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Chapter 2: Conceptual Models

In this chapter is outlined the reasons for building models, the method of development and the context of application for this study.

None of the models studied in the literature review stage provided a general framework for representing concurrency in supply chains (distributed systems), the problem of actually operationalizing complex supply chains has remained challenging: such supply chains not only have a large number of concurrent components (Plans, processes, people, etc.;), but these components can interact asynchronously to create an exponential number of possible outcomes. The need to coordinate the behavior of the autonomous entities to maintain coherence in the supply chain adds considerable complexity (Jung & Jeong, 2004) in managing performance in compliance to the metrics outlined in the supply chain service level agreement (SLA). Such coordination involves dynamic temporal relations between events occurring at different entities (Chinn & Madey, 2000), resulting in a large number of messages and the response to them.

2.1. Workflow Equilateral Triangle Model

I started by constructing the Workflow Equilateral Triangle Model (WET) based on flight dynamics of airplanes (There are many similarities between an airplane and a business). An airplane has 3 axes for flight coordination and control i.e. Ailerons (x-axis for roll), Rudder (y-axis for yaw), and Elevator (z-axis for pitch). Similarly, in order for a business to fly well there is a need to control the 3 axes of a business. See below Fig. 2.1
The WET model is an equilateral triangle representing the three primary aspects of a business i.e. Planning, Scheduling (i.e. MPS) and Production (i.e. Delivery). Communication is pervasive throughout the business and therefore is depicted as the core of the model. Communication also enables integration of the three otherwise independent functions of an organization.

The vertical or Y-axis, represents the planning aspects of a manufacturing organization. The outcome of planning due to changes in market forces (i.e. forecast versus the actual) may necessitate the revision of plans. The inhibitor for the planning process is uncertainty of future events. The oblique or Z-axis, represents the Scheduling i.e. MPS aspects of a manufacturing organization. The materials that need to be purchased; when and in what quantities to ensure that finished goods delivery can take place as planned. The production capacity and finished goods inventory required to ensure that the required service level is maintained. The inhibitor for the MPS process is complexity of production scheduling. The production i.e. delivery aspects of a manufacturing organization is represented by the horizontal or X-axis. To ensure delivery performance reliability, the right products, the right quantity has to be delivered to the right place and person. The inhibitor for the delivery process is variability of production and delivery (i.e. action).
If you pull on one of the axis e.g. Y-axis and displace the triangle. By shifting X-axis or Z-axis or both the equilateral triangle can be restored. As one aspect of supply chain e.g. planning occurs or is acted upon, there need to be a corresponding reaction by one or both of the other two aspects of the WET. Any update or change in planning will require a corresponding need to reschedule and/or reconsider the delivery activities. Whilst the functions of Planning, MPS and Delivery are executed independently however to maintain equilibrium of the functions (i.e. in an integrated manner) a means of communication, coordination and collaboration is mandatory. In the context of supply chain, workflow automation fulfills this need. Messages and responses can be exchange with the objective of reducing performance inhibitors, function disruptions and time delays.

Given that WET model is rooted in kinetics. I needed to redefine WET to focus on strategic performance management, in order to “operationalize” the model for this study. The first AR iteration conducted at SAM (i.e. the first study site, please see chapter 4) concurrently with the literature review phase of this study enabled the re-conceptualization of WET model. The process diagram in Fig 2.2 below, documented during the first AR iteration provided the link to frame the WET model to strategic performance of supply chains. The 3 levels of supply chain in the process diagram formed the 3 units of analysis i.e. network, entity and individual and the 3 performance attributes formed the 3 main or anchor variable (i.e. synchronization effectiveness, synchronization efficiency and synchronization competency) of this study. The detail explanation of the other elements in the process diagram is postponed until chapter 4.
This re-conceptualization of WET model towards strategic performance of supply chains resulted in the development of the Strategic Performance Inhibitors (SPI) model outlined in Fig 2.3, below. SPI model is a value proposition of policies, procedures and programs for the alignment of related plans, processes and interactions with the objective to improve *throughput* in the supply chains formed by autonomous business entities. Alignment between the entities to maintain “correct order” often involves temporal constraints (Stahl, 2002).
2.2. Strategic Performance Inhibitors (SPI) Model

In this section is the explanation that will sharpen the reader’s intuition concerning those aspects of the SPI model that describe the structure, scope and application as relating to strategic performance management of supply chains. Starting at the top of the model, the supply chain is conceptually made up of three levels namely: network, entity and individual. The performance attributes of synchronization effectiveness, efficiency and competency is associated to the respective supply chain level.

Fig 2.3: Strategic Performance Inhibitors (SPI) Model

<table>
<thead>
<tr>
<th>Supply Chain Level</th>
<th>Network</th>
<th>Entity</th>
<th>Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Attributes</td>
<td>Synchronization Effectiveness</td>
<td>Synchronization Efficiency</td>
<td>Synchronization Competency</td>
</tr>
<tr>
<td>Performance Inhibitors</td>
<td>Uncertainty</td>
<td>Equivocality</td>
<td>Complexity</td>
</tr>
<tr>
<td>Performance Management Objective</td>
<td>Reduces Uncertainty</td>
<td>Reduces Equivocality</td>
<td>Reduces Complexity</td>
</tr>
<tr>
<td>Observed Event (Govin’s Vee)</td>
<td>Planning</td>
<td>Communication</td>
<td>* MPS Operating Standards</td>
</tr>
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Model Elements

- Observable Records of Event: Sales forecast, Customer Orders, Workflow Messages, Purchase & Work Orders, Receipts & Deliveries, Coordination & Expedition
- Domain of Event: Sales & Operations Planning, Workflow, Production Control, Shop Floor Control, Workplace
- Intent of Event: Strategic, Policy, Tactical, Quality, Knowledge & Skills
- Impact of Event: Reduce Risk, Reduce Time Delays, ** Improve ATP & CTP, Improve Productivity, Improve Mental

* MPS = Master Production Scheduling, ** ATP = Available to Promise, CTP = Capable to Promise

There are 2 main performance inhibitors at the network level in the supply chain i.e. uncertainty of events and equivocality of communication (Pich et al., 2002). The objective is to reduce uncertainty and equivocality in the supply chain. This is implemented through policy e.g. Service Level Agreements (SLA) and by harnessing of Information Technology (e.g. workflow automation). Improvements at the network level result in feed forward to entity level in terms of reduced uncertainty (i.e. risk) and reduction in time delays.
The other 2 performance inhibitors apply to the entity level in the supply chain i.e. complexity of MPS (Blackstone, 2001) and variability of production (Chopra, 2004). The objective is to reduce complexity and variability. This improvement (outcome) is influenced and subordinate to the network level objectives. At the entity level, the objectives are pursued independently through the adoption of ERP. Improvements at the entity level feeds back into the network level through better entity rationalization (i.e. inventory and capacity) and productivity. Thus the interplay between the 2 levels feeding each other over time comes to form iterations or continuous improvement cycles (Dalcher, 2003).

The remaining performance inhibitor applies to the individual level in the supply chain i.e. anxiety of learning. The objective is to reduce anxiety of learning in the workplace (Coutu, 2002). At the individual level, these objective is achieved by means of “action learning” in supply chain and the development of a knowledge-base of past problems (Coghlan et al., 2004). Improvement at this level is pervasive through the entire supply chain as the basic building block of supply chain and business entities is still the individual. To keep the momentum of the continuous improvement cycles (form by the supply chain and entity levels) running, the individual needs to maintain competency through action learning in a changing environment. Motivation to keep going and earning the satisfaction of a job well done is crucial to overcome the anxiety of learning.

**Observed events (Gowin’s Vee):** The meaning of all knowledge eventually is derived from the events or objects being observed. In the context of supply chain, the business events to be observed in this study are:

a) Planning and communication associated with the network level,
b) MPS and processing or assembly operations associated with entity level and,
c) Action learning at the individual level.

### 2.2.1. SPI Model Elements

The SPI model elements clarify the scope and provide the parameters for possible outcomes of the model application in the context of strategic performance managements of supply chains.

**Observable records of event:** is the variable that will be used to observe and evaluate the abstraction i.e. performance inhibitors of the observed event corresponding to the three levels of a supply chain.
a) Sales forecast and customer orders for the planning event,
b) Workflow messages & responses for the communication event,
c) Purchase orders and works orders for the MPS event,
d) Receipts & Deliveries for the operating standards events and
e) Coordination and expediting for the action learning event.

**Domain of event:** is the scope of the observed event i.e. planning in relation to sales and operations planning (S & OP), communication in relation to workflow, MPS in relation to production control, quality in relation to shop floor control and action learning at the workplace.

**Intent of event:** is the nature of the events objective in relation to strategic performance management of supply chains.

a) The objective of planning in the S & OP domain is strategic. S & OP main objective is to maintain a balance between demand and supply i.e. to maintain a competitive edge and increase market share.
b) The objective of communication in the workflow domain is policy driven. Policies are set of operating rules of engagement to ensure behavior compliance to a desired standard of the organization.
c) The objective of MPS in the production control domain is tactical. Production control in a manufacturing company has the responsibility for MPS. The output of S & OP i.e. demand and supply plan, is used by MPS to generate a detail schedule i.e. what to make, when to make and how many, for execution on the shop floor.
d) The objective of operating standards on the shop floor domain is quality. Shop floor is where the actual manufacturing/assembly of a product takes place. Quality has to be built into the product during manufacturing/assembly in compliance to the product bill of material, manufacturing/assembly drawings and work standards.
e) The objective of action learning in the workplace domain is to develop knowledge and skills. Supply chain is dynamic by nature and the problems faced by the supply chain manager can be new challenges that have not been encountered in the past. The supply chain manager needs to develop a habit of continuous learning on the job.

**Impact of the event:** is the desired outcome of the event objective in relation to strategic performance management of supply chains.

a) The outcome of the planning from a strategic intent is to reduce risk of potential problems to efficient operations throughout the supply chain. By speeding up the flow of information in the supply chain, inventory can be replaced by information therefore reducing the risk caused by shifts in customers demand.
b) The outcome of communication from a policy intent is to reduce time
delays caused by non-response, delay in getting access to complete
information, unclear procedures, unclear messages & responses, long
lead times and functional conflicts.

c) The outcome of MPS from a tactical intent is to improve ATP and
CTP. One of the key goals of a supply chain is to ensure
“availability” of the product and the quantity on demand by
customers. In the event that the product (or quantity) is not available
from inventory (i.e. ATP), then MPS is able to forecast based on the
current production capacity to deliver the product and the quantity
desired by the customer (i.e. CTP).

d) The outcome of operating standards from quality intent is to improve
productivity. Rework, rejects, scrap are all examples of waste i.e.
working time and resources. By ensuring the right version of the
drawings, work procedure, measurement tolerances, tools to be used
are communicated to the right workstations. Costly quality problems
can be avoided.

e) The outcome of action learning from knowledge and skills intent is to
improve morale. As the supply chain manager resolves potential
problems and handle challenges in coordination of the supply chain
operations, the supply chain manager gains confidence. This
resolution of potential risk to efficient supply chain operation also
improves cross functional integration in the organization.