On Analysis of Trust Dynamics in Supply Chain Collaboration

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

[1] International Graduate School for Dynamics in Logistics (IGS), University of Bremen, German
(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 Technology and Health, KTH, Royal Institute of Technology, Sweden

Abstract Trust is an essential asset to support Supply Chain Collaboration (SCC), and it is a complex construct of dynamic nature. This dynamic behavior stems from trust ability of changing forms or states over time. Due to this dynamicity, SCC requires that the partners have a clear understanding of how trust changes throughout the lifetime of their alliances. This understanding is necessary in building and maintaining trustworthy relationships in dynamic environments. However, the authors have found no framework that sufficiently describes trust dynamics in SCC. Thus, this research presents the first approach toward a holistic framework describing trust dynamics by considering distinct dimensions, forms, states and roles of trust. The trust framework describing aspects attributing to trust dynamics is applied in an industrial case involving change events accruing to trust dynamics.

Keywords: Trust, trust dynamics, supply chain collaboration, trust dynamics framework

1 Introduction

Cloud computing innovations are continuously accelerating and reorganizing supply chain interdependencies towards Supply Chain Collaboration (SCC) relationships. The SCC relationships are fundamental to increasing shared visibility among chain entities. The visibility helps lessening variability in demand and supply forecasts. Such visibility is realized through improved flow of information among collaborating nodes, connected by robust and affordable cloud infrastructures. Similarly, in logistics, collaboration has become crucial due to increased environmental concerns and improved efficiency through collaborative planning that supports resources sharing [1]. According to [2, 3, 4], collaborating entities can manage reducing costs, improving quality of service, reducing emission and congestion [2, 3, 4]. Nevertheless, logistics and transport collaboration contribute to minimizing encountered inefficiencies on poor capacity utilization, empty backhaul and high transport costs [5]. While SCC appears a promising strategy to improving material and information flows, its practice is difficult due to "concerns involving trust amongst cooperating firms" [6]. As well, trusting has become more difficult to develop in virtual than on-site teams because of diverse locations and technology-enabled communication [7]. As a result, while engaging in SCC, partners encounter partially seamless interactions featured by supporting cloud platforms.

A successful SCC requires an existence of trustworthy relationships amongst manufacturers, suppliers, distributors, and retailers. These relationships are essential to overcome adversarial effects resulting from a win-lose desire in place of win-win situation. Literature has emphasized on diverse source factors accounting to lack of trust in collaborative networked organizations. Specific to supply chain and logistics, sources of mistrusts comprise of commitment [8, 9], opportunism [2, 4, 10], capability [11, 12], information sharing [4, 13], decision synchronization [2, 3], incentive schemes [2, 3], and asset specificity [14, 15]. With these sources, successful SCC aspire committed partners who are capable and believe in true goal congruence. Such partners are to openly share required information, exert symmetrical power and assume fairness to distribution of costs, savings and risks. Where needed, SCC partners may invest necessary assets to further sustain collaboration. While realizing these sources of mistrusts, trust building, repair, and management must as well take into account the SCC dynamics.

Trust is a dynamic construct [16] and critical ingredient to achieving and maintaining functional SCC. Trust is considered dynamic because it changes over time. The change involves a particular dimension, form, role or state of trust adjusting into other distinguishable ones. Trust dynamics are closely associated

with dynamics of SCC alliances, because such alliances are initiated, and operate in dynamic environments. Considering this co-variance, and towards building and maintaining trust, acquiring insights resulting from SCC trust dynamics is imperative. Alongside this view, a clear understanding of how trust changes with time under the influence of diverse SCC aspects is needful. Motivated by this requirement therefore, this paper addresses the following research questions: *(1) What aspects characterize trust dynamics in SCC? (2) What components constitute those aspects?* These questions are answered by establishing a framework of trust dynamics. Identification of such aspects is intertwined with how trust changes along the SCC life cycle. Moreover, contribution of this research benefits supply chain entities including manufacturers, shippers, carriers, distributors and retailers to build and maintain trust in their collaborative networks.

This remaining of the paper is organized as follows. Section 2 reviews literature on trust dynamics as well as organizational models of development and change. Section 3 presents briefly the methodology followed, while in section 4 a framework of aspects of trust dynamics is established. Section 5 provides discussions and applications of the framework. Finally, conclusion and implications follow in section 6.

2   Trust Dynamics and Organizational Change

SCC alliances comprise of individual and organizational partners, working closely to better manage and improve supply chain processes. These processes are highly dependent and must thus be interlinked to facilitate planning, sourcing, making, and delivery of finished goods to consumers. It can be recalled that during collaboration, SCC partners undergo development and change processes, resulting into changing trusting relationships. Therefore, this section discusses relevant trust dynamics in literature, together with underlying organizational models of development and change.

Trust is considered as a complex construct because it possesses many distinct set of properties. Trust is realized a reciprocal construct due its ability to exhibit partial temporal forms: "a cause and an effect of change" [17, 18]. Trust becomes a cause whenever it leads a trustor-party to develop a confident belief of being vulnerable to actions of a trustee-party. Similarly, trust becomes an effect of change when it is signaled back to trustor-party, being the feedback resulting from actions of the trustee-party. Also, trust is a history dependent construct [7] because its assessment utilizes past records accumulated within specific time period. This means, trust is built and managed through interactions of the trustor and trustee parties, taking place over a considerable time period. Likewise, trust is produced internally by partners from relationship history and/or forthcoming expectations [19]. Herein, trustor-party develops confident belief upon satisfaction of facts resulting from past relationships. Contrary to past records, trustor-party may also trust depending on the extent of perceived upcoming expectations in absence of any reference. Moreover, trust is dynamic [20] because it changes with time depending on various causes. In this paper, while comprehending to the outlined trust complexities, the focus is on trust dynamics.

Dependent processes of SCC are main causes of trust dynamics. These dynamics involve interactions and actions of the partnering entities. This being the case, "trust has to evolve depending on the specific history of actions and interactions, and other events taking place" [17]. This evolution takes into consideration previous trust possessed by partner and trust changes taking place thereafter. In particular, "trust acquired by an actor depends on initial trust and trust dynamics [20]. As an illustration, once trust is acquired it remains unfixed; instead it changes depending on specific causality inferring that change. In [21] they have equally emphasized that initial trust evolves dynamically over time, and is replaced by revised trust; having different *dimensions*, *types* and *roles* of trust during latter stages [16]. In essence, it is revealed that at a point in time, partner's current trust is a function of initial trust, and the trust change resulting from underlying dynamics. This partner's current trust may be less, equal or more than the initial value. Nevertheless, trust dynamics are as well attributed by underlying organizational models of change and development.

The organizational models of development and change, namely: *evolution* and *life-cycle* are suitable to analyzing trust dynamics. The evolution model describes a phenomenon wherein multiple entities undergo a stipulated pattern of change on basis of competitive survival. This model of change features a repetitive sequence of variation, selection, and retention events among entities [22]. Analogy to SCC trust dynamics, evolutionary model describes individual-based trust dynamics. Meaning that, within collaborative community members possess trust levels which vary from one member to the other. Hence, during creation of the alliance, best-fit partners are selected based on their competitive trustworthy and they can only be retained if such trustworthy remains acceptable. Comparatively, the life-cycle model

describes a change phenomenon in which a single entity undergoes many sequential steps in a stipulated pattern. In this change, a "developing entity has within it an underlying form, logic, program, or code that regulates change process [22]. The entity itself decides how to respond to induced change. The progression of events under life-cycle change model is cumulative, thus characteristics acquired in earlier stages are retained for later stages [22]. Analogy to collaboration, SCC alliances progress in four stages [23]. In each of these phases trust changes accordingly, such that trust experience acquired in previous phase is retained for future reference in subsequent phases.

3   Methodology

Devising of aspects characterizing trust dynamics in SCC proceeds by formalizing perspectives representing changes. The perspectives are formalized through: "(1) factors influencing how initial trust is established; (2) how trust is influenced by events, and; (3) organizational models of development and change (figure 1). The first two perspectives are further discussed in [21] while the latter is discussed in [22].
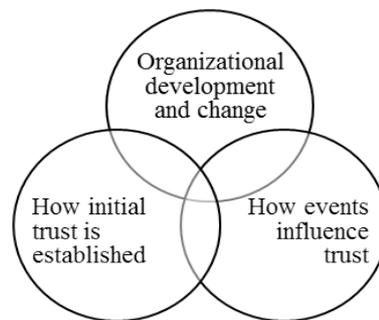

Figure 1: Research methodology

Thereafter, analysis of various works in literature reveals diverse aspects contributing to trust dynamics. Included are trust properties like reciprocity, dimension, level of analysis, and multiplicity in assessment criteria. Although these properties are significant, this paper emphasizes on aspects incorporating inter-organizational systems change or dynamics. With this view, SCC trust dynamics are analyzed considering five perspectives: (1) goal adjustment; (2) interaction style; (3) organizational structure; (4) alliance composition; and (5) alliance development phases. These perspectives contemplate basic requirements to changes SCC partners undergo during collaboration lifespan. Alongside outlined aspects, components constituting them are identified. Finally, cases relying on secondary data in literature are discussed to illustrate relevance and applicability of the resulting framework.

4   Aspects of Trust Dynamics

In this section, a trust dynamics framework tailored to SCC alliances, as well as other networked organizations is established. Operationalized as a framework of aspect constituting trust dynamics, it is devised based on methodology in figure 1.

Goals adjustments Collaborative alliances are initiated, and are to operate under common goal(s). These goals normally are defined at the beginning, forming a foundation of agreements as well as contracts (if any). Although SCC partners define goals at the beginning, such goals are likely unfixed due to internal and/or external business environmental factors. In [24] they claim that the ultimate goal setting in collaboration does less happen before, but becomes a recurring task along the process. This change in goals over time is referred to as goal dynamics. In [25] they have referred to goal dynamics as changes to the explicit mission established for the collaboration. The dynamics in goals are accelerated by existing co-evolution between alliance and its goal(s). This means, as alliance evolves, there is a high chance for underlying goals to change. The change may comprise of adding, removing and modifying goals. In [25]

they have established three ways in which collaborative goals can change: *adding new goal, dropping goal, and replacing original goal*. Goals adjustments infer a corresponding change effect on existing trustworthy. This change effect is brought about by needs of re-defining new trust requirements. The need for new trust requirements follows the view that, different collaborative goals are accomplished by different trust requirements. For example, competency and capability needed for collaborative manufacturing differ to those of collaborative transportation. As trust requirements are established depending on a specific goal, change in SCC goal results into trust change. Whereby goals are adjusted within a time progression, the changed goal induces a corresponding change to trust requirements, hence trust dynamics.

Interaction style The extent of partner interactions, especially those involving information exchange enact a consequential effect on existing trustworthy. The effect stems from partners' interaction behaviors realized while exchanging information. These interaction behaviors are embedded "in signs and signals about what and how information is brought and done" [26]. The behaviors may be favorable and thus aiming at improving synergy or weaken the alliance. Considering interaction style context, two behavioral dimensions linked to information exchange are: *competition and cooperation*. Partners practice competitive behaviors by limiting and constraining information sharing, opposed to cooperative behaviors in which open information sharing is assumed [25]. SCC alliances are featured with both dimensions, but in a changing fashion. Cooperative behavioral dimension allows high information visibility while competitive one restricts it. Accordingly, SCC trustworthy relationships become stronger under cooperative interactions. However, transiting from more open to restricted interactions will deteriorate trust. Therefore, over time, switching between competitive and cooperative interaction styles oscillates trust amongst partners.
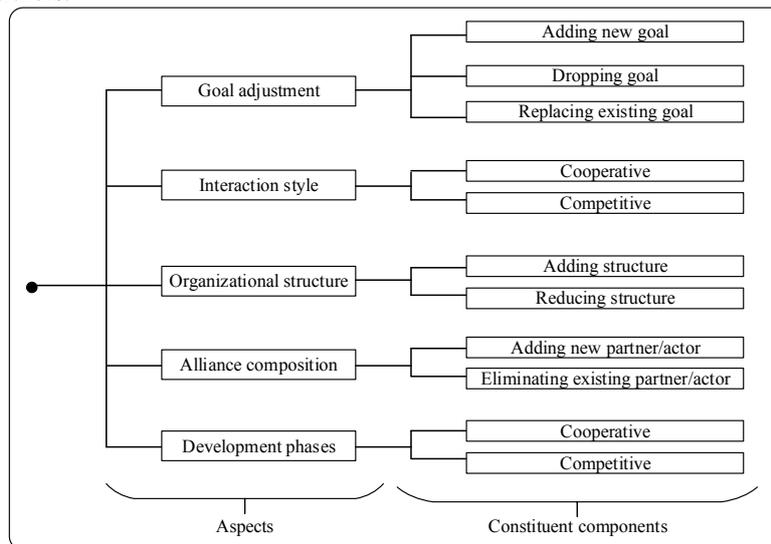

Figure 2: A framework of aspects constituting trust dynamics.

Organizational structure Organizational structures relate to organization's hierarchical arrangements in which roles, tasks, responsibilities and power are assigned. Units composing organizational structures are coordinated to achieve organization's objectives and are normally non-static. Organizational structure dynamics refers to the degree of formalization and standardization of roles and processes, and involve shifts toward and away from increased structure [25]. These dynamic structures feature as: enablers involving multi-disciplinary center-led organizations, and; as resistors likely impeding creation of collaborative capability [27]. Changing of organizational structures may strengthen or weaken efforts to collaboration, and trust. The change consists of "*adding* and/or *reducing*" structure [25]. Adding and/or reducing structures in roles and processes denote corresponding needs for appropriate resources. The resources may be in form of partner organization, actors, capabilities as well as skills. With time progression, for a change involving re-defining roles and processes, there is a corresponding trust change. This change occurs because SCC entities possess distinct capabilities and competencies in relation to alteration of roles and processes. Correspondingly, same entity will perform differently while executing

different roles defined under different processes. Therefore, adjustments in organizational roles and processes attribute to trust dynamics.

Alliance composition SCC alliances are composed of partner organizations, and actors constituting those organizations. The partner organizations with their actors enter and leave the alliance due to various reasons, leading into dynamic composition. In [25] they have discussed this composition concept in similar context. They describe actor composition as membership in the collaborating partner organizations and respective key individuals. These actors' entry and exit behaviors represent organizational behavioral dynamics. Such dynamics formalized as "*adding or eliminating*" actor in [25] affect trusting relationships, directly or indirectly. The effect rests on partner organizations or actors possession of variant capabilities/competencies, inferring similar outcome on performance and trust. Thus, with time progression, entering and leaving partners/actors bring in pendulum swing on trust. Provided that partner trust is assessed based on capabilities/competencies, resulting outcome induce trust change. Whereby such change occurs in a time interval, trust dynamics is encountered.

Alliance development phases Similar to other networked organizations, SCC alliances undergo life-cycle model of change in their development phases. In [23] they have described these phases as: preparation, creation, operation and decomposition. The preparation phase represents a SCC community comprised of prospective partners, interacting for prior familiarization. The creation phase features selection of capable partners, while in operation phase, partners execute assigned tasks, and finally the alliance decomposes. Accordingly, over time, trust changes in roles and forms as the alliance transits its phases. In creation phase, trust has a form of competency and plays a role of partner selection. In operation phase, largely, trust has a form of integrity and plays a role of examining partner's compliance to collaborative agreements. The alteration in roles: selection to compliance, and forms: competency to integrity contributes to dynamics of trusting. Finally, in decomposition phase, trust is a learning experience applicable for future collaborative opportunities.

5   Discussions and Application of the Framework

The framework in figure 2 portrays trust dynamics integral to SCC alliances. It depicts how dynamics of supply chain relationships induce equivalent trust change. Seeking to exemplify the significance and applicability of conceived framework, this section discusses related industrial cases. The cases are considered adequate to initially demonstrate practical usage of the framework prior to further empirical evaluation. Thus, six industrial cases reported in literature are employed as secondary data sources (table 1) to illustrate required applicability.

Table 1. Extracted cases on dynamic events impacting trust in SCC

Element	Alliance	Initial state	Next state	Literature
Adding new goal	SEMATECH	Developing new manufacturing technologies and methods, and transfer them	Strengthening supplier industry	[28]
Goal replacement	Biotech partnership	Lead optimization	Lead discovery, and then technology development and transfer	[29]
Competitive behavior	HP and Ericsson	Lacking information exchange	Exchanging filtered information	[30]
Cooperative behavior	HP and Ericsson	Out of joint venture, HP internally developed a product, leading to alliance divergence	On negotiation, the joint venture decides to integrate the product	[30]
Adding structure	Sun MicroSystems and Birkbys	Birkbys only supplied the plastic enclosure, into which Sun fitted components such as cables and power supplies	Birkbys built a new factory near to Sun; both companies created new roles in which people had more dedicated and clear responsibilities	[31]
Adding partner	Development of aircraft material	At beginning, the alliance had two partners	Three partners were added at different times: Akzo, Alcoa and 3M	[33]

Element	Alliance	Initial state	Next state	Literature
Eliminating partner	NedCar	Three partners: MMC, Volvo, Dutch government	Dutch government left the venture	[32]

In the partnerships configured under SEMATECH and Biotech, dynamics in alliance goals adding new goal [28] and replacing goal [29] (table 1). Whereby SEMATECH's initial goal was to develop manufacturing technologies and methods, afterwards, it had to additionally engage in strengthening the U.S supplier industry. This goal addition proceeded into an impediment of finding a structure through which SEMATECH could influence supplier [28]. This task sort calls for search and selection of capable partners whose engagement, relatively, leads into trust change. Meanwhile, in the biotech partnership, the initial goal was replaced, "… redirected the collaboration from lead optimization to lead discovery …" (pp. 62 in [29]). This new assignment requires re-assessing capabilities of the partnering entities, obviously, resulting into different trust levels compared to those before goal adjustment. Moreover, goal replacement in biotech partnership brought negative perceptions as a consequence. Some actors were surprised, "Looking at the move from optimization to discovery, weren't happy" [29]. It is also pointed out by authors, in the second change; one partner became worried that he was providing too much sensitive information. On the whole, with all these changing relationships, there is no way previous trustworthy remain unaffected, it rather falls and rises.

Dynamics in competitive and cooperative behaviors were observed in EHPT (HP and Ericsson) alliance (table 2). It is reported that there was a change associated with information exchange, from non-visibility to restricted visibility. For example, changing to filtered information exchange resulted into "lack of understanding about type and degree of problems, leading partners to develop divergent interpretations" [30]. Similarly, when developing a new product, "the joint venture questioned validity of the existing technological base (divergence)" [30]. However, it was later decided to integrate the product into joint venture. This decision "reduced the level of conflicts for several months, and later engineers started working together" [30]. These scenarios depict competitive and cooperative behaviors in a swinging pendulum. Competitive behaviors deteriorate trust, opposed to cooperative ones. Thus, the swings in styles of interactions oscillate trust to fall and rise, hence trust dynamics.

In a partnership between Sun Microsystems and Birkbys, addition of structure appears to increasing the level of mutual trust among partnering entities. This is evident in quotes: "there is a close relationship with my opposite number in Sun; the relationships are a bit different as there is a more comfortable feeling; people are becoming more open with each other" [31]. These positive feedbacks stemming from structural change increased a sense of partner/actor commitment to the alliance, and consequently rise up the trust. Adding and eliminating partner/actor events were observed in alliance for developing aircraft material, and NedCar alliance. In NedCar alliance, after Dutch government had pulled out, remaining firms clarified their respective expertise contributions, leading to increased benefits. They expanded their joint venture to include development of a new diesel engine [32]. This change event was of positive influence against previous mistrusts. On the contrary, adding three partners to the alliance [33] developing aircraft material increased capacity, and thus trust was more influenced.

6 Conclusion and Implications

Technologically supported SCC requires properly managed trust to strengthen as well as sustain business relationships. Towards this requirement, understanding trust dynamics inherent in collaborative organizational processes is imperative. This understanding, among others, consists of clear insights on how trust change over time along the SCC lifecycle. This research therefore has identified various aspects attributing to trust dynamics in SCC. In brief, five aspects as well as the constituting components have been analyzed and conceived to produce a trust dynamics framework. Essentially, trust dynamicity is immanent in SCC events, as well as development and change models. To advance successful collaboration therefore, partners urge taking into account various outlined aspects which lead to trust change. This is critical because once trust is broken it becomes difficult to repair it as compared to managing its sustainability. Alongside this reality therefore, the framework uncover sources accruing to trust dynamics, especially in medium and long-term alliances. Further analysis may explore aspects external to SCC alliances which lead to trust dynamics.

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