximize individual gains (opportunism). The outcome and opportunism constitute the internal and external environments which influence partners' decisions.

Information accuracy, which is the attribute of InfQ, is used to investigate the information sharing behavior of partners. It is modeled using the quantitative stream. Under this stream information accuracy stands on a continuum of information certainty and uncertainty. Concordant to [6], logistics elements such as the production capacity, market demand, and forecasts are modeled to be affected by a specific factor. This means that collaborating partners are enabled to manipulate (modify/distort) or retain the factual beliefs (true/actual information) before they exchange it. A degree to which partners distort the actual information is determined by influential situations that surround them, such as previous trustworthiness. Three kind of factors (or affection) are formalized to affect the degree of information accuracy. Meaning that partners retain or distort accuracy of information in three ways: negative distortion (or negative information accuracy) that is denoted by a symbol "$\boldsymbol{\gamma}$"; no distortion (or neutral information accuracy) that is denoted by the symbol "$\boldsymbol{\alpha}$", and; positive distortion (or positive information accuracy) that is denoted by the symbol "$\boldsymbol{\beta}$". Such factors imply that partners choose to exchange information that is: below the exact value (affection by factor γ); equal to the exact information without distorting (affection by factor α), and; above the exact value (affection by factor β). Each factor has its set whose elements are selected by partner to affect the accuracy.

Partners are guided by the information behavior (*stress, coping, barriers, and likely outcome*) to choose which factor to use when affecting the accuracy of information. This affection is realized by multiplying the chosen factor with a real world situation data. For example, let the real world data be denoted by $\boldsymbol{q_0}$ and the

value after affection be denoted by q_n. Then the affection is of the form: $q_n = q_0 + q_0 * factor$. To illustrate, if q_0 is 100 units and *factor* is -0.15 then the value after affection is 85 units ($q_n = 100 + 100 * -0.15$). The factor is a coefficient whose value may be negative, zero, and positive. Particularized to this study the sets of information accuracy for each affection are defined as follows:

- *Negative information accuracy*: $\gamma \leftarrow$ *{-0.45, -0.40, -0.35, -0.30, -0.25, -0.20, -0.15, -0.10}*. Partner who exhibits this behavior is considered untrustworthy and acts in a manner of maximizing individual payoff. The partner exchange information that is underestimated and is affecting the accuracy negatively.
- *Neutral information accuracy:* $\alpha \leftarrow$ *{-0.05, 0, 0.05}*. Partner who affect logistics elements using this factor are considered honest, congruent, and can certainly be relied upon. If a factor chosen is zero then the partner is absolutely honest and reports the true information. Otherwise it is a normal honest partner.
- *Positive information accuracy:* $\beta \leftarrow$ *{0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45}*. Partner who exhibits this behavior is still considered untrustworthy (similar to the negative information accuracy). He instead exchange overestimated information.

Besides the established affections, further enrichment to the trust model are provided.

If a partner had previously experienced the best (or better) trustworthy it becomes realistic by reporting almost undistorted information, on the one hand. On the other hand, if it had previously experienced the worst (or worse) trustworthy it struggles to recover by reporting distorted information. In each cycle partner develops an expectation that is to be compared with reality thereof. In the matter of this, this paper advances on the trust mechanism proposed already in [19]. This mechanism emphasizes that human trusting process propagates in three stages: intention to trusting; action to trusting, and; transaction to trusting. In a second stage, the trustor develops specific expectation in the trustee with respect to a task (transaction) it desires to delegate. Once transaction is executed the trust level is assessed by comparing resulting score (outcome) against the expectation.

In the present study the predictor and response variables are specified (Fig. 2). The main predictor variable, information accuracy, consists of three sub-variables: *negative information accuracy, neutral accuracy, and positive accuracy*.

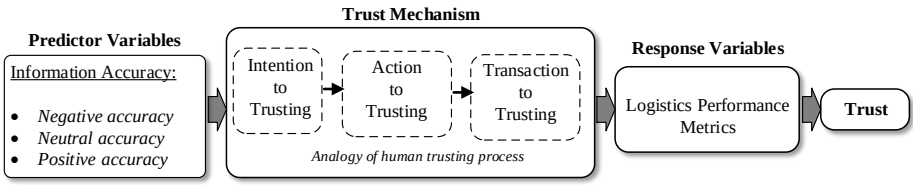

Fig. 2. The trust model used in simulation

Five response variables used to observe and evaluate trust. They are forecast accuracy, cost saving, full truck load, order fill rate, and vehicle fill (refer section 6 for further details).

Moreover, two hypotheses (claims) are derived to help understand how information sharing behavior of the collaborating partners affects trust. Struggling to fulfill goals, partners have options decrease, increase, or even retain actual information about their orders and/or capacities. What is still unestablished is whether distorting information by decreasing or increasing orders and/or capacity marks a distinctive impact on trust level. As well, if the distinction exists what affection may relatively be better? To unveil this, the following claim is set:

Claim 1: *The positive and negative information accuracies generates trust levels which are equivalent*.

It has been conceived that partners who are normally stressed tend to master a situation they encounter by trying to choose options which can maximize their expected gains. Although the factor ($\boldsymbol{\alpha}$) is assumed to be entirely certain, still the {0} element is the only absolute member of a set by which partners may report exact information compared to the rest: *{-0.05, 0.05}*. In this case, it is gain necessary to understand whether partners prefer to *exactly* be honest or they deviate slightly. The {0} and {-0.05, 0.05} factors are referred to as the *absolutely exact* and *slightly deviated* information accuracy, respectively. To realize this, the second claim is set as follows:

Claim 2: *Under the neutral information accuracy partners prefer to report the slightly deviated than the absolutely exact information accuracy.*

6 Design and Setup of Experiments

The design and setups of experiments proceed as follows. A logistics network applied in this study correlates partly to that in [23]. The network comprises of 7 shippers and 7 receivers (to simplify interactions), and 3 carriers. One shipper serves one and only receiver but with multiple orders. Each carrier owns one vehicle truck that is put in a pool and the carrier cannot choose who customer to serve. Three predictor variables (Fig. 2) are manipulated to affect the trust mechanism. An outcome of such manipulation is observed using five response variables: forecast accuracy, cost saving, full truck load, order fill rate, vehicle fill. Each experiment yields 12 samples, and it is replicated 5 times to yield 60 samples in total. Settings involved are benchmark values for each response variable. These benchmark values are essential for deriving a trust meter. The forecast accuracy in sales is benchmarked to 32.5% [24] using MAPE[1] while cost saving ranges between 10 and 15% of the original transportation charge per pallet [25]. Vehicle fill is derived from benchmark value of the full truck load [26] and are both benchmarked to 95%. Finally, the order fill rate is benchmarked to 95% [24]. Except the cost saving, a width for assessing trust to remaining benchmark values is established by creating an interval of ± 5 units. For example, forecast accuracy (32.5 ± 5) has a Lower value ($\boldsymbol{L_v}$) of 27.5 and Upper value ($\boldsymbol{U_v}$) of 37.5 units. This interval is further divided into Likert scale of size 5 to yield a class width ($\boldsymbol{w}$) of 2 units. For cost saving, $\boldsymbol{L_v}$ and $\boldsymbol{U_v}$ are 10 and 15, respectively,

[1] Mean Absolute Percentage Error

while a width (***w***) is set 1 unit. In the end, trust is measured and assessed based on a trust meter established in Table 1.

Table 1. Trust meter.

Range	Quantitative value	Qualitative value
(L_v <= score < (L_v + w)	1	Least trustworthy[2]
(L_v + w) <= score < (L_v + 2w)	2	Less trustworthy
(L_v + 2w) <= score < (L_v + 3w)	3	Trustworthy
(L_v + 3w) <= score < (L_v + 4w)	4	More trustworthy
(L_v + 4w) <= score < U_v	5	Most trustworthy[3]

7 Results and Discussions

Obtained results are analyzed and summarized in both graphical and statistical forms. In Fig. 3, a subjective comparison of the FIRE model and trust mechanism based on the graphical display technique is presented. To a large extent, the graphical patterns between the FIRE and trust mechanism correlate although variations are also observed. On the whole the trust mechanism scores higher than its rival, the FIRE.

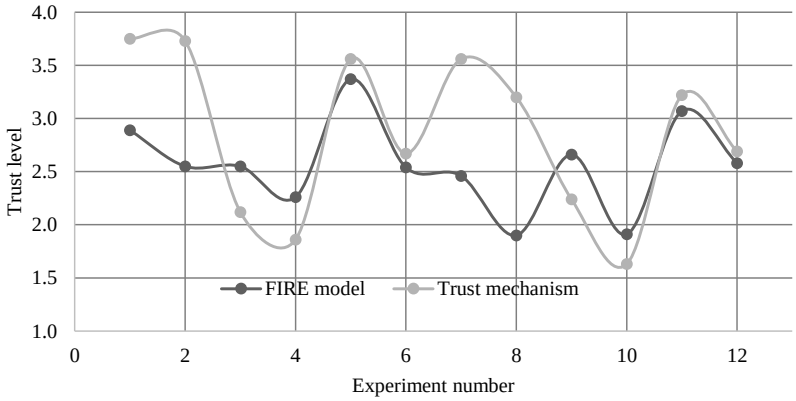

Fig. 3. Comparison of the FIRE and Trust mechanism

To establish a clear difference or correlation, outputs of the FIRE and trust mechanism are compared using the t-test. The t-test compares only the outputs for positive information accuracy. Since the two models evaluates trust differently this comparison employs unpaired observations technique. With a sample size of 60 for each model the mean trust level for the FIRE and Trust mechanism are 2.18 and 3.38, respectively. The standard error of the estimate for both models coincides to 0.20 trust level. The 96% CI for difference ranges in the interval: {-1.762, -0.617}. With

[2] If a score is less than L_v the trust level is also assessed as the least trustworthy
[3] If a score is greater than U_v the trust level is still assessed as the most trustworthy

reference to the internal, conceptual, and operational validity what do these results imply?

Firstly, building on the subjective decision, the trust mechanism is credibly accurate since it produces outputs whose pattern match to that of the valid model, the FIRE model. Secondly, the range for CI excludes a null value. If the range excludes the null value it implies that the two models are significantly different, and that one model is better than the other. A decision on which model is better depends comparing mean trust levels of the two. The model with higher trust level is statistically better. It is thus established with 96% confidence the trust mechanism yields better performance than its rival. To this end, theories and assumptions underlying the employed trust mechanism are reasonably accurate and credible. This credibility counts also from the standard error whose magnitude is observed to be small and tolerable.

Furthermore, Fig. 4, Fig. 5, and Fig. 6 present graphical displays to compare output behavior (trust level) resulting from the model and system data. The output behavior in Fig. 4, Fig. 5 produce similar trends (patterns), although slight variation may be observed in Fig. 6.

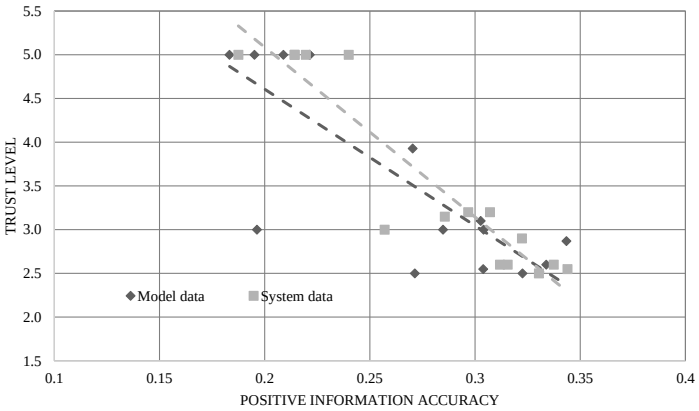

Fig. 4. Impact of positive information accuracy on trust

On the whole, patterns in all three figures have considerably matched. This signifies that the trust mechanism is operationally credible in representing information sharing and trust behavior of partners (humans).

Succeeding the conceptual and operational validity are results and discussion regarding the claims. The first claim was set to investigate if the positive and negative information accuracy generate distinct impact on trust. This claim is refuted as there are no significant differences (Fig. 4 and 5) that may be observed. Instead, the positively and negatively distorted information influence trust in similar magnitudes. Moreover, in both cases, an increase in the magnitude of the affection factor (γ and β) results into a decrease of the trust level. This observation is consistent with an expectation that partners who increasingly distort information they exchange create equivalent distrust in the network.

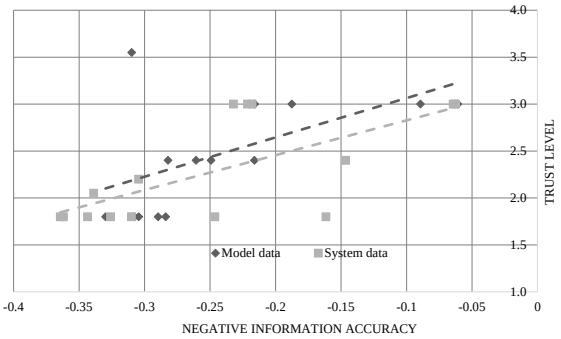

Fig. 5. Impact of negative information accuracy on trust

The second claim was set to investigate if under the neutral information accuracy (α) situation partners prefer to be exactly honest or not. This claim is supported. To a large extent, partners prefer to slightly deviate from reporting the exact information. Looking at Fig. 6, on the average, there is only two incidences where partners report the exact information. This implies that, to cope with uncertainty and bad outcomes, information behavior of collaborating partners is largely inclined to adjusting (distorting) the true information they exchange.

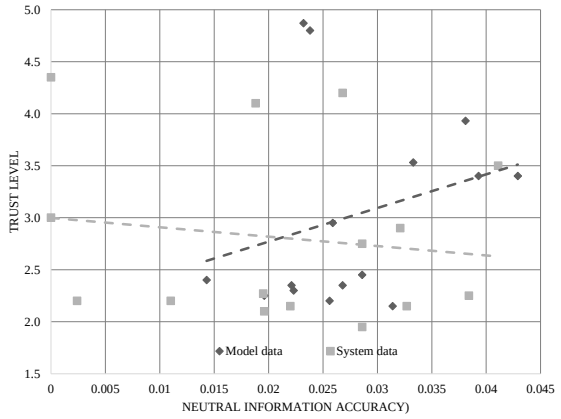

Fig. 6. Impact of negative information accuracy on trust

These findings bear differences and similarities to previously related works in literature. Firstly, a positive relationship between the perceived level of InfQ and level of information sharing has been established in [11]. Different from the positive relationship reported in [11] the present paper has looked up on distinct levels of the InfQ and their impact on trust. Secondly, it is reported in [3] that there is a direct impact of trust to the level and quality of information sharing. Since trust is a reciprocal construct (both a cause and an effect) then findings in [3] can be restated to closely relate to the context of the present study. It can therefore be restated that there is a direct impact on the level and quality of information sharing on trust. Equally, the present findings relate to those in [3]. Similar to [11], one key difference is that findings in [3] do not reveal an extent of this impact as it has been addressed in the

present paper. Finally, it has been found that supplier tends to deviate from reporting true information [6]. This finding relates to what this study reports especially on the aspect of certain (neutral) information accuracy. One difference is that there are few cases in which partners report true (exact) information (Fig. 6). On the whole, a major difference of this study to related works is that it explore in details about an extent to which the information sharing behavior of partner affect trust.

Referring to the RQ and general implications of this study, the following can be stated. Information behavior of the collaborating partners affects trust in different magnitudes. Less distortion in the accuracy of the shared information remains relatively trustworthy than larger distortions. It also appears that collaborating partners are as not honest as it is ideally desired. Instead when they realize fairness they exchange nearly true information which is not harmful. These findings are helpful to designers of information systems who suggest encapsulating exchanged information to avoid risks of exposing proprietary business models. That the encapsulated information may be distorted slightly to maintain company's privacy, and still achieve chain visibility and sustain the trustworthy.

8 Conclusion and Outlook

Information sharing marks a core heart of collaboration and daily living of humans as it affects way collaborating partners can trust each other. The quality of shared information depends on information sharing behaviors of partners. In a viewpoint of such behavior, collaborating partner may deceitfully manipulate information they exchange to maximize individual gains. Focusing on a dimension of information accuracy, this paper has investigated how the information behavior of partner affects trust. Both, the positively and negatively manipulated information accuracies influence trust in similar magnitude. It is argued that partner's deceitful behavior on information accuracy can be reduced but not eliminated. Future works is unlimited to exploring the impact of the positively, negatively, and neutrally manipulation of information accuracy in combination. As well, replicating this study by expanding the size of collaborative network (such as increasing number of partners) may strengthen the present findings.

References

1. X. Xu,.: Collaboration Mechanism in Horizontal Logistics Collaboration. Dissertation, Ecole Nationale Supe´rieure desMines de Paris (2013)
2. Simatupang, T. M., Sridharan, R.: Supply chain discontent. Bus. Process Manag. J., vol. 11, no. 4, pp. 349–369 (2005)
3. Ouzrout, Y., Chaze, L., Lavastre, O., Dominguez, C., Akhter, S. H.: Simulation of Trust in Supply Chains. Supply Chain Perform. Collab. Alignment Coord., pp. 267–315 (2013)
4. Zhou, Q., Lee, T.: The Interactive Effects between Internal and External Resources Constraints on Supply Information Sharing. J. Syst. Manag. Sci., vol. 4, no. 3, pp. 22–41 (2014)

5. Zhao, X., Xie, J.: Forecasting errors and the value of information sharing in a supply chain. Int. J. Prod. Res., vol. 40, no. 2, pp. 311–335 (2002)
6. Firouzi, F., Jaber, M. Y., Baglieri, E.: Trust in supply forecast information sharing. Int. J. Prod. Res., vol. 7543, no. December, pp. 1–12 (2015)
7. Han, G., Dong, M.: Trust-embedded coordination in supply chain information sharing. Int. J. Prod. Res., vol. 53, no. 18, pp. 5624–5639 (2015)
8. Bao, X., Bouthillier, F.: Information Sharing: As a Type of Information Behavior. McGill Univ. Canada, pp. 1–14, (2007)
9. Jeske, M., Grüner, M,. WeiB, F.: Big Data in Logistics: A DHL perspective on how to move beyond the hype. Report (2013)
10. Mayer, R. C. , Davis, J. H., Schoorman, F. D.: An Integrative Model of Organizational Trust. Acad. Manag. Rev., vol. 20, no. 3, pp. 709–734 (1995)
11. Chen, J. V., Yen, D. C., Rajkumar, T. M., Tomochko, N. A.: The antecedent factors on trust and commitment in supply chain relationships. Comput. Stand. Interfaces, vol. 33, no. 3, pp. 262–270 (2011)
12. Daudi, M., Baalsrud Hauge, J., Thoben, K.-D.: Behavioral factors influencing partner trust in logistics collaboration: a review. Logist. Res., 9(1), p. 19 (2016)
13. Bobrowski, M., Marré, M., Yankelevich, D.: A Homogeneous Framework to Measure Data Quality. Fourth Conf. Inf. Qual., no. J, pp. 115–124 (1999)
14. Wilson, T. D.: Human Information Behaviour. Informing Sci., 3(2), pp. 49–55 (2000)
15. Huhns, M. N.. Singh, M. P.: Cognitive agents. IEEE Internet Comput., 2(6): 87–89 (1998)
16. Dervin, B.: An overview of sense-making research: concepts, methods and results to date. in International Communications Association Annual Meeting (1983)
17. Wilson, T. D.: Information behaviour: An interdisciplinary perspective. Inf. Process. Manag., 33(4), pp. 551–572 (1997)
18. T. D. Wilson.: Models in information behaviour research. J. Doc., 55(3), pp. 249–270 (1999)
19. Daudi, M., Baalsrud Hauge, J., Thoben, K.-D.: Effects of decision synchronization on trust in collaborative networks," in IFIP Advances in Information and Communication Technology, vol. 480, pp. 215–227 (2016)
20. Datta, P. P., Christopher, M. G.: Information sharing and coordination mechanisms for managing uncertainty in supply chains: a simulation study. Int. J. Prod. Res., vol. 49, no. 3, pp. 765–803 (2010)
21. Sargent, R. G.: Verification and validation of simulation models. *Journal of Simulation*, *7*(1), 12–24 (2013)
22. Huynh, T. D., Jennings, N. R., Shadbolt, N. R.: An integrated trust and reputation model for open multi-agent systems, Auton. Agent. Multi. Agent. Syst., 13(2), pp. 119–154 (2006)
23. Zolfagharinia, H., Haughton, M. A.: The benefit of information sharing in a logistics outsourcing context. Int. J. Logist. Syst. Manag., 13(2), p. 187, 2012.
24. Supply Chain Consortium.: Supply Chain Core Benchmarks: Understanding Key Metrics (2011) Retrieved from http://www.tompkinsinc.com/wp-content/uploads/2012/07/corebenchmarksreport.pdf
25. Tseng, M., Yan, J., Cruijssen, F.: Position paper on compensation rules. CO3 Deliverable D2.5 (2013) http:// www.co3-project.eu/wo3/wp-content/uploads/2011/12/CO3-D-2-5-Position-Paper-on-Compensation-Rule.pdf.
26. VICS.: Collaborative Transportation Management: White Paper. Lawrencevill, NJ Volunt. Interindustry Commer. Solut. Assoc., pp. 0–32 (2004)