A SCOR Reference Model of the Supply Chain Management System in an Enterprise

Danish Irfan[1, 2], Xu Xiaofei[1], and Deng Sheng Chun[1]
[1]School of Computer Science and Engineering, Harbin Institute of Technology, China
[2]Department of Computer Science, COMSATS Institute of Information Technology, Pakistan

Abstract: *State-of-the-art supply chain management systems can be obtained from the supply chain operations reference-model for business applications, advancement and practices. Problematic management processes in standard process reference model form improves competitive advantage, communication, dimensions, management, control and alter to a specific purpose among the supply chain management processes. This helps organizations capture the "as-is" state of a process with the objective of achieving the desired "to-be" future state. This paper presents supply chain management efforts, key challenges and opportunities in pakistan's industrial and organizational most successful sector and span of business 'from seed to smoke' by deploying the eminent supply chain operations reference-model.*

Keywords: *Supply chain management, supply chain operations reference-model, supply chain.*

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1. Introduction

Supply Chain Management (SCM) has become a significant focus of competitive advantage for firms and organizations over the past decade. The ability to cope and automate the flow of item data between SCM quickly and reliably could spell the difference between success and failure. Businesses are increasingly facing global competition, which forces companies to improve their efficiency. SCM concepts in a set of linear, individualized and linked processes in the form of a human/ paper chain have been used since the middle of the last century. The primary objectives of SCM are to reduce supply costs, improve product margins, increase manufacturing throughput, and improve Return On Investment (ROI) [8].

Around the 1990's leading companies started to look beyond the boundaries of their own company for areas where they could improve. The current phase is the Integrated Supply Chain Management (ISCM) phase. Supply Chain (SC) can be conceptualized as integral (vertical) or modular (horizontal), which allows fragmented ownership and cultural diversity. SCM is about breaking down walls between companies which traditionally looked at SCM only as a way to cut costs; however, lower costs are just one area in which SC should be competitive. Each enterprise will be different in complexity of chain due to its size and dimensions. No matter how complex the enterprise is, it must operate in an integrated manner.

Each function in SCM has its own objectives, so they strive to achieve their goals without considering the effect they will have on the other functions and lack an integrated plan for the enterprise [3]. SC can be characterized as selective, adaptive, effective and integrated. Selective SC sets up 'pricing versus product'; adaptive SC positions 'operational configurations'; effective SC causes exponential growth; and integrated SC relates closer to geographical, organizational, cultural and electronic proximity. SC decisions can be classified into three levels: (1) strategic level: having a long-lasting effect e.g., (numbers, capacities and flow of materials). (2) Tactical level: updated anywhere within a year e.g., (production and purchasing), (3) operational: day to day decisions e.g., (scheduling, routing, loading etc.) [10].

The SC modeling approach can be separated into three areas: (1) simulation based: a method by which a comprehensive SC model can be analyzed, considering both strategic and operational elements. (2) Network design modeling: a normative model for the more strategic decisions. It focuses on design, establishment and associated flows of networks. (3) Rough cut: policy modeling to guide operational decisions.

For applying proper SCM, one must always think in terms of SCM. It provides opportunities for growth because it promotes flexibility and responsiveness, effectiveness through collaboration, understanding and visibility, increasingly global, agile and dynamic business operations, certainty and competitive advantage. SCM matures companies that find themselves in stable and relatively predictable environments and have clearly defined organizational structures and internal processes.

Mathematically, the linear total cost function of SCM can be described as:

$$S = c_{ij}\, x_{ij} + c_{kl}\, x_{kl} + c_{mn}\, x_{mn} + c_{opq}\, x_{opq} \quad (1)$$

c*ij* is cost of raw material *i* at vendor *j*.
x*ij* is amount of raw material *i* purchased from vendor *j*
c*kl* is cost of holding material *k* at inventory l.
x*kl* is amount of material *k* retained at inventory l.
c*mn* is cost of manufacturing product *m* at plant *n*.
x*mn* is amount of manufacturing product *m* at plant *n*.
c*opq* is cost of transportation material *o* between node *p* and *q*.
x*opq* is amount of material *o* transported between node *p* and *q*.

The next section gives the related work about SCM illuminating its definitions, improvements and vision. Section 3 provides a brief introduction of the company and the aspects of SCOR model when applied on a company. SCOR disconnects are given in section 4, and section 5 ends with the conclusions.

2. Related Work

In this section we initiate with the following definitions of SCM:

- Achieving a sustainable competitive position and maximizing shareholder value by optimizing the relationship of process, information, and physical goods among internal and external trading partners.
- Inter-organizational management of goods flows between independent organizations in supply chains, such as raw material, component manufacturers, finished product manufacturers, wholesalers and retailers.
- Speed-to-market items, agility, flexibility to respond more quickly to actual customer demand, while keeping cost at a minimum and focused (speed, agility, rapid growth, deep skills, etc.).
- Proactive act of improving the efficiency and effectiveness of supply chains. A good short-hand description of food supply chains would be the 'plough to plate' analogy or 'cow to cornflakes' for milk.
- Mechanism for integrating every function in an organization so that they work at the same pace.
- Logical progression of developments in logistics management with physical and logistics phases.

To improve inventory management, [6] proposed a form to take SC inventory problems and opportunities. [2] described goals and architecture of Integrated SCM system (ISCM) that can be managed by a set of intelligent agents responsible for planning and execution. [12] reviewed SC general ideas to keep all units synchronized and solve entire business problems by maneuvering through upstream and downstream information. Successful components included well-defined decision making, removal of functional barriers, early visibility to change in demand throughout SCM and sets of plans that drive SC operations and integration.

The challenge of managing the SC will focus on understanding modern explosive expansion beyond its traditional role. Logistics must tackle Points Of Stock (POS), reduce inventory, and rationalize delivery based on customer-demand. The core principle behind SCM is the reduction of uncertainty in the decision-making processes of organizations in supply chains. The coordination of the management processes in a SC requires information exchange between the organizations in the SC. The extra availability of information in decision-making units reduces uncertainty, resulting in better control and finally, in improved performance.

The vision of [5] of SC's future is a forum for continuous real-time interaction between companies, as well as between suppliers and their customers. It will integrate key business processes from end-user through original supplier. SC reliability is the result of this survey and there are both tangible and intangible results for this SCM. SCM is being successfully used by world class firms like Wal-Mart, Procter and Gamble, Cisco and HP.

SC leaders are intent on time compression work with their chains on three fronts: first, they work to provide each company in the chain with better and more timely information about orders, new products and special needs; second, they help members of the chain, including themselves , to shorten work cycles by removing the obstacles to compression that one company often unwittingly imposes on another; third, they synchronize lead times and capacities between the levels or among tiers of the SC so that more work can flow in a coordinated fashion up and down the chain. Each of the three fronts is demanding, and it takes a big effort to get the various companies in the chain cooperating in all these areas [4, 8, 9].

3. Enterprise's Profile

Pakistan Tobacco Company (PTC) Ltd, pakistan was incorporated in 1947 immediately after partition of the subcontinent. It is part of the trans-national British American Tobacco (BAT) group, which employs some 90,000 people worldwide at its operations in 180 countries. It is the market leader in more than 50 countries selling over 300 brands, committed to providing consumers with pleasure through excellent products. PTC was the first multinational and largest excise tax generator in the private sector in the country, and has come a long way since its start. Because PTC was able to span their business 'from seed to smoke' they are considered to be the most successful SCM adopter in pakistan [13].

The PTC's SC team focuses on continuous improvement of planning processes and supply and operations (S and OP) of supplies and products. It

comprises procurement, movement and manufacturing of materials, including raw materials for manufacturing that originate from pakistani or overseas locations. Then these manufacturers further distribute finished goods throughout pakistan to retailers, and eventually, on to consumers.

3.1. PTC Supplier's Care

PTC nurturers are among the most evolved in the country, benefiting from SCM's constant support and guidance. PTC's product, once made entirely by hand, is today almost fully automated. It's cultivators of raw material include farming processes and curing and leaf processing concludes the supplier activity.

The raw tobacco PTC buys for two months is a huge quantity in terms of volume, at 30 million kilograms. The storage space required is 6000 truckloads of tobacco, from 13 buyer centers, worth Rs/- 2 billion (US $50 million). PTC processors must maintain proper moisture, packing, and temperature. The buyers are agriculture experts with agricultural activities and experience.

PTC's farmers are considered to be the most significant stakeholders. As part of an economy highly dependant on its agriculture sector, PTC takes great pride in improving the conditions of trade for the farmers by launching an entirely integrated, electronic system of leaf purchasing called BAT leaf. This system allows for efficient purchase during the buying season resulting in prompt compensation for farmers. BAT can help the farmer by providing seeds and fertilizer and by giving counsel on planting, growing, harvesting and curing tobacco and other crops.

Curing is a carefully controlled process used to achieve the texture, color and overall quality of a specific tobacco type. The cured leaf is then processed through a green leaf threshing plant. Processing is to remove sand, dust, scraps and foreign matter; separate the lamina from the stem (threshing); drive down the tobacco to a safe 'keeping moisture' content. Processed tobacco is then packed into 200kg cardboard boxes for shipping to manufacturing sites. At the factory (Jhelum and Akora Khattak) maintaining roadway, the matured leaves are checked for quality and then carefully blended with other ingredients such as flavorings for pre-processing. Moisture content is the crucial element of packing machines which put the blends into the familiar brand packs, wrap the packs in protective film, and group them into cartons and cases. Further testing takes place at each stage to make sure the cigarettes are properly protected.

Pakistan tobacco company's supply chain function can be further defined as:

- The execution of the internal and external processes for the coordination of planning, supply, distribution and security of PTC's materials and products.
- From the supplier of raw materials, through the manufacturing facility to the consumer.
- With the intention of ensuring availability of our product to the consumer at all times.
- At optimal quality, while maximizing efficiency and cost effectiveness for all parties involved while ensuring that the product reaches the consumer in the best possible condition.

3.2. PTC Standardization-SCOR Model

The Supply Chain Operations Reference-model (SCOR) has been developed for applying and advancing state-of-the-art supply chain management systems and practices through its structured framework and approach. It provides us a comprehensive methodology to improve our overall supply chain operations. SCOR, a flexible framework and a common language that can help companies improve their SC internally and externally, were developed by real-world supply chain experiences. SCOR evaluates the objective, effectiveness of reengineering, performance, quantification, testing and future planning as well as specific process operations in SC. It is not possible to have a perfect SCM model but a closely adapted model is being applied at PTC, which is a first in the history of SCOR at the factory level.

Complex management processes can be transformed in standard process reference model form to achieve competitive advantage, communication, measurement, management, control systems and alterations for a specific purpose. Since SCM systems can be represented in the form of a model which represents the real world situation. It is necessary to study modeling approaches for the integration of each function through SCM concepts.

SCOR and SC's intangible benefits include mature improvement, collaboration and team work as well as internal and external processes fully shared with issues and expertise. It also provides a communication platform, standardization and ERP migration to the new SAP. SC projects are complex and face problems addressing broad SC processes while defining the complete set of required SC IT systems' functionality and evaluating the myriad of vendors. Local legislation and revenue targets for the government authorities pose another challenge to the SC simplification. Any consolidation may lead to double taxation and hence extra cost to the organization. Best practice employed: Corporate and Regulatory Affairs (CORA) department involvement in the team helped evaluate the impacts of taxation on company performance.

3.3. SCOR Model Levels

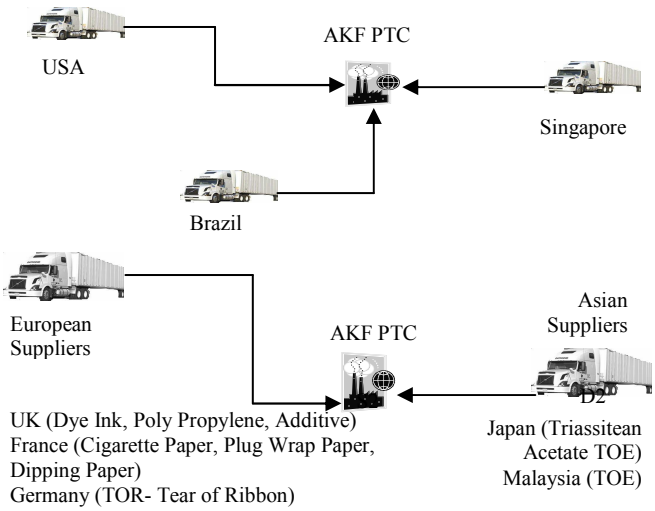
Now we state the Supply Chain Operations Reference-model (SCOR) [11] that has been implemented for the

state-of-the-art SCM systems and the structured framework of PTC.

SCOR contains four levels. Level 1 defines the scope and content for the SCOR reference model. Here, the basis of competing performance targets is configuration level. A company's SC can be "configured-to-order" at level 2 from approximately 30 core "process categories". Companies implement their operations strategy through their unique SC configuration. Level 3 defines a company's ability to compete successfully in its chosen markets and consists of process element definitions, information inputs and outputs, metrics and best practices. Companies "fine tune" their operations strategy and implement specific SCM at this level. Level 4 defines practices to achieve competitive advantage and to adapt to a changing business. Figure 4 shows SCOR model from a top down view, i.e., the macro level triangle shows the PTC organization with its small triangles including suppliers, supply chain, manufacturing, engineering department, finished goods and the interaction with the customer. The SC concludes in leaf logistics and Wrapping Materials (WMs) and Billing Materials (BMs). Leaf logistics is further classified into green and processed (internal and external) leaf. The manufacturing department contains a Primary Manufacturing Department (PMD) and a Secondary Manufacturing Department (SMD). PMD maintains an Leaf Reception Room (LRR), PMD main, winnowing that adds back facility for product, rip and Cut Tobacco (CT) store for storage. The PMD main looks after the casing kitchen, lamina, stem and FP silo of the tobacco plant.

a. Level 1: SCOR provides a definition of the plan, source, make, and deliver process types. This is the point where a company establishes its SC competitive objectives. The basic structure of the reference-model focuses on the four key SC processes: plan, source, make, and deliver.
   We will study it step-by-step as it is applied in PTC:
   - Mapping all current processes in SCM and then finding some opportunity/ improvement which you want to raise. E.g., reduce cycle time, reduce inventory, and relocate warehouses. These are the results which come after studying these processes.
   - Map current processes for managers across all areas including planning making, moving and selling etc. We will identify some areas of opportunities/ improvements in these processes. Then go for "to be" part of the process which is to be improved. It provides a solid background and foundation. We start with geographical locations.

b. Level 2: SCOR defines process categories that are potential components of a SC. Organizations can configure their ideal or actual operations using these processes. Figure 1(a) shows the international tobacco supplier from all over the world to supply to PTC including DAC material from USA, FCV BARLEY from Brazil and HYGROMETER from Bangladesh suppliers. The most appropriate Level 2 execution process categories are described along with their activities associated codes which are used in Table 1.



(a) International tobacco supplier.
(b) International WM-wrapping material supplier.

Figure 1. International supplier.

Table 1. Activities associated codes.

Source		Make		Deliver	
S1	Source to Stock	M1	Make to stock	D1	Deliver to stock
S2	Make-to-Order	M2	Make to order	D2	Deliver to order
S3	Engineer to Order	M3	Engineer to order	D3	Deliver to engineer
				D4	Deliver Retail Product

Figure 1(b) gives an International WM Supplier D2 from asia and europe to PTC S2. Supplier D2 supplies only when it is "make to order", as they don't stock the product. In our case, factory PTC S2, i.e., make to order (opening an LC, contracting manufacturers or suppliers).

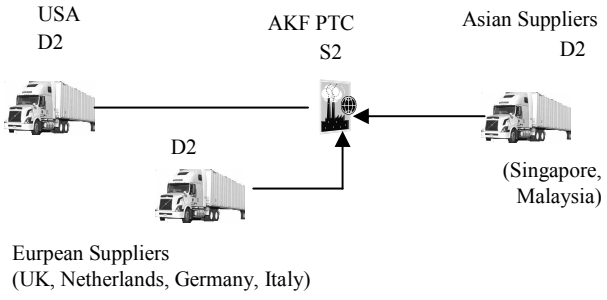


Figure 2. International competitive supplier.

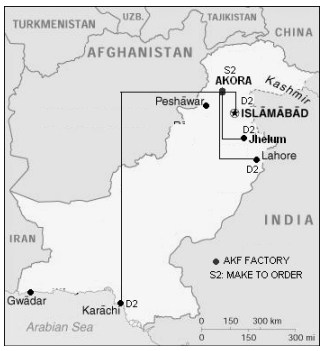


Figure 3. Local material supply chain.

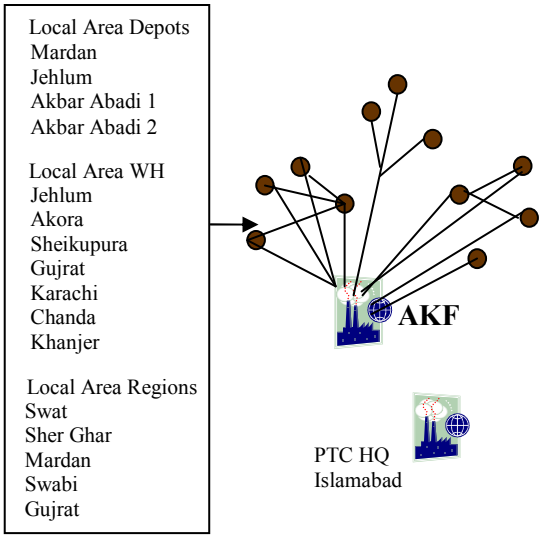


Figure 4. Green leaf movement (depot-to-depot).

Figure 2 shows the international competitive suppliers from all over the world. Local material SC from different cities of pakistan is shown in Figure 3, while Figure 4 shows the green leaf movement depot-to-depot. RONA (Return On Net Assets) tells about health of a company. It should be 30% of an organization to survive. Due to the RONA factor, the green leaf movements are made from depot to depot, and sometimes the storages are made at much further distances from the PTC HeadQuarter (HQ). In the PTC WareHouse (WH) at Jehlum, storage is handled by a third party; hence RONA is maintained and doesn't increase net capital.

Figure 5 shows the SC flow synchronization adopted by SCOR model version 7.0, in order to improve and enhance PTC SCM system. SCOR is structured around five distinct management processes including plan, source, deliver, make and return. Analysis of physical, information and financial SCM is described with the total lead time taken by local and imported wrapping material suppliers. It takes about 65 days to complete its lead times in the case of physical SCM. Since information is communicated via the internet, it may be referred to as integrated SCM because it takes about four days including the physical lead time from the AKF factory. Financial SCM ends in 29 days for local and about twice that time for imported WM suppliers.

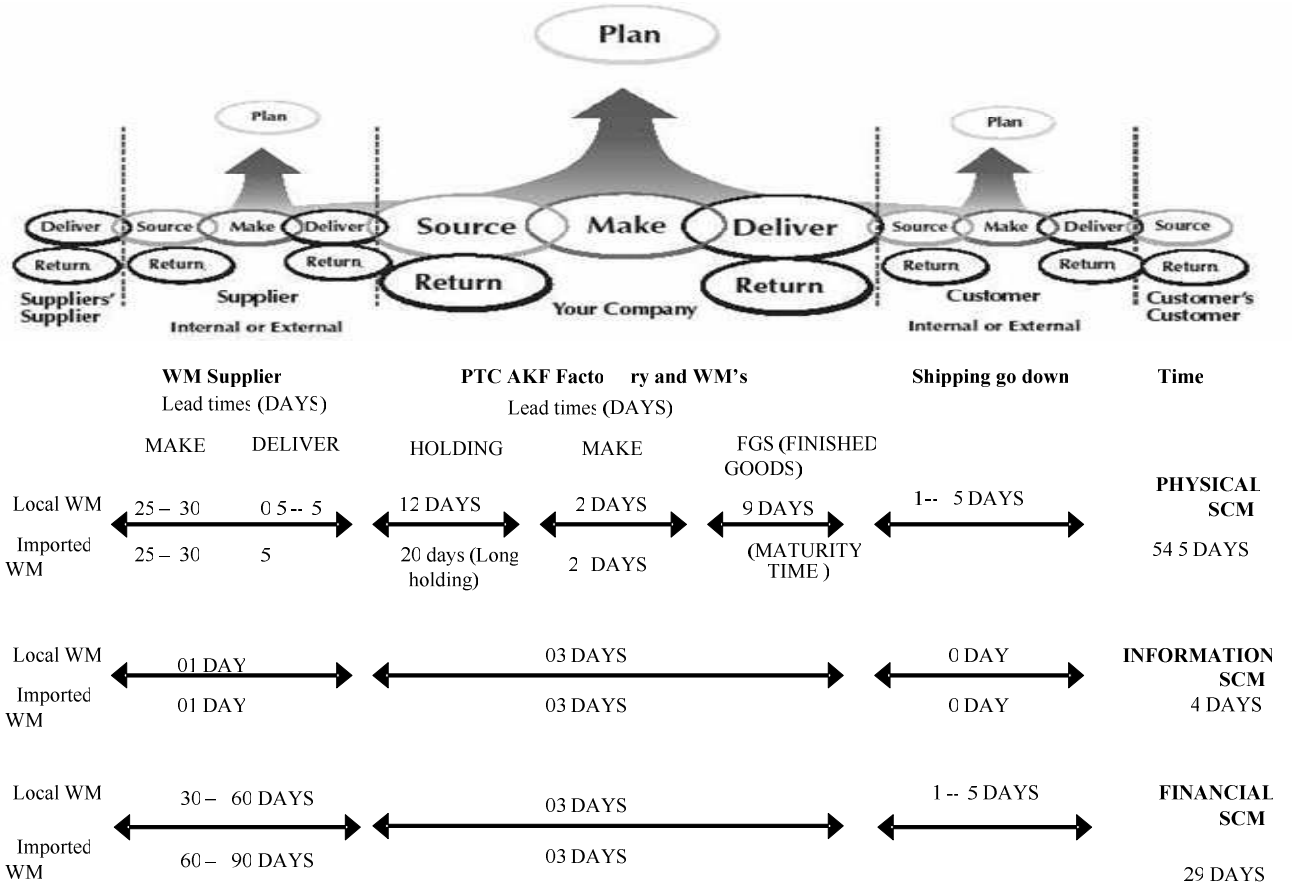


Figure 5. Supply chain flow synchronization adopted by SCOR model version 7.0.

PTC's competitive requirement summary of the planning process is given in Table 2.

Table 2. Competitive requirement summary.

	SX 10's	SX 20'S	CH 20'S	WI 10'S	WI 20'S	AY	CL
Reliability	S	S	P	A	P	P	P
Flexibility	S	S	P	p	P	p	P
Responsiveness	A	A	P	P	A	A	P
Cost	P	A	P	P	P	P	S
Assets	S	S	A	S	P	P	A

S-superior, A- Advantage, P-parity. The financial flow of PTC is shown in Figure 6.

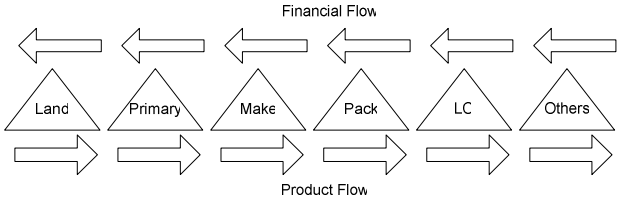


Figure 6. Financial flow of PTC.

c. Level 3: This level provides the information required for successfully planning and setting goals for SC improvements. This includes defining process elements, setting target benchmarks, defining the best practices, and improving system software capabilities to enable best practices.

We refer to Table 3 which gives the level 3 processes details of PTC.

Table 3. Competitive requirement summary.

Work Streams	No of Level 3 Processes Identified
SC	
- Leaf logistics	133
- WM and BMs	48
- Shipping and goods	6
Manufacturing	
- SMD	194
- PMD	151
Engineering	
- Staff	194
TOTAL	736

d. Level 4: It focuses on implementation, i.e., putting specific SC improvements into action. It says about planning "as is" i.e., current. In the PTC IT system storage is the main focus for implementation. i.e., it shows very low use of SAP in PTC.

Even though PTC is mature, SC is still able to enhance the company. There is no use of SCADA PI and T in PMD as analyzing application. Low use of win-1 in SMD is present in PTC. Through, this could improve the IT system using SCM. So, SCM is to be improved in PTC and must be mapped first to enhance speed and lead time.

4. SCOR Disconnects for PTC

SCOR is a scalable model is fully operational when higher levels of details are present. Still, standardization (opportunity/ disconnect) is one of the major concerns of SCM which lies in the above mentioned model. Observed disconnects and opportunities which PTC needs to address are:

- Upstream movement of the supplies should be taken care of. About 30 truck/ transportation companies are currently working with PTC. It needs to create a system for the transporters.
- FIFO, traceability system must be present/ checked.
- When in transit, it doesn't have traceability, as PTC's truck/ transportation service is out, so it needs Radio Frequency IDentification (RFID), also called Dedicated Short Range Communication (DSRC), an emerging technology that has found its applications in almost all fields of today's competitive environment [1]. It is a wireless form of automated identification technology that allows for non-contact reading of data, which makes it effective for manufacturing and other hostile environments where bar code labels may not perform well. RFID tags have the potential to streamline and improve inventory management by allowing manufacturers to more efficiently enter and track the flow of goods. Though, the RFID systems are now being manufactured by vendors around the globe, an integral gap still remains between the RFID and the internal system of an organization:
- For tracing items, PTC currently has a Seat Tracking System (STS) for Finished Goods (FG).
- It has storage in a big WH near the AKF factory. It needs to minimize the IT overhead cost through larger WH.
- Transportation, lead times, degradation of items, additional labor cost and security at every label has a cost. Unfriendly regime statute primarily acknowledges the limitation/ offsets of SCM in PTC, since it is an old company.

5. Conclusions

In our current study, state-of-the-art SCOR model implementation on one of pakistan's best SCM recognized organization, PTC, is being made. Admirable SCM systems can be obtained from SCOR for business applications, advancement and practices. The SCOR model enables companies to communicate, compare and learn from competitors and companies both within and outside of their industry. It not only measures SCM but also the effectiveness of SC reengineering. We conclude further work and directions in ability to test and plan future process improvements in SCM.

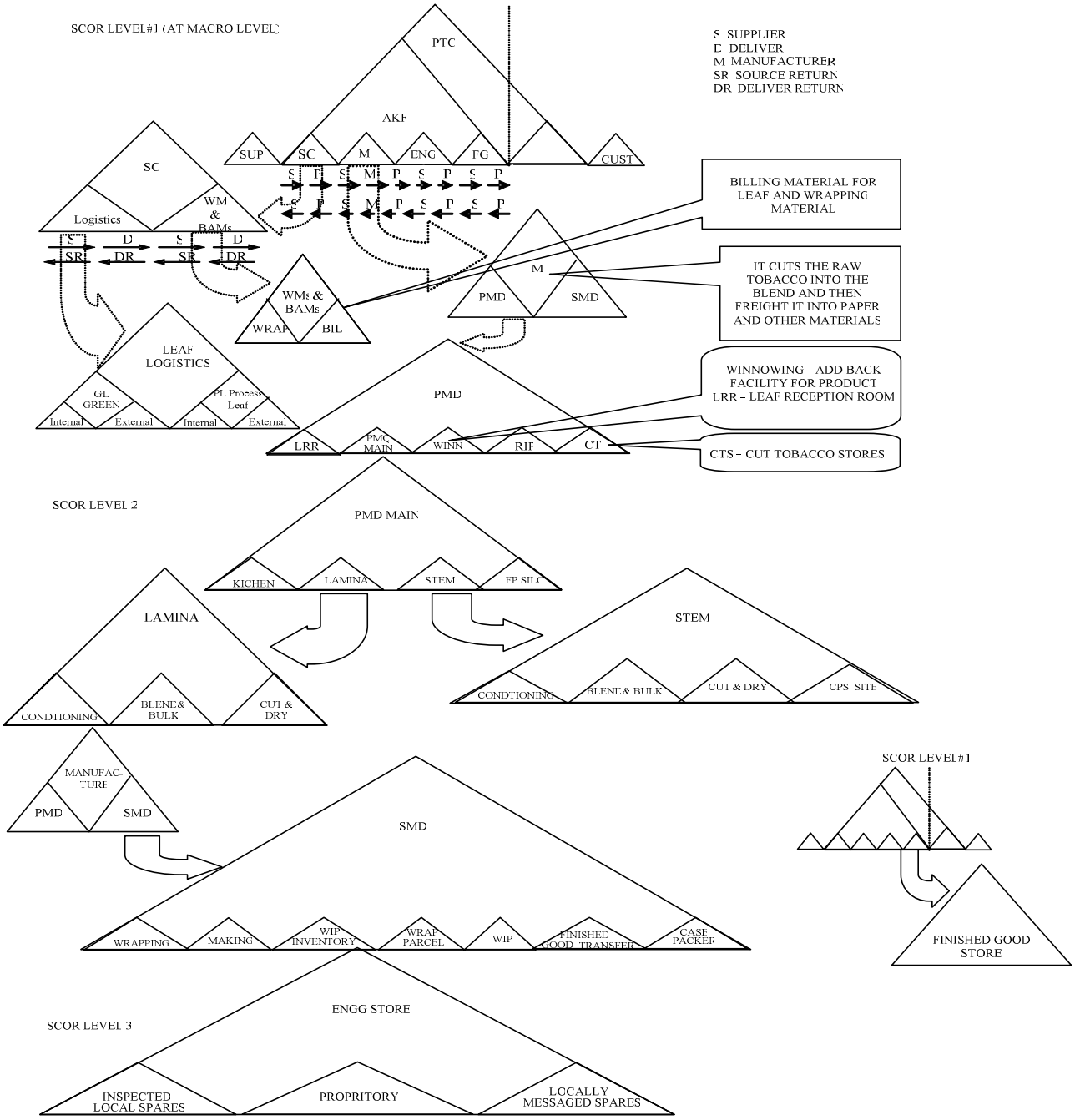


Figure 7. SCOR level description, SCOR model version 7.0.

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Danish Irfan is a PhD scholar in School of Computer Science and Engineering at Harbin Institute of Technology, Harbin, China PRC. His research interests include data clustering applications, business intelligence, and SCM.

Xu Xiaofei is a professor and dean of School of Computer Science and Engineering at Harbin Institute of Technology, Harbin, China PRC. His research interests include computer integrated manufacturing system, database systems, supply chain management, agile virtual enterprises, management and decision information system, and knowledge engineering. He has published more than 200 academic papers. He is the standing member of the Council of China Computer Federation, member of the Expert Group for Discipline of Computer Science and Technology in the Academic Degree Committee of China State Council.

Deng Sheng Chun is an associate professor in School of Computer Science and Engineering at Harbin Institute of Technology, Harbin, China PRC. His research interests include computer integrated manufacturing system, supply chain management, business intelligence, and data mining applications.