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Research Article

Key Strategic Issues in Supply Chain Domain Pertaining to Battery Industry.

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I. Abstract:

This research paper identifies the key strategic issues in operations and supply chain management for the automobile battery industry. Supply chain management (SCM) is all about an integrated approach to developing a bridge among the suppliers, manufacturers, warehouses, and customers. This eventually helps to distribute the end-product at the right place and at the right time. In order to minimize the system-wide cost component while assessing its requirement, SCM can be considered as a logical step for profit share and market share maximizing of a firm. Strategic issues concerning supply chain management in the Indian automotive battery industries are assessing demand, meeting the same with supply, creating the essential bridge between demand and supply through the network. For demand, the main issue is forecasting, and in the automotive battery industry, as they offer new replacement of faulty batteries for accepted warranty claims, forecasting also includes the estimation of warranty replacements along with sales projections. For meeting supply, production planning is the key strategy for consideration, whose complexity is compounded with multiple factors having different product mix. For creating the agile network, inventory planning is the key strategic driver, primarily as dispatches occur at stages being location-specific, material-specific and time-bound.

Keywords: Operations and Supply Chain Management (OSCM), Supply Chain Management (SCM), Automobile Battery Industry, Strategic Issue,

II. Introduction:

The term OSCM includes a broad area applicable for both service and manufacturing organizations encompassing key functions of procuring to pay, plan to produce, order to cash, finance and controlling, integrated planning, demand forecasting, logistics and distribution etc. (Bhatnagar & Teo, 2009). In a nutshell, the process involves the conversion of raw materials by manufacturers or service providers into finished goods or intangible services and ultimately providing them to consumers through a process involving multiple stakeholders and their individual business operations.

In a manufacturing process such as lead-acid batteries, raw materials like lead, acid, container, casing, etc., are used as raw materials sourced from multiple suppliers and then assembled and manufactured through a complex process to finally shape them into a physical product, a battery. Similarly, an information technology (IT) service provider would design software that can help in production planning during the manufacturing process of a battery or a call centre that can address the after-sales service process of batteries. The output of these services is intangible, which cannot be touched but can form actual movement of the physical product or raw materials and warehousing and storage process that help in storing the raw materials or finished goods. Both these processes may happen inside or outside the factories having multiple internal and external stakeholders *(Larson & Halldorsson, 2004; Leger et al., 2006; Lee & Lee, 2015).*

In the supply chain, the products and services are provided to plants and warehouses at the input end, and products and services are provided to the customers at the output end. So, the entire process has to run efficiently, and every

function has to be balanced properly else the entire business structure will get haywire. The objective of OSCM is to control all facets of the process in an efficient and optimized manner.

In order to survive in this hyper-competitive world, organizations have to scale up rapidly, and during their journey, they have to face a critical situation whereby they have to keep their costs manageable but have to produce quality products with the flexibility *(Chase et al., 2014); Lin et al., 2012* opined that organizations who have mastered the art of optimizing their OSCM systems through sound strategy, automation, intelligent software and smart operation processes such as procurement, logistics and fulfilment with real-time information have been able to outpace the competition and create barriers for competition.

An ideal OSCM strategy is the cry of the day in the operation structures of large e-commerce portals like Flipkart or Amazon. A lot of e-commerce players are there in the market, but everyone is bleeding, but their ultra-smart OSCM backed by high-end technology infrastructure has made them leaders in the market in India today *(Eyers & Potter, 2015).* Key objectives of OSCM are (a) manage and reduce cost through increased productivity (b) reductions of cost (c) smart sourcing and procurement (d) increased efficiencies and effectiveness in logistic chain (e) demand and supply planning *(Chase et al., 2014).*

Gangadharan & Swamy (2004) presented that supply chain as a domain appears to be most susceptible due to the advent of business intelligence (BI) and allied technologies in the automotive industry. The key challenges in OSCM are (a) designing a global supply chain network *(Burt et al., 2003, pp. 78-88).* (b) responding to predictable variability (seasonal fluctuation) in SC (c) managing uncertainty in a supply chain *(Buyurgan et al., 2019).* (d) determining the optimal level of product availability (e) route optimization (f) balance between efficient and responsive SC (g) improve customer service in terms of cost and supply *(Chaston, 2008)* (h) SCM Planning (i) maximize the supply chain surplus.
OSCM will be practically useless if not backed by proper control of inventory. Efficiencies must be measured, and the time duration to make a product has to be fixed. Also, quantifiable measures of improving quality and lowering defects are important concepts that may vastly improve an OSCM process. There are methodologies like six sigma, Kanban that can help organizations effectively to implement strong OSCM processes in their organization.

Information systems aided by devices such as a personal computer (PC), barcode readers, image recognition devices, mobiles and a host of other data capture devices are fed with various metrics which are analysed by software and decision support systems (DSS) such as SAP, Oracle, Tableau to provide meaningful information that goes a long way in developing, and managing and maturing an OSCM process in an organization.

Hence, it can be concluded that OSCM in all facets of a business process from the supplier side to the manufacturer side and finally on the consumer side plays an integral and important role. Past research articles *(e.g. Jonsson et al., 2007; Routroy & Maddala , 2009; Kazantsev et al., 2018; Jones, 2018)* highlight that there are five key pillars:

A) Supplier side OSCM involves:

- Selection of the supplier on optimized parameters
- The setting of pricing, delivery, and payment processes
- Matrices to monitor and improve the relationship between supplier and manufacturer.

B) Manufacturing side OSCM Involves:

- Scheduling of job and coordination of material and other critical resources
- Matrices to monitor speed, quality, and productivity.

C) Delivery side OSCM Involves:

- Coordination and scheduling of movement of goods & information through the supply network.
- Develop and operate a network of warehouses.
- Effectively monitor all the matrices

D) Return side OSCM Involves:

- Processes of receiving worn-out, defective, and excess products back from customers
- In the case of service delivery, it involves all types of follow-up activities that require after-sales support

- Monitoring all the metrics and effectively solving deviations through the standard operating procedure (SOP) based on escalation matrices

D) Planning side OSCM Involves:

- Processes needed to operate an existing SC
- To determine how anticipated demand will be met with available resources
- Matrices to monitor supply chain efficiency to deliver high quality and value.

The departments that are involved in bring goods and services to the customers are operations, production, sales and distribution, finance, planning, customer service, research and development etc. All these departments not only deal with the material flow but also are responsible for material and cash flows.

Each stage in a SC is connected through the flow of products, funds and information. These respective flows often occur in both directions and may be managed by one of the stages or departments or an intermediary. *Balasubramanian & Tewary (2005)* explained that the design of the supply chain depends on both the customer's needs and the roles played by the departments or stages involved.

The goal of the supply chain is to maximize the total value generated by it. The total value of the supply chain is closely related to profit-making. The more robust is the supply chain management of an organization, the more profitable and cash-rich the company will be. The value of the final product or service can be estimated by the maximum amount that the customer willing to pay. The estimates are subjective and would vary from person to person and from situation to situation. In supply chain profitability (also known as supply chain surplus), the total profit is to be shared across all supply chain stages and intermediaries. The success of SC depends on SC surplus, and it is measured by the equation, as follows: Supply Chain Profitability = (Revenue generated from a customer) – (Overall cost across the supply chain). In the supply chain, the customer is the only source of revenue. All flows of information, product, or funds generate costs within the supply chain. Thus, the appropriate management of these flows is key to the success of the supply chain. Effective supply chain management thus involves the management of supply chain assets *(Baller et al., 2007)* and product, information, and fund flows to maximize total supply chain profitability.

Today, the materialistic cum market world is being reshaped by data at an exponential rate. Massive improvement in storage and processing speed motivates organizations to collect data from every corner of their business operations. However, most of these data are being generated from their internal sources, though, for any strategic decisions, companies depend on internal as well as external data. Due to the huge expansion of the internet, another aspect that needs attention is a recent surge in unstructured and semi-structured data being generated by call centres logs, e-mails, blogs, tweets and various social medium forums. Fortunately, cloud computing technology helps organization to integrate internal data and external data. Data is coming to the business at a much faster rate than earlier. That is the basic reason for which companies are investing in BI for strategic analysis *(Ghosh, 2016).* Many researchers *(e.g. Scheuing, 2009; Waller & Fawcett, 2013 ;Wieland, 2013)* emphasize the importance of increasing strategic supply chain management, but it is evident from research study and also from practical day to day findings that there is still a lack of concrete guidance for supply chain executives faced with strategic decisions in this area particularly for the automotive battery industry. As a consequence, it has become harder for supply chain executives for any kind of decision making to comprehend in the disruptive world. SCM becomes a competitive advantage, and strategic decisions gain more significance in today's world.

III. Literature Review:

The Supply chain process contributes to reducing operating costs and inventory management. It also contributes to increasing the speed of the delivery process and enhancing consumer service. However, it has been experienced that the implementation of the supply chain process is complicated in the automobile industry in India in particular. *Schwarz (2008),* through extensive analysis, concluded that the production process in the automobile industry includes assembling 20000 components and sub assembling of 1000 parts or modules. It includes establishing coordination with the tier1, tier2, and tier3 suppliers through different dealerships so that the manufacturing process may be performed effectively and concisely. *Meyr (2004)* examined that along with carrying out concise production activities, and it is also essential for the firm to manage individual customer's demand and customize the products as per each customer's needs. It requires the adoption of a systemized supply chain process so that the firm operations and customers' needs both are met adequately and satisfactorily. However, the automobile industry faces several issues such as integration, supply chain challenges, OEM supplier synergy, leveraging technology and visibility, and performance measurement and quality related to the implementation of the supply chain process.

Integration issues are faced by the automobile unit while performing supply chain activities. For example, to ensure the manufacturing activities are carried out productively, Toyota ensures that the product enlargement procedure is closely related to the manufacturing system that is adopted by the company. Toyota also performs formal and informal supervision activities with the help of coordinators so that changes that are occurring in the demand side are included in the production process. As a result, the company acquires flexibility in the production process, which provides it with an edge over the rivals and meets customers' expectations increasingly. *Naylor et al. (1999)* examined lean and agile processes that are also included in the supply chain process so that the market-related challenges are met successfully. However, if such supervision and coordination of lean and agile systems are not adopted by the firm, it becomes difficult to manage information, material, and production supply procedures. Related issues such as transparency, cost restraint, risk administration, mounting client expectations, and globalization are faced by the automobile industry in India to implement the global supply chain process. However, the supply chain mechanism of the Indian automobile industry is not efficient and faces issues such as lack of resources, fragmentation of suppliers, lack of collaboration, and complicated tariff and duty system. The other issues, such as lack of proper infrastructure and multiplicity of distribution channels, are also faced by the automotive industry. *Deman & Tuyishime (2009)* examined that automobile companies such as Hyundai also met issues such as cultural diversity challenges, sourcing difficulty, and income-price disparity while working in the Indian automobile market. However, by combating all the challenges, Hyundai launched a new car model known as Santro in the Indian car segment with unique features so that the sales of the company increase. *Sahoo et al. (2011)* examined that unskilled labour and high attrition rate issues are also faced by an automobile company which reduces the efficacy of the firm to low levels. It not only lowers the productivity of the firm but also adversely impacts its capabilities to serve the customers.

Childerhouse et al. (2003) examined that lack of synergy with the OEM suppliers and tier-1 vendors create issues for the automobile industry to implement proper supply chain process. OEM suppliers are responsible for technological advancement, assembling, and sub-assembling of the product parts. However, when there is a lack of coordination between the OEM suppliers, technology adoption does not take place adequately and thus impacts the entire production and delivery process adversely. In order to overcome the issue of fragmented suppliers, Tata Motors applied 'One Part One Vendor' system supply chain management. It helps in integrating the supplier and the company process, which enhances the compatibility and efficacy of the firm. Technology adoption issues are also faced by the automobile industry. It is because there is a lack of coordination between the adoption of technology and the goals of the firm. As a result, due to a lack of technology implementation such as data analytics, ERP, RFID *(Oghazi et al., 2018)*, there is a shortage of coordination between the tier1 companies and tier-2 suppliers. Thus, the lack of adoption of any standardized performance of management system also creates an impact on the performance aspects of the firm. Due to the lack of adequate performance assessment, the efficacy of the firm could not be estimated, which reduces its capacity to bring improvements in the current operating process. Thus, it can be opined that different challenges such as lack of integration, lack of technology, and absence of performance assessment procedures create high impact supply chain management in the automobile industry *(Lee & Ozer, 2007; Jamaludin et al., 2018).*

Soni & Kodali (2011) examined that the Indian automobile industry possesses all the qualities such as supportive governing policies, favourable exchange rates, and reduced duty rates to increase production and performance levels. However, presently, the Indian automobile industry is striving in the global markets because of a lack of proper supply chain process**,** restrictive policies, unskilled labour, technology backwardness, and lack of adequate capital investments. Therefore, it is essential to introduce mitigating strategies and measures so that the performance of the automobile industry enhances. *Kapoor & Ellinger(2004)* examined that the adoption of an adequate supply chain process by the Indian automotive industry will help the industry to increase its ability to compete in the global market. It is because when effective collaboration is established with the suppliers, vendors, manufacturers, warehouse, logistics, retailers, and consumers, there is a rightful flow of information, and all the production processes are carried out concisely *(Formentini & Romano, 2016)*. By including 'Leagile' innovations into the supply chain process of the Indian automobile industry, the issues related to decoupling and lack of coordination could be resolved. Moreover, the adoption of a standardized supply chain process will also help in developing synchronizing component supply chain activities, enhancing visibility, and developing customer relationships. As a result, the firm will be in a better position to meet customer expectations and provide them with quality products in real-time. Adequate government intervention will also help in promoting the automobile sector. When supportive policies such as favourable taxation policy, research and development activities, and export regulations are provided by the government, it helps to enhance the working of the automobile industry. Several initiatives have been taken by the Government of India to promote manufacturing activities of the automobile industries in India. For example, a tax deduction of INR 1.5 lakh has been proposed by the union budget of India 2019-2020 so that the initiatives that are taken by the automobile companies to launch electronic

vehicles are accelerated. The governing body has let out US$ 388.5 million to carry out research and development activity in the automobile industry sector. Additionally, automobile company such as Tata Auto Comp Systems has established a partnership with Prestolite Electric (Beijing based company) to carry out research and develop electric vehicles in India. Ford Motors internationally renowned automobile company, has invested INR 600 crore in the Indian automobile market to develop new models of vehicles.

Sahoo et al. (2011) examined that to overcome the issues related to unskilled labour, and the Indian automobile industry is providing training, education, and overall development to the workers. For example, automobile manufacturing company such as Bosch Ltd. has introduced Bosch Vocational Center (BVC) to enhance the abilities and competencies of the workers. It not only helped the company to improve the capabilities of the workers but also increase the productivity and efficacy of the company. Advanced technology such as performance at customer elation (PACE) is also adopted by automobile company such as Mahindra and Mahindra to enhance their technical capacities and improve supply chain management and customer relationship management processes. Thus, it can be said that the adoption of different strategies such as training to unskilled labour, the introduction of advanced technology, supportive government roles, and appropriate supply chain adoption thus help in overcoming the challenges related to the supply chain domain *(Lorentz et al., 2013)* about the automobile industry.

IV. Key Strategic issues:

The major findings and practical implications that would define the success of the battery industry can be summarized as follows:

Distribution Cost:

The leading battery manufacturers supply their batteries from the factory to warehouses (called primary freight) and from the warehouse to hubs/spokes, and from spokes to dealers/distributors (called secondary freight). The major portion of total freight (primary + secondary) expenditure corresponds to primary transportation. Another component of freight cost is secondary freight. Challenges in the management of freight are (a) cost-efficient operation, (b) delivery of goods and (c) planning accuracy.

Cost-efficient operation: The freight cost depends mainly on three factors like (1) unit rate as decided by freight contract on per kilometre basis for standard sizes of transport carriers. The unit rate is dynamic, so finding the optimized unit rate remains a challenge; hence proper algorithm must be designed so that organisations can zero in on the best possible unit rate. (2) loading of trucks to the fullest capacity so that products are shipped in the most optimized way, thereby controlling transport cost. Efficient planning ensures optimized alignment of logistics capacity with production and timely delivery of dispatch. (3) optimizing the dispatches by clubbing demand, selecting the right routes. Demand forecasting and route planning are pertinent for cost-effective transport and delivery, thereby keeping control of overall product pricing. Various demand forecasting and route planning software are available, which can help decision-makers chalk out the best route plan for efficient logistics and can also help in effectively forecast demand.

Delivery of goods: The lead time specified varies considerably due to road conditions. If the road network is not up to the mark due to damages and potholes, it invariable slows down the movement of transport vehicles resulting in longer shipment duration and added fuel costs, thereby increasing transport costs and finally spinning up the prices of the product *(Ramachandran et al., 2015).*

The large beeline of trucks at unloading points only increase the cost of the manufacturer and distributors as they must bear the cost of additional time usage required for product unloading at distribution or retailing points. Therefore, proper designing and arrangement of unloading spaces with trained manpower and equipment and information systems is the need of the day for effective unloading activities.

Safety during transit – If safety is compromised during transit of goods, it may result in accidents, breakdowns, compliance and health-related issues of drivers and helpers, thereby not only delaying the process of movement of goods but also supplementing the cost of delivery.

Handling issues during loading/unloading and transportation. - The loading and unloading process must be smooth and hassle-free without any tussles among the workers on all the points. A proper standard operating process (SOP) has to be defined, and all the parties have to train to follow the norms.

Planning accuracy: The distribution planning is key for (1) on-time dispatches from factories – The contractors or the staff involved must be sensitized to follow a proper dispatching schedule. IT systems with roster management and alerts with detailed reports should be implemented to keep track of timely dispatches. (2) Sufficient advance notice to transporters for the deployment of trucks – The transporters should be priorly intimated for the deployment of goods vehicles. Mobile apps with alerts and dashboards involving plants, transporters should be deployed so that all the activities of deployment of vehicles are monitored, and in the course of any deviation, requisite alerts should be sounded through a well-defined escalation matrix. (3) Avoiding rush dispatches and spot high freights.

Rental Charge: The hiring is done considering (1) local sales team experience and demands (2) volume handled (3) service angle for replacement batteries (4) convenience of delivery (5) space availability at a reasonable cost (6) loading unloading arrangement for vehicles, bay area etc. The average rental cost per square feet varies from Rs/square feet to Rs/kg according to city and area. Infrastructure requirements specific to battery storage is created, and expenses are shared on a negotiation basis with the service provider. Usually, the rental cost is lower in outskirt areas whereas it goes increasing inside the city. A midway balance is achieved for faster delivery time and lower rental cost.

Clearing and Forwarding (C&F) agents: Normally, C & F agents handle warehouses, manages stocks and deliveries. The cost of engaging a C&F agent has to be optimized, and also, their roles and responsibilities have to be clearly defined so that they can perform to their optimal capacity. Their tasks, targets and costs must be tracked so that the organization can come to know their value of engagement. C&F services impact sales performance as mismanagement can damage the brand as well as lose customers.

Spoke to Dealer Delivery (Another secondary leg): The function of the depot is to provide batteries on a specific distribution area. Secondary freight occurs for dispatching batteries from spokes to dealers or distributors. To provide 24 hours of services to dealers, vehicles (various capacity) to be kept available at each depot. These vehicles can do the milk run on fixed routes every day to satisfy the dealer's demand. This operation has challenges such as route may not have full load demand and several times under load vehicles run to deliver batteries within 24 Hours. Also, the same vehicles are used to collect free replacement batteries where replacement is assured immediately. Scrap collection also happens in the same vehicles are many places resulting in complex vehicle management.

Reverse logistics

The collection of replaced battery is a challenge for the battery manufacturing firms in India. This is a critical aspect that is directly related to brand value. Such replacement needs to go fast without generating dissatisfaction with end-users. *Pradhan et al., 2019 described*, the distribution network thus needs to (a) detect warranty demand, (b) allocate from the nearest depot (c) physically deliver battery using a fixed vehicle. This also has a cost impact since the vehicle must go with a warranty battery even if they're less than a full vehicle load on that particular route that day.

Collection of scrap battery is mandatory according to Govt rules and handover to licensed recyclers or self-collection and recycle. Usually, scrap batteries, warranty batteries and fresh stock are at the same warehouse, which is partitioned for ease of operations *(Bansia et al., 2014).*

Inventory (Slow-moving, Non-Moving, Discontinued stock etc.)

The battery has a specific shelf life once charged and kept for selling. The charge reduces over a period of time, proportionate to elapsed months. Slow-moving battery detection in the warehouse is thus critical. Batteries can be scanned with barcode while leaving from the factory, inward to a regional warehouse, outward to a regional warehouse and inward to a local depot. Any enterprise resource planning (ERP) software helps with the ageing report, which indicates batteries approaching shelf life. The first in first out (FIFO) to be followed while allocating

batteries to dispatch. Necessary actions like mapping such stock with where demand exists and cross transferring of stock are done to sell these batteries. Occasional changes in battery models and also the withdrawal of certain products generate non-moving and discontinued battery stock. Such stocks are brought back to the factory, or appropriate disposal actions are taken. Cross transfers are normally seen as wastage since the cost incurred is double. The stock needs to move from one depot to another instead of the usual process flow of where material moves from factory-regional, warehouse-depot. Cross transfers are a result of inaccurate demand. It is sometimes necessary to salvage slow-moving stock. Sometimes this is a result of rush demand at a location and excess stock of the same products in nearby another depot.

Location of Charging

Battery charging is a subprocess of manufacturing where dilute sulphuric acid is used to charge batteries and as media. It has the following aspects:

a. Storage and dilution of concentrated acid.
b. Lead time for charging
c. Power consumption and cost

Inside charging has advantages such as better control over the charging process, better control on cost and wastages also better control on the lead time of making batteries ready that requires space and manpower for a relatively less critical operation to sometimes preferred to be outsourced. The concept of near to market charging is to make batteries available just before demand hits. There is a limitation on how long a battery can be stored in a charged condition beyond which charge starts going down with each passing month. This becomes a limitation when the stock building is done anticipating the seasonal demand. Also, dry batteries can be converted to a specific battery brand if charging is done to a nearby market where similar dry batteries are used as a base to create new products with only label difference. This offers flexibility to supply, and dry battery transport is relatively less complicated *(Goyal et al., 2018).*

Raw Materials:

The grid structure of the lead-acid battery is made from a lead alloy. Pure lead is too soft and would not support itself, so small quantities of other metals are added to get the mechanical strength and improve electrical properties. The most common additives are antimony, calcium, tin and selenium. The battery is a major application where lead metal is used globally, usually with very low impurities.

There are two streams from where lead metal is made available for the battery industry globally:

a. Prime lead producers who make it directly from Ore. Lead commonly occurs in mineral deposits along with other base metals, such as copper and zinc.
b. Re-melted lead from battery scrap, which is refined for purity and addition of alloys for properties

The sources and supply chains are very different: Primary producers are big manufacturers listed on London Metal Exchange (LME), where lead is traded based on the LME index and premium over it. The only big producer in India is Hindustan Zinc Limited (HZL).

Recycled lead is usually traded based on local market battery scrap availability, and prices are determined with smelting cost plus profit which variates as per demand and supply. Both types are used to make different parts in the battery to optimize cost based on prices. Sulphuric acid is manufactured by chemical plants and requires safety tankers to supply since battery application cannot tolerate iron content is acid above ten ppm. The cost has a major component of transport cost. Sulphuric acid is based on sulphur prices which is basic and major raw material to make acid. This acid has very wide applications; almost all chemical industry uses sulphuric acid in reactions. The demand supply constantly varies, and battery producers tend to make contracts with acid suppliers to ensure availability in all conditions.

Polypropylene Copolymer (PPCP**)** is a major raw material that is sourced and then converted to make battery casing and top with several other small parts. Quality of PPCP is critical to hold battery parts and acid together without leakages and busting. This is a widely produced chemical in bulk production in chemical plants across India and overseas since the application of PPCP is not limited to battery casing but also other packaging items such as paint containers and domestic furniture. The PPCP is contracted by battery makers on pricing formula and supplied to moulders who in turn make battery casings, lids and other components. The relevant moulds are also controlled by the battery industry to monitor cost as well as quality.

Green Supply Chain

Transporting on-road adds pollution, so each manufacturer tries to develop the sourcing network nearest to the factory. This also benefits in the reduction of lead time and inventory. Particularly for lids and containers, the closest distance from the factory is preferred during the selection of a vendor. Other initiatives such as returnable and reusable packing are applied to have sustainable procurement practise. *Arya & Jain (2018)* opined that the plastics used in packing is eliminated, and wherever it cannot be, same is collected back for recycling, usually thru Govt approved recyclers. *Ashraf (2019)* presented in a conference that wind power, solar power are added to various locations to reduce direct grid power demand and consumption. Excess power is generated in giving back to the grid. Safe transport practices are applied during the transportation of critical items such as sulphuric acid. The transporters eligibility, transport emergency card, licenses and valid documents are checked prior to hiring vehicles. Before entering in the factory, the documents to be checked, including pollution certificates *(Balasubhramanian & Shukla, 2017; Balakrishnan & Suresh, 2018).*

Information Flow

The information flow encompasses various entities working together, eliminating a whole lot of existing barriers to coordinate and manage the flow of goods, raw materials finished goods, starting from the end of supplier and manufacturer, distributor, retailer and finally to the consumer. Information flows from supplier to consumer via manufacturer, distributor and retailer. Also, information flows from Consumers to suppliers through retailers, distributors, and manufacturers. The information flow starts from procurement by manufacturers from suppliers in a defined quantity, pricing, quality, and assortment in a defined and agreed time duration. All these activities are information-centric and generate quite a vast amount of data that is captured for effectively deploying in decision support systems (DSS) for MIS reports and developing predictive models for analytics reports *(Pinto et al., 2020)*. The manufacturer develops the finished goods and transports them to distributors and retailers. In this process lot of data with regards to logistics, payments, delivery, timeline demand and fulfilment are generated, which are captured at distribution or retailing points using accounting packages, dealer management systems, salesforce applications etc. The consumer data is captured in customer relationship management (CRM) systems and again travel through retailers and distributors to reach manufacturers who analyse the complex data for production planning demand generation, customer service, operational forecasting and human resource deployment. In all the facets of information flow, effective IT systems are employed to capture operational data at all points. The more data is captured, the more agile the entire system becomes, which finally helps the organisation to become a smart enterprise *(Salo & Karjaluoto, 2006; Song et al., 2018; Marron et al., 2019).*

V. Conclusion, Limitations and Further scopes:

This research uses data from various published and readily available sources as well as commercial data and successfully achieved the research objectives. The current paper is based on data collected from an extensive literature review and face to face interview with the leading battery manufacturing firms in India. So, findings may not be generalized and applicable to other industries. Battery manufacturing firms of India may use this concept to benchmark their performance in terms of better customer experience as well as the performance of supply chain management which are essentials to sustain in the current competitive markets. Still, there are wide scopes for developing mathematical models using NLP and dynamic programming models to analyze and measure the performance of these KPIs mentioned in this research paper. As a summary, the above analysis provides guidelines to the battery industry to develop strategic decision-making frameworks in the area of the supply chain.

It is expected that further empirical research initiatives would be undertaken between India and other developed and developing countries with respect to SCM, especially from the point of view of regulatory and cultural differences to establish a generalized model or framework to derive better business value from global supply chains.

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