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RESEARCH ARTICLE

GLOBAL PASSENGER CAR SUPPLY CHAIN MANAGEMENT: NAVIGATING ECONOMIC DOWNTURN AND RECOVERY

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ABSTRACT

The paper aims to highlight the impact of economic phases, namely, slowdown and recovery on supply chain of passenger car industry. Supply chain management becomes vulnerable during economic slow-down when the inventory builds up and production becomes unstable. At times of recovery the supply chain is characterized by backlogs when organizations explore all available opportunities and build resources as well as capabilities for growth and sustainable development. So far literature review shows that impact of customer' choice, their behaviour and marketing variables on sales of passenger car have been studied to a great extent. Very few studies have been done on impact of economic conditions on sales of passenger cars and its consequent effect on supply chain. Recent economic downturns factor have left the supply chain managers clueless and take ad-hoc decisions. In this paper managing the supply chain of passenger cars during economic downturn and recovery period have been studied and decision making framework suggested for supply chain managers. The results show that a sale is sensitive to economic variables such as GDP, WPI, Fuel-Price, Inflation Rate, etc. This suggests that the supply chain decision framework needs to be integrated with the variations of economic conditions. This paper proposes a decision making model based on System Dynamic (SD) approach for enabling decision and policy makers to experiment with their policies and analyse the outcomes.

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INTRODUCTION

Realization of supply chain and supply chain management acts in industries and organizations is a part of essential and survival priorities and today, no organization and industry wouldn't be exception, (Beamon,1999). From 1960 onwards, the active participation in supply chain and its appropriate management is the basic principle structure of any activity especially inthe field of business (Beamon, 1998). Gilaninia, *et al* (2013) opined that the results of their research indicated that among characteristics of supply chain strategy, relationships with supplier strategy, has the maximum relationships with organizational performance of companies operating in poultry industry. Nowadays, supply chain components, consist raw material preparation stage to the final delivery to the consumer (Bititci, *et al*., 1997, Busi *et al*., 2006). In a world where change is unrepeatable part of industry, study the processes of each industry, enables the supply chain management to design process and, if necessary, take action to redesign or reengineering processes. The global supply chain experienced a serious crisis after the financial breakdown in USA in September 2008 that has been dubbed the "Great Trade Collapse" for its impact on international commerce.

The shock, stemming from the largest world financial centre, spread very quickly and almost simultaneously to most industrial and emerging countries. The collapse of world trade has been unprecedented, even in comparison with the Great Depression of the 1930s (Eichengreen and O'Rourke, 2009). During the first quarter of 2009, world exports in value terms were 31 percent lower than one year before and world imports 30 percent lower. The freight rates for containers shipped from Asia to Europe have reached zero in the middle of January 2009 for the first time in history. International trade, which dropped five times more rapidly than global GDP, was both a casualty of the 2008-2009 crisis and one of its main channels of transmission. While a decrease in trade is expected when world output falls following a severe financial crisis, the magnitude of the collapse has surprised observers. This overreaction is reflected in high trade elasticity. Moreover, the trade collapse was not only sudden and severe, but also synchronized, which is another distinguishing feature of the current crisis (Escaith, H., Lindenberg, N., & Miroudot, S., 2010).Flexible buyer-supplier relationships would be invaluable in times of crisis and when uninterrupted service to customers deemed essential (Braunscheidel& Suresh, 2009). In this regard, a concept of elasticity in buyer-supplier relationships has been introduced and explained as an important element of relationship flexibility.

Elasticity is viewed as a level of tolerance threshold of cooperating parties in face of their behaviour fluctuations. Therefore, it should also be expected that global supply chains would play a role in the synchronization of the trade collapse and its size. One reason for this is the inherent magnification effect of global production networks: intermediate inputs cross the border several times before the final product is shipped to the final costumer. All the different production stages of the global supply chain rely on each other – as suppliers and as customers. Thus, if a shock occurs in one of the participating sectors or countries, the shock is transmitted quickly to the other stages of the supply chain through both backward and forward linkages. These transmission channels apply both to financial shocks, e.g. a credit crunch in one country, and to trade policy shocks, e.g. rising tariffs and non-tariff barriers, or implementing "buying local" campaigns. To survive with the worst economic downturn, it's critical that manufacturers look ahead and prepare for the eventual economic recovery. Historical data indicates that it's the period immediately following a recession that offers the most opportunity for businesses. According to the recent Quarterly Economic Forecast issued by Manufacturers Alliance/MAPI, there are enough economic indicators to forecast an eventual, though modest, recovery following a long and deep recession. Manufacturers must ensure they have a solid foundation to effectively and profitably leverage the opportunities that a recovering economy will offer. Although there is much speculation on the rate of the economic slow-down, some indications suggest that consumers' frugal spending behaviour during the recession may last well into the recovery period and beyond. Given this situation, manufacturers should recalibrate their supply chains now to assist them in operating successfully in today's "new normal" environment, effectively navigate the recession-recovery cycle and lay the groundwork for future growth.

During period of economic recovery organizations explore all available opportunities and build resources as well as capabilities for growth and sustainable development. Supply chain management becomes vulnerable during economic slow-down. The management of supply chain during "Recovery Period" requires new innovative approaches to recover from economic slowdown and market uncertainties. Now, all those discussion here, concentrates on automobile industry and exclusively the market for passenger cars are taken in to consideration. The reason behind that, it is believed vigorously that "Automotive industry is a representation of mechanical genius by human generous". Basically, the purpose of this paper is to discuss opportunities that businesses have to grow their operations in a more scalable way with a higher level of association with some important economic variables *viz.* GDP, WPI, Inflation Rate, Fuel Consumption Costs, etc. along with some assets and resources. For most companies around the world, resources have been reduced, inventory drained, technology spending curtailed, and core processes scaled back in order to adjust to the current reality of reduced demand. In this connection supply chain operations for any manufacturing industry need to be more scalable and flexible as they anticipate economic recovery and increase capacity. Moreover, this can be easier to achieve coming out of a severe recession(Eric G. Olson, 2010). The economic difficulties require a focus on the creation of real wealth and real value – products and services for which there is a demand in domestic and international markets. SCM has a pivotal role in creating this value.

The reality in today's competitive world is that standing still effectively means falling behind. Innovation in all aspects of SCM is the key to survival and success (Sweeney,2009).

Research Background: Statistical analysis of sales of passenger cars, with data from Indian passenger carindustry, as dependent variable and economic variables as independent variables has been carried out. The results show that sales are sensitive to economic variables such as GDP, WPI, Fuel-Price, Inflation Rate, etc. In the Indian context, the sales (of passenger car) to per-capita-GDP elasticity, is more than 1. More precisely it is 1.5. This has been computed with data available from RBI (Reserve Bank of India) and SIAM. The value greater than 1 suggests that sales of passenger car are affected by the change in per-capita-GDP. This suggests that the supply chain decision framework needs to be integrated with the variations of economic conditions. In the period of economic downturn the inventory is expected to be high with decreasing rate of production, while in time economic recovery the backlog is expected to be high with reduced inventory levels.In this paper, managing the supply chain of passenger cars during economic downturn and recovery period have been studied and decision making framework suggested for supply chain managers. The paper proposes a decision making model based on System Dynamic (SD) approach for enabling decision and policy makers to experiment withtheir policies and analyze the outcomes.

Understanding the Supply Chain

Supply Chain Driver's Approach: Chopra and Meindl, (2004) established a framework for analysing supply chains. This includes definitions and examples of supply chains, relationships between supply chain strategy and a firm's competitive strategy, and drivers and obstacles of supply chain performance. The key drivers identified are inventory, transportation, facilities, and information. The explanation of

Four Drivers

- **Inventory:** It consists of all raw materials; work in process, and finished goods within a supply chain.
- **Transportation:** It involves moving inventory from one point in the supply chain to another point.
- **Facilities:** A facility is a place where inventory is stored, manufactured or assembled. Hence facilities can be categorized into production facilities and storage facilities.
- **Information:** It consists of data and results of analysis regarding inventory, transportation, facilities, customer orders, customers, and funds.

Push and Pull Strategies: A pull strategy is related to the just-in-time school of inventory management that minimizes stock on hand, focusing on last-second deliveries. Under these strategies, products enter the supply chain when customer demand justifies it. With a pull strategy, companies avoid the cost of carrying inventory that may not sell. The risk is that they might not have enough inventories to meet demand if they cannot ramp up production quickly enough. A "Push Strategy" makes or assembles to stock primarily based on downstream orders instead of end customers' order. This strategy tends to make the supply chain cost efficient but not responsive.

Levi *et al* (2008) defined a strategy as a mixture of the push and pull strategies to leverage on the efficiencies as well as making the supply chain responsive.

Contingency Approach: Wanke *et al* (2013) introduces the subject as "the contingency approach to management basically argues that there is no one best way to manage (Drazin and Van de Ven, 1985). Central to the contingency approach is the proposition that the structure and process of an organisation must fit its context. This is in contrast with the 'best practice' approach (Voss, 1995), which is reflected in the proliferation of operations and supply chain management (SCM) practices that have frequently and long been considered by some advocates as having universal applicability – independent of context – such as total quality management (Feigenbaum, 2004), lean production (Womack *et al*., 1990; Jones and Womack, 2003) and Six Sigma (Martin, 2007). According to Sousa and Voss (2008), operations management best practices have now matured, and research on practices has begun to shift from the justification of the value of such practices to the understanding of the contextual conditions under which they are effective. Similarly, in SCM, after years of emphasis on developing and demonstrating the value of practices such as continuous replenishment (Liz, 1999; Vergin and Barr, 1999); collaborative planning, forecasting, and replenishment (Johnson, 1999); efficient consumer response (Mathews, 1997); and vendor-managed inventory (VMI) (Kiely, 1998; Waller and Johnson, 1999), it may also be time for research to shift toward a better understanding of the contextual conditions under which such practices work best". They analysed the relationships between logistics complexity-related contextual conditions (e.g., size of the company, number of stock keeping units (SKUs) and frequency of product launches) and two aspects of SCM:

- The perception of how critical supply chain managers consider each different decision area (e.g., logistics and distribution networks, sourcing and VMI) for achieving supply chain excellence.
- The supply chain managers' perception of the criticality of different supply chain objectives (e.g., cost, customer service, time, response and profitability).

Trends in supply chains

- World trade patterns are changing- At the start of the 1990s, global trade was dominated by the developed nations; by 2010, the advanced economies accounted for a little more than 60% of global merchandise exports.
- Supply chains are transforming- In response to these changing patterns in global trade, companies are rapidly transforming their supply chains to go wherever necessary to support growth and reduce costs and risks. For many companies, supply chain activities — such as product engineering, sourcing, manufacturing and logistics — are now widely dispersed around the world. As activities are outsourced, the efforts are directed to centralized and streamlined supply chain management to gain efficiencies and maximize scarce resources; the corporate structures and functions are also being transformed (Pankaj M. Madhani, 2012).

Supply Chain Strategies during economic upheavals: Referring to the breakdown of 2008-2009, some authors have pointed out that they may explain the abrupt decrease in trade or the synchronization of the trade collapse. As environmental uncertainty increases, organizations strive to cultivate, maintain and develop capabilities required to enhance their responsiveness against changes (Gunasekaran, Lai, & Edwin Cheng, 2008; Sheffi& Rice, 2005; Swafford, Ghosh, & Murthy, 2008). These capabilities such as flexibility need to be envisaged not only within the organization boundaries but also across its supply chain partners (Stevenson 2007). This is essential as it has been widely acknowledged that today's competition is among supply chains rather than individual firms (Christopher, 2005). Therefore, supply chain management (SCM) is an important strategy in order to sustain competitiveness of business (Gunasekaran, *et al*., 2008). The vital recession-recovery strategies, suggested by the authors, for manufacturers to effectively mitigate supply chain risks, quickly respond to opportunities associated with the economic recovery, as well as operate a more efficient and competitive business include:

1.Strengthen Cash Position: Manufacturers that can free-up unnecessary inventory and keep it lean will have the flexibility to change business strategies or respond to any market surprises. One way to strengthen cash position is to continue rationalizing inventory levels against the changing product mix across the entire supply chain so that levels are optimally aligned with current consumer demand. Cash is also essential for companies to establish a healthy framework for growth, whether that consists of new product innovations, expansion into new markets or merger and acquisition activity.

2. Realign the Supply Chain to Achieve Financial Goals: In addition to addressing real-time supply chain issues like replenishment and forecast planning; it's time for manufacturers to think strategically about their businesses over the long term. An effective way to achieve this is to take control of financial and operational strategies with a revised approach to sales and operations planning (S&OP). An integrated business planning approach goes beyond supply-demand balancing and integrates time-phased strategic revenue, cost and margin plans with a company's operational plans. This also enables executives to more accurately set financial expectations for all sales, marketing, promotion, inventory and capital expenditure plans.

Consider a Hybrid Near-Shore/Offshore Approach: Companies with an eye on global growth understand that off-shoring is an excellent way to expand overseas. However, companies also understand that fluctuating transportation costs and other events such as political instability or volatile raw-material costs can actually increase the cost of off-shoring, making near-shoring more appealing. According to a recent AMR Research quarterly risk report, companies are continuing to look to near-shore opportunities for sourcing and manufacturing (11 percent of respondents), with four times as many respondents planning to increase activity versus decrease.

Plan for Strategic Expansion: Manufacturers should be able to gain quicker market share in emerging markets, where the competitive landscape has changed significantly. By focusing on untapped or emerging international markets companies can mitigate the risk associated with too much dependency on a single region. However, globalization requires strong fundamentals to be successful — such as the aforementioned cash on hand and most importantly — integrated business

planning. Planning for global expansion should also include investment in change-management preparedness and a focus on technology to make enterprise-wide visibility and communication more efficient so that strategic decisions can be made in a timely manner.

Capitalize on the Consumers' New Normal: Even as the economy rebounds, consumers will continue to be more spend conscious than ever before, with increased due diligence on value going into every decision. Successful companies will see this as an opportunity to create a strategic advantage by realigning their product offerings with the new consumer preferences. By weeding out poor-performing products and setting the right pricing and promotional strategies for high growth and new products, manufacturers can drive profitability. Catering to consumer demand now will also enable manufacturers to build market share and long-term brand loyalty, even as consumers find themselves with more discretionary spending income in the future. Additionally, establishing closer collaboration with retail partners can provide insight into point-of-sale and SKU data, enabling manufacturers to better respond to shifts in market conditions, inventory production planning and scheduling.

System Dynamics: System Dynamics, developed by (Forrester, 1961, 1968) identifies cause-effect relationships and structures them in a feedback control framework to understand the dynamic behaviour of the systems. The approach professes causality doctrine associated with determinism. System Dynamics is a methodology that has ability to capture and model dynamic complexity of complex systems. Dynamic complexity refers to state where cause and effect are subtle and where effects over time interventions are not obvious (Senge, 1990). According to (Coyle,1977) a System Dynamics study aims at the following objectives: Explaining the systems behaviour in terms of structure and policies, and suggesting changes in structure, policies or both, which will lead to an improvement in behaviour .In practical system dynamics work, and as a conceptual framework, it is useful to look at systems in the light of how much certain knowledge about their workings it is possible to acquire, at any rate in principle, and how far it is possible to exert actual and direct control over what goes on. He proposed three sectors in the structure of a firm. These are the internal environment or the controller (can be controlled and influenced), the complement (cannot be controlled but may be influenced) and the environment (cannot be controlled or influenced). A firm but cannot control its complement.

System Thinking: Systems thinking offer a method for describing and analysing problems in such contexts, and are therefore well suited to solving the complex and dynamic socioeconomic problems found in logistics systems today. However, the problems reported by many organizations show that the use of systems thinking is insufficiently developed, although it has been with us for several decades. Senge (1992) elaborates on this theme, and claims that firms seem more concerned with detail - as opposed to dynamic - complexity. If firms deal only with detail complexity, they are obstructed from seeing how relations of different kinds reach beyond their own firms and change over time. The nature of the problems reported indicates that many organizations act as autonomous units instead of components of a larger system, and thus neglect the width and scope of their interdependencies with other firms.

His discussion is aimed at positioning measurement problems and initiatives in a framework based on systems thinking, suggesting that adopting a systemic view of the supply chain can assist in improving performance. The framework is based on Senge's (1992) ideas about what kinds of explanations to phenomena firms' use, depending on how well they have adopted systems thinking. Firms not recognizing the relationships between phenomena within the context in which they operate characterize the first and lowest level of adoption. Accordingly the problem statement identified, are as follows-

RESEARCH GAP

A holistic approach meeting the following challenges need to be taken. The challenges are:

- Changing demand patterns and response behaviour
- An evolving customer base, from traditional to new customers.The former seeking ways to reduce costs and new customers posing challenge to customization.
- Commoditization of products over product life cycle and availability of substitutes leading to reduced switch over cost.
- "Green" regulations and mandates from customers
- Changing economic scenario leading to inflation or deflation or recessions and recovery from such environment
- Risk arising out of political, social, technological, and legal environment of nodes in the supply chain.

The problem statements that this paper proposes to addresses are:

Problem Statement-1: In spite of attempts to integrate, the supply chain exhibits vulnerability during economic slow-down and subsequent market-recovery.

Problem Statement-2: A holistic approach encompassing contingency, systems and drivers approach needs to be developed.

Problem Statement-3: Model for Decision making: Many researchers have suggested models that are deterministic in nature neglecting the uncertainty. Some have suggested stochastic models to deal with uncertainty (Oliveira, Claudia Sagastizábal, and Susana Scheimberg, 2011). However, Models for simulating decision-effect during market recovery are insignificant.

RESEARCH OBJECTIVES

The paper proposes a decision making model based on System Dynamic (SD) approach for enabling policy makers to experiment with their policies and analyse the outcomes.

The proposed frame work

The proposed frame work can be represented as shown in Figure 1.

- The state of level variable Backlog indicates the combined performance of Order-Level and Inventory Level. If the Backlog increases then it can be concluded that the plant is unable to meet order received from customer.

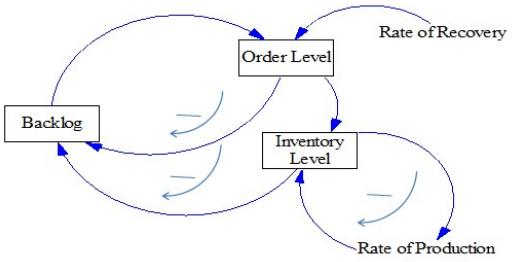

Figure 1. Causal loop diagram

- The order-level is also dependent on Accumulated backlog and Rate of Recovery.
- The inventory-level is dependent on order-level and rate of production.
- The Rate of Production, i.e. the auxiliary variable is in-turn dependent on Inventory Level. If the rate of production is high then the accumulated inventory level will also increase, resulting into unnecessary accumulation of inventory.
- On the other hand, if inventory is higher than backlog will be reduced to meet-up customer's order, provided there is enough demand (order-level).
- If the order-level is higher than accumulated inventory level then backlog will be increased, until the rate of production meets the demand.
- If the rate of recovery is high then back-log will be reduced even when there is high-level of orders.
- Moreover, if the order-level is moderate due to moderate rate of recovery and the accumulated inventory is low, and then backlog is also likely to increase.
- Next, if the order-level is low, rate of recovery is high and accumulated inventory is high, and rate of production is also low then backlog is expected to be low.
- Lastly, whatever be the order-level, if the rate of production and inventory level is optimum then rate of recovery is immaterial and backlog is expected to be zero or reduced. This can happen only if there is flexibility in production level i.e., a JIT manufacturing based on Pull strategy.

Therefore, it may be concluded that the rate of recovery is likely to affect the order level which in turn affects the inventory and production rates. If these have imbalances will result in backlog causing order level to fall. Through this causal framework it has been tried to illustrate that a transition is expected from pre-recovery phase (characterized by high inventory level, low production level, zero backlog and low order-level) to the recovery period where the order level is expected to grow either at steady rate or at slow rate or the recovery may take a downward ward dip again. There are three loops that explain the dynamics of the system, *viz.*

- **Order Level – Backlog Level Loop:** The increase in Order Level will result in increase in Backlog Level. Increase in Backlog Level will decrease the order level. Hence a negative loop.
- **Order Level – Inventory - Backlog Level Loop:** The increase in Order Level will result in decrease in Inventory level. Increase in Inventory Level will decrease the Backlog Level. Increase in Backlog Level will decrease the order level. Hence a negative loop.
- **Inventory –Production Rate Loop:** The increase in Inventory will result in decrease in Production Rate. Increase in Production Rate will increase Inventory level. Hence a negative loop.
- The causal loop diagram (figure-1) initializes the preliminary condition for simulation, i.e. discussed below-
- **Model Simulations Conditions:** Figure 2 shows the proposed System Dynamics model for simulating the decision-effect during market recovery.

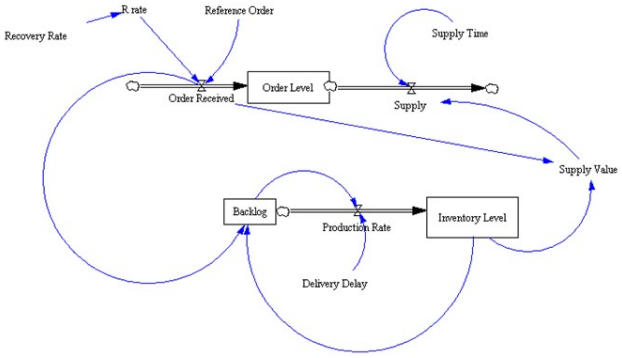

Figure 2. System Dynamic Model for Simulation

INFERENCE

The pre-recovery stage is characterized with the state as:
Order level=Low,
Inventory level=Very High,
Production Level = Low
Capacity Utilization= Low

Figure 3 illustrates the pre-recovery stage graphically.

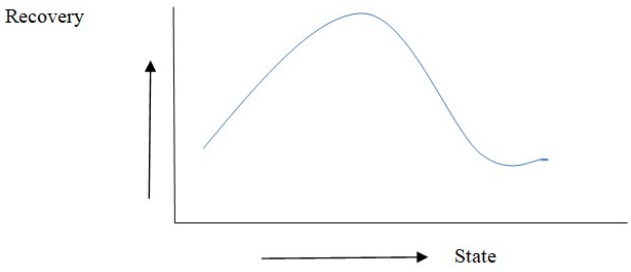

Figure 3. Graph for Pre-Recovery State

Thus pre-recovery with respect to supply-chain can be defined in terms of inventory level, obsolescence, backlog, order-levels and production levels. In pre-recovery the inventory level expected to be higher, obsolescence higher, production level very low, backlog is zero (0), order-level is low. These form the initial condition of the system dynamic model. Figure 4 shows the inventory level during different phases of economic cycle as outcome of simulation of the System Dynamics Model In real world scenario the recovery rate may be as shown in figure 5 below.

With the increasing rate of order received, which is a function of recovery rate i.e, during economic growth period, the behaviour of the system is shown in figure 6. In order to meet the increase in order level (during the recovery period), depleting the previously held inventory, firm needs to increase the production capacity to meet the rise in demand.

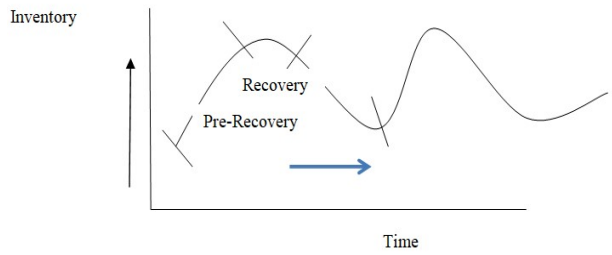

Figure 4. Inventory Level - Recovery vs. Pre-Recovery Phase

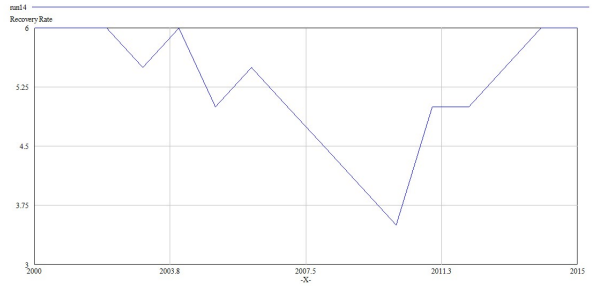

Figure 5. Recovery rate graph based on year wise data

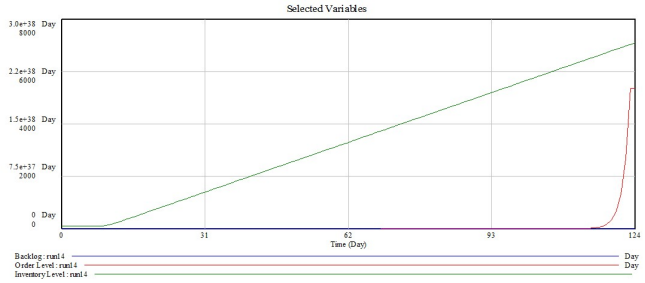

Figure 6. Graph showing three (3) levels of variables, *viz.* Backlog, Order Level and Inventory Level

Increasing of production capacity will involve some delay due to time taken to install additional capacity. During this delay period the firm is expected to experience lost sales affecting its credibility. Hence the firm needs to ramp up production with agile manufacturing approach and resort to outsourcing to meet the upsurge in demand. The extent of ramping up production and outsourcing would depend on the rate of recovery.

The relationship between the variables can be stated as:

In the used system dynamic model the following details are undertaken

Initial time estimated as 0 (zero),
Final time=3000 i.e. 10 years (assuming each of the 100 days of a year is considered for calculation)
Units=Day
The variables used are named as-
Order Level=OL
Initial value of OL=1
OL=OL-OR
Order Received=OR
Initial value of OR=2
OR=RO*(1+(R.Rate/100))
Reference Order=RO
Initial value of RO=15
R. rate is an additional variable showing the Recovery Rate
R. Rate=RR*(150/15) (calculated values are put in the equation)
Recovery Rate =RR
RR used a look-up table, where the data set is-
((0,0)-
(2015,10)),(2000,6),(2001,6),(2002,6),(2003,5.5),(2004,6),(2005,5),(2006,5.5),(2007,5),(2008,4.5),(2009,4),(2010,3.5),(2011,5),(2012,5),(2013,5.5),(2014,6),(2015,6))
Backlog=BL
BL=ABS(Min(IL-OR),0)
Production Rate=PR
PR=BL/DL
Delivery Delay=DL
Initial value of DL=2
Inventory Level=IL
Initial value of IL=100
IL=PR
Supply=SP
SP=SV/ST
Supply Value=SV
SV=Min(IL, OR)
Supply time=ST
Initial value of ST=5

FUTURE RESEARCH SCOPE: The System Dynamics model presented in this paper may be validated with real life scenarios and primary data in further research work.

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