Secure Supply Chains; Design Restrictions & Organizational Boundaries

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Abstract

An important issue in the design of secure supply chains is the understanding of the relation between supply chains and the organizational responsibility of specific parts of these supply chains. Organizational boundaries change over time by means of vertical and/or horizontal (des)-integration and so do the related organizational responsibilities. This paper provides an overview of possible intra- and inter-decoupling points in supply chain organizational responsibilities. All these decoupling positions will have implications on establishing supply chain security. Several reference models were explored and assessed on there usability to identify supply chain organizational relationships. Finally an extension on The Balanced Scorecard was proposed as reference model to identify secure supply chains organizational responsibility issues.

Introduction

Supply chains are configurations of several internal supply chains (logistical systems) of often different companies. Supply chains are fulfillment structures where physical, informational and money flows have to be coordinated between all relevant organizations (customers) to satisfy the changing demand of end-consumers. The structure of supply chains changes and can be identified as dynamic because they are reorganized from time to time at several aggregation levels to give appropriate answers to deal with short, mid and long term expected or experienced changing demands.

Supply chains are vulnerable to adverse events causing supply chain malfunctions and supply and demand disturbances & disruptions; like: interfering by third parties, labor strikes, natural hazards, human errors, changes in customer taste, technological failures, financial distress, etc. etc. Failures in supply chains also occur when they cannot respond to large fluctuations and uncertainties in demand and supply. Disturbances or even worse disruptions in the supply bring the supply of goods and services may in jeopardy. Building more robust and secure supply chains will make businesses and societies less vulnerable for unwanted external effects.

Most effort on how to design secure supply chains have been given to the operational level, mainly related to transport, e.g. adding security measures like:

- Identifying if all direct and indirect actors and intermediaries in the supply chain are authorized and trustworthy.
- Taking measure around tracking, tracing and validating the content of cargo being shipped.
- Frequent notification of the content of the cargo between origin and destination.
- Ensuring the security of cargo in-transit using a wide set secure (electronic and physical) locks, tamper-proof seals, and controllable protocols.
- Inspection of the content of the goods at the destination by authorized and qualified personnel.

Supply chain security issues can be addressed from several directions. They can be from the inside when the company’s strategy is based on security, or it can be seen as a moral obligation to focus on security. It can also be from the outside if forced by government regulations on security or by market forces to include security
as an import issue in daily business processes. In all these circumstances it is necessary to understand if supply chain security investments are affordable and avoidable and if there are any restrictions.

Currently supply chain security is still in its infancy and not a real specialization. In most educational programs it does not get any or only minor attention. The focus often is on secure transport and when and how to organize checks on cargo in transit, paperwork (security and customs related) and checking the integrity of information and organizations. A clear supply chain orientation let alone the organizational supply chain orientation are not at hand. Being a poor developed field it is best to draw from other areas where organizational issues are addressed and understood more in detail.

Furthermore the composition of organizations responsible for the coordination of processes within the supply chain changes and is complex. It is necessary to indicate where to address security and to understand who is responsible and what for restrictions can be identified.

In the remaining part of this paper several reference models will be discussed and assessed on there usability to identify supply chain organizational relationships. Finally an extension of one of these models is proposed as a suitable reference model to identify secure supply chains organizational responsibility issues.

Organizing for demand fulfillment management

Supply networks are collections of nodes and links facilitating the physical, information and financial flows all three necessary to fulfill customer demands. What is the right configuration of the fulfillment structure that should be in place, when is change required and when should a certain configuration be maintained? The main supply chain qualities are high responsiveness and customer service in the pull based parts and low costs in the push parts of supply chains. What if certain qualities like environmental friendliness, security, resilience or others are more important? Can this be done together while keeping the other supply chain qualities up to level, or should considerable trade-offs been made? Even if the right answers to these questions can be found another problem arises. This is the problem of organizational responsibilities for installing, changing and maintaining all these qualities in respect to the three identified flows.

A supply chain organization as such does not exist; it is a collection of organizations (meta-organization) that have to negotiate their responsibility each time they organize how certain demand is facilitated be means of the available infrastructure. Besides external organizations supply network often have several internal organizations belonging to the same company or departments (sub organizations) of a company that have its own responsibilities, procedures and ways of working. Companies often have their own internal supply chain.

Organizational Supply Chain Responsibilities

Supply chains can also be seen from several levels. Three levels that can be identified where also supply chain vulnerabilities can be identified (figure 1) [1]:

- Infrastructure and Asset Level (hard-ware);
- Process and Value Stream (flow-ware);
- Inter-organizational Network Level (org-ware).

![Figure 1: Levels of Supply Chain (based [1])](image1)

In every supply chain a focal company is controlling the customer decoupling point; this is the point where the demand is dictated by the customer is interfacing with the supply that is dictated by the supplier. The last being responsible for organizing a fulfillment structure that matches this demand, figure 2 [2].

![Figure 2: Customer order decoupling point (adapted from [2])](image2)
The customer order decoupling point dictates the coordination of the supply chain and at the same time is a fragile part of the supply chain in sense of and its physical, informational and financial flows.

**Responsibility of different supply chain issues**

Supply chains can be visualized at multiple aggregation levels and seen from multiple perspectives. A widely used decomposition of the supply chain is identifying several nodes and linkages that are connected to form supply networks that can extent globally to connect raw material resources with customers. Usually companies are the focal point of attention, we work at them, we are asked to conduct analysis for them, and from that perspective we know about the individual companies and we know about the supply network they are part of. Even during analysis getting detailed insight in the supplier’s network and the customer’s network is not easy. The Supply Chain Council introduced the SCOR-methodology (Supply Chain Operational Reference methodology), figure 3 [3].

![Figure 3: SCOR-methodology [3]](image-url)

This is a helpful tool to visualize and analyze supply chain processes that extend beyond the company level al the way to the suppliers’ supplier and the customers’ customer. Connecting all outbound processes of suppliers with the inbound processes of customers is what a supply chain really is about. The reference model indicates organizational segments of the supply chain, not necessary belonging to a different owner (company) but responsible for the management and control of it. It also is a useful tool to see if and how the coordination (via the plan activity) between these underlying processes is organized and what information sharing and communication take place. It also is a reference model for communicating Key Performance Indicators (KPI). Currently a KPI of security is lacking.

**Supply Chain Dynamic & Organizational Change**

Markets are more and more global and interwoven. A complete overview of which organizations are part of a supply chain/network is often unknown. Often a company does not know “Who is my suppliers’ supplier and who is my customers’ customer?” Crisis, world-recession, technology change, takeovers by other companies, expansions, shrinkages, continuous organizational changes and many more external influences have an impact on the organizations that are part of the supply chain. Organizational change follows directly and indirectly the supply chain dynamics, but it is often unknown if this is done in the right direction, and if this should be done pro- or re-active. So the structure of supply chains changes and can be identified as dynamic because it is reorganized from time to time at several aggregation levels to give an appropriate answers to deal with changing demand. But also the organizational boundaries change over time by means of vertical and/or horizontal (des)-integration, as can currently be viewed in the automotive industry. Securing supply chains means understanding the role of organizations in it.

**Multiple Aggregation Levels & Perspectives**

In general supply chains are highly interwoven networks that can be seen from many levels and perspectives. Every Product Market Combination may differ and could have a dedicated supply chain in place as its fulfillment structure. Supply chains may change and adapt in such a way that it follows the respective product-life cycle phases. So finding usable approached to see and understand supply chains seems an interesting endeavor.

When looking for usable reference models understanding the many levels and perspectives supply chains and their organizations can be seen from is of importance. Supply chains can be seen from vertical and from horizontal aggregation levels. The first being the traditional supply chain coordination between supply chain flows and the latter being value creation using physical and more often virtual markets that are available using other vertical aggregation levels.

Looking from the perspective side the level of complexity and integration that takes place within the fulfillment structure and overall
arrangement of supply chains and how it relates to the complex structure of the products and services that it brings forward is important. Another perspective understands that inclusion of several activities that happen at your supplier and or your suppliers’ supplier and your customer or your customers’ customer is necessary to understand the systemic behavior of the supply chain or supply network.

**Vertical aggregation levels**

The already discussed SCOR-model is good to visualize and communicate the four value-adding processes focusing on the vertical aggregation level.

1. **Transformation** means transforming raw materials into assembly parts and assembly parts into final products.
2. **Stability** means keeping and storing goods in facilities.
3. **Translation** means goods in transition during transport between two locations.
4. **Possession** is the exchange of ownership of goods and services.

Expanding the three supply chain flows in four flows gives us a good insight in what type of value-adding processes can take place in the these flows. Table 1 summarizes this confrontation.

**Table 1**

<table>
<thead>
<tr>
<th>Organizational Flow</th>
<th>Utility of Transformation</th>
<th>Utility of Stabilization</th>
<th>Utility of Translation</th>
<th>Utility of Possession</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward &amp; Segregate</td>
<td>Change Management</td>
<td>Change Management</td>
<td>Change Management</td>
<td>Change Management</td>
</tr>
<tr>
<td>Backward &amp; Integrate</td>
<td>Backing - Selling (Salesmen, Reps)</td>
<td>Backing - Selling (Salesmen, Reps)</td>
<td>Backing - Selling (Salesmen, Reps)</td>
<td>Backing - Selling (Salesmen, Reps)</td>
</tr>
</tbody>
</table>

Another vertical view is based on systems dynamics relations one can find if the inventory systems and the order and delivery cycles are made visual over a series of organizations that make up the supply chain. [4] The behavior of supply chains is systemic and should be understood taken the behavior of the whole supply chain into consideration (figure 4).

A narrow view together with the reactive behavior of people in a single organizations may degraded the performance of the overall supply chain. Transparency, information sharing and collaborative negotiating and decision-making or simple follow a ‘just fulfill the order behavior’ will lead to better performances than be results than a re-active behavior.

**Figure 4: Systemic behavior of supply chains (adapted from [4])**

It is important to understand that supply chains are not static but dynamic. Even in balanced multi-tiered systems (figure 5) several option for focal companies to segregate or integrate in the upstream or downstream flows by controlling directly of by means of take-over’s or outsourcing is a possible option. In this case we talk about forward en backward integration or segregation. If all these case the organizational responsibility changes and so does the control and responsibility on security issues.

**Figure 5: Forward en backward integration or segregation within supply chains (adapted from [5])**

The type of relationship companies seek while outsourcing is determined by the length and intensity of co-operation among companies within a logistics network. To design effective logistics networks one needs to take the type of co-operations into consideration [6]:

- traditional customer-supplier relationship for sources that can be found everywhere no real co-operation is necessary;
- supply management for sources that can be found everywhere but where the finding time and effort is minimized;
• supply chain management for sources that are of crucial important and long-term and intensive co-operation is necessary to avoid failure;
• virtual organizations, in full grown markets like in the automotive industry products and services (highly specialized and complex) are modular and standardized so switching between suppliers is possible.

During the design of supply chains one needs to understand that choosing the right co-operation is always necessary. The chosen structure determines for an important part the inherent security. But on top of that it is important that building into the negotiation especially what the impact of security is and what to agree upon to can make the supply more secure in situations of supply chain impacts.

**Horizontal aggregation levels**

Value can be added in several ways. More and more companies outsource non-core business activities. Often these activities are part of the physical layer of the value pyramid (figure 6). While outsourcing they concentrate on those activities that generate the most value and less on those that do not. They find that innovation in how to bring services to the market (virtual layer) is more important that selling products alone. New combinations are made and knowledge of how to bring service to the market becomes the crucial business activity. Finally these companies make the value creation of using knowledge of using services of using products as their business.

Within the supply chains these relationships need to be understood to first understand where real value is created and what organizations are responsible for this value creation.

**Confronting Vertical and Horizontal Aggregation Levels**

Another important issue to consider in understanding vertical aggregation levels is the alignment of the structure of the products that are designed and developed and the structures of the fulfillment structure that is designed to manufacture these products. Product development in full grown industries has evolved in a form of aligned supply chain development. This is partly a planned and partly a grown evolution that resulted in highly modular products structures where interfaces are predefined by the industry and subsystems are sourced by highly specialized companies, but in a way that products and company are changeable in virtual market structures (figure 7).

**Visualizing Organizational Boundaries**

In this section three different models that are helpful in visualizing organizational boundaries for secure supply chains are discussed, respectively: (1) value network [8], (2) the balanced score card [9], and (3) supply chain management processes [5].

The value network consists out of a series of sequentional and parallel organized value chains [8] all types of organizational relationships can be identified within these networks, either being currently existing organizational relationships or possible relationships. The lines in figure 8 give an indication of these possible relationships. Very common relationships are between sharing purchasing processes, outsourcing some of the value adding activities to suppliers and sharing the management of several layers in the supply chain. The standard is all organizations are completely responsible of there own processes and only pure buying and selling relationships exists not sharing capacities and organizational
responsibilities. Though for every possible relationship (line in the figure) the value relation and so the organizational relation changes and so does the responsibility of security issues.

Figure 8: Organizational relations in a supply network (adapted from [8])

The Balanced Scor-card [9] is the second model that has interesting potentials identifying clear viewpoints that exist within organizations that normally are assigned to dedicated departments.

Figure 8: The Balanced Scor-card [9]

This model is more oriented internally and has less a supply chain orientation, though the internal business processes is linked by means of vision and strategy to the customer process processes. So basically also this model is useful for modeling organizational supply chain behavior when we include the internal business processes, the fulfillment structure of the suppliers of the company are included. An important aspect of The Balanced Scor-card is that for all perspectives metrics can be added that can be used by the management to keep the big picture.

The last model consists of a complex series of eight possible supply chain processes that have to be organized in a company from a strategic and an organizational level. Normally the responsibility of these processes lies with one or more departments of a company. If the same approach is taken as the value network even more detailed organizational relationships can be identified between direct and indirect supply chain partners.

Figure 10: Supply chain processes (adapted from [5])

Supply chain organizational reference model

From the briefly introduced three models The Balanced Scor card model was chosen as the building block to build a supply chain organizational reference model. Before this can be done The Balanced Scorecard has to be transformed into a more supply chain orientated model.

In the updated version of the model the vision and strategy part is used as the control between input transformation and output a company is responsible for from a supply chain perspective. Added is a box indicating the supplier perspective. The financial and learning and growth perspective have been added as parallel processes to the three processes or processes: supplier, internal and customer. Finally the mechanism that enables the transformation from input to output is added and called business infrastructure (figure 11).

Figure 11: Demand/Supply Chain Balanced Score Unit

The newly created Demand/Supply Chain Balanced Score Unit can be used in the same way as been previously done with the value
chain, so it can be put in a network perspective (figure 12).

![Figure 12: Demand/Supply Chain Balanced Score Unit in network perspective](image)

By putting the unit in a supply chain perspective we can bring in all the types of relationship earlier indicated in the value-network perspective. By using the idea of including metrics but doing this a little more structured as is done in the Scor-model a clear set of supply chain metrics can be made available. Finally a security metric has to be added to show the clear organizational responsibility for this metric within the company and the supply chains it is part of.

Conclusions and recommendations

The main result of this research shows that it is harder to identify internal organizational decoupling points and to assess the impact on Supply Chain Security than it is with external organizational decoupling points. To understand the differences and commonalities between intra- and inter-organizational decoupling points a systemic analysis is necessary.

Several models exist that are helpful to show these organizational responsibilities but not is sufficiently useful to do so. Finally an extended Balanced Scorecard unit that can be put into a supply chain and network perspective have been developed that looks promising as a supply chain reference model that can also address the metrics of security. More time an effort has to be put in the development of this model and its assessment.

Finally it is shown that a clear set of key performance indicators have to be developed to assess the impact of supply chain security; key performance indicators that before to be of any practical value have to rely on professional information gathering and registration.

As next step an agenda of a set of case-studies is necessary to assess practical value to use the identified decoupling points to assess the impact of organizational responsibility on security for different supply chain configurations using the extended balanced scorecard.

References