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An Empirical Study of Knowledge Management for Downstream Supply Chain Management of Indian Public Sector Oil Companies

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ABSTRACT
Supply chain management is a complex process involving many processes in oil industry. Managing these processes is a challenging task in itself. Our focus is on BPCL, its processes and stakeholders throughout India especially the customers and retailers. Our study will find whether Knowledge Management is helpful for BPCL for improving its processes, better decision making and formulating a short and long-term strategy for business.

General Terms
Software Engineering, Downstream SCM

Keywords
Knowledge Management (KM), Supply Chain Management (SCM)

1. INTRODUCTION
Knowledge Management has its roots in organizational learning and innovation. Successful managers have used intellectual assets and recognized their value. Forrester Research, IBM and Merill Lynch studies provide an estimate that 85 percent of a company's knowledge assets are scattered across the organization in the form of e-mail, Word documents, spreadsheets and presentations on individual computers.

Organizations have newly initiated the application of IT tools to facilitate the knowledge inside the organization. Knowledge management (KM**)** is a process that helps organizations identify, select, organize, disseminate, and transfer important information and expertise that are part of the organization's library where they are stored for recall.

2. SUPPLY CHAIN MANAGEMENT (SCM)
Supply chain management (SCM) is defined by the Global Supply Chain Forum (GSCF) as "the integration of key business processes from end users through original suppliers that provide products, services and information which add value to customers and other stakeholders" [1].

Supply Chain Management uses various business processes and companies which are of relevance to service customers: order fulfillment, customer service management and product development [2].

Supply Chain collaboration starts due to the low mutual trust between the partners. Later this may gradually increase and lead to a complicated and profound collaboration mechanism [3].

Collaboration in a Supply Chain has one common goal: to create a transparent and visible demand pattern that paces the entire supply chain [4]. Holweg et al. [4] says, to achieve more transparent information in order to reduce uncertainty in the environment, which is another of the goals of the collaborative processes in the Supply Chain.

Two main aspects are commonly considered in the study of the collaboration relationship in the Supply Chain: the first deals with the intensity of the relationships between partners whose considerations vary from simple information sharing to risk and profits information sharing; the second studies the extent of the collaboration across the Supply Chain[5].

Drawbacks of the Supply chain are as follows:

- **Trust and collaboration**: Trust involves a process where a company estimates the costs and rewards of either cheating or keeping the trust.
- **Global issues**: Global issues such as political concerns, currency risk, governmental concerns, production quality and infrastructure issues.
- **Outsourcing:** It concerns basically with make- or-buy decisions.
- **Many-supplier strategy:** This tends to decrease risk and increase costs.
- **Vendor Selection:** From whom to buy goods and services. Includes vendor evaluation, vendor development and vendor negotiation.
- **Difficulty in Demand Forecasting:** Demand and supply mismatches can lead to short and long term loss in sales and market share, excess inventories or unavailability of products.
- **Cost of reverse logistics**: Reverse logistics is the process of taking back products or package materials to avoid wastage. It can be costly and can create difficulties when managing supply chain life cycle.

The solution for this problem would be to create an application that handles the Supply Chain. At one end we have Supply Chain and at the other end, we have Knowledge Database and Artificial Intelligence tools to handle the problems.

In the diagram below, the documents coming from various sources like "Excel sheets", "application programs", "word" or "pdf" documents, etc. are collected and stored into the Knowledge Database only after converting them into useful information.

This conversion is done by an expert who knows about the information collected. The application server consists of

application programs which help the expert for converting these documents into some meaningful information.

Another way of collecting information is to use a graphical user interface through which data can be put directly into the Knowledge Database, here, the expert will decide before storing the data in the Knowledge Database, which is the useful information and which is not useful information.

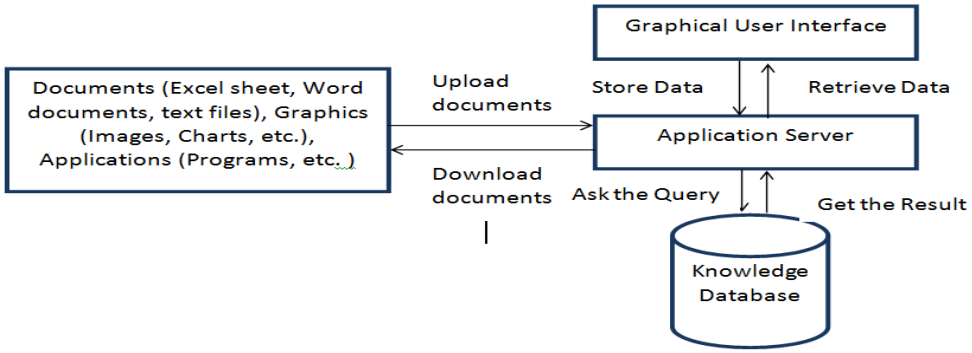


Fig. 2.1 Interaction between Knowledge Database and Transactions

If an employee retires or leaves the organization, still his knowledge and experience (transcendental knowledge) is present in the Knowledge Database in the form of information. So if another employee replaces him, he will be able to continue from where the latter had left his work.

Also the new employee will be able to grasp what the earlier employee had done in the organization just by referring to the Knowledge Base.

Similarly for a Supply Chain Management, we too can have a Knowledge Database which will store data related to the same domain together. For this to be implemented properly, we need to keep a demand-driven business model instead of a supply-driven business model which totally focuses on the requirements of the customers.[6]

3. KNOWLEDGE MANAGEMENT (KM)

Nonaka (1991) [7] establishes that knowledge can be understood as the information flow among the resources within the company. Information flow can come about from the worker's experience or be a result of the physical document generation process (which, in our case, can also be understood as knowledge), where tacit knowledge may be most important because it is one of that is most unpredictably and uneasily expressed. [8]

More often than not, these partners do not like to share their private information completely. Therefore when knowledge/information must be shared, it must be managed in such a way that it develops over a period of time [9]. So, it is necessary that managers should not only be skilled in technical and operational areas, but should also develop relationships that favor the trust required to encourage information exchange.

Collaborative architecture based on a multi-agent coordination mechanism. Then, the knowledge management process is assigned to agents who are able to retrieve information for specific applications from databases, made possible by considering mechanisms that use intelligent queries. Furthermore, these agents are also able to process the information by storing, transforming and transporting it.

Linking enterprise models, mainly those related to the enterprise environment in which the enterprise goals and strategies are considered to be the first step in the software development process, and which involve establishing a requirements elicitation, are presently becoming a very common research trend [10]

4. IDENTIFICATION OF ISSUES AND PARAMETERS [8][9]

Issue No.	Issues	Parameters	Measures
S1	Information sharing and lead time reduction	1.) Order placed, 2.) Consignment delivered	1.) TCWM (Time placed -Time received) 2.) Tcd (Time to dispatch-Time required to deliver) A.) Order placement speed: TOPR = Time Order Received at Depot-Time Order placed B.) Order placement frequency(product wise): No. of orders placed per week per product C.) Order compliance speed: TORP=Time consignment received- Time order placed TORPA=Time consignment received- Time order placed automatically (ERP) D.) Weekly non-compliance / short compliance information: 1.) NCW= Non-compliance warning (No. of days before due date) 2.) SCW= Short-compliance warning (No. of days before due date)
S2	Strategic planning: 1.) Long term, 2.) Medium term and 3.) Short term		**I. Long term: (KM level)** A. Business and Operating plan i.)Two years, ii.) One year B. Demand forecast: (Product, capacity, specific requirements, new categories, advancements) i.)Two years, ii.) One year C. Planning meetings (Frequency)

			D. Review meetings (Frequency) E. Exception Reporting: (Frequency) **II. Medium term (6 month)** A. Demand forecast: (Product, capacity, specific requirements, new categories, advancements) B. Planning meetings (Frequency) C. Review meetings (Frequency) D. Exception Reporting: (Frequency) **III. Short term: (3 months)** A. Operating status meetings (Frequency) B. Exception Handling (Frequency –product wise)
S3	Career Management	Training schedule	1. Annual training calendar Level wise and skill wise 2. Training support and skills up gradation material (Online, frequency of updates) 3. Feedback frequency and solution support (Planned and need based) 4. Reward and recognition to outstanding performers 5. Warning and punishments to defaulters
S4	Building trust	1. Knowledge shared 2.Support in distress	Knowledge shared is Low, Medium or High
S5	Time to market, Speed , response time, reliability, security	1.) Time to market (TM), 2.) Response time for a service (TR), 3.)Information Availability (IA)	1.) TM= Time taken for the product to reach from depot to retail, 2.)TR= No. of minutes taken to receive the service from the retailer by the customer, 3.)IA= (MTBF+MTTR) / Total time taken
S6	Information overload	Amount of Information shared	Information shared is Low, Medium or High
C1	Lateral co-ordination	1.) Use ERP	Use of ERP to address lateral co-ordination issue is Low, Medium or High
E1	Transfer of best practices	Knowledge shared	Knowledge shared is Low, Medium or High
E2	Capturing expertise	Knowledge captured	Knowledge captured is Low, Medium or High
E3	Train field representatives	Training modules	1. Annual training calendar Level wise and skill wise 2. Training support and skills up gradation material (Online, frequency of updates) 3. Quality of the trainers (H, M,L)
E4	Improve customer service and service quality	1.) Waitng time for service (TQ), 2.)Days taken to resolve a problem (Np)	1.) TQ=No. of minutes waiting in the queue for service 2.)Np= No. of days taken to resolve the problem faced by customer
E5	Minimize paper work and looking through thick manuals	Use of electronic medium for recording and using manuals	Electronic medium is used Not significantly, Significantly, Very Significantly
B1	KM on daily basis	Use of KM	Use of KM is Low, Medium or High
B2	Sharing experiences	Sharing of experience in working	Experience sharing is Low, Medium or High
B3	Knowledge value	Use of KM	Use of KM is Low, Medium or High
BP1	Transportation Cost	1.) Order placed, 2.) Consignment delivered	1.) TCWM (Time placed -Time received) 2.) Tcd (Time to dispatch-Time required to deliver)
BP2	Customer service	1.) Waitng time for service (TQ), 2.)Days taken to resolve a problem (Np)	1.) TQ=No. of minutes waiting in the queue for service 2.)Np= No. of days taken to resolve the problem faced by customer
BP3	Outsourcing	1.) Outsourcing factor (OF), 2.) Efficiency Improvement factor (EIF), 3.) Cost Improvement factor (CIF)	1.) Outsourcing factor (OF) = Total no. of tasks outsourced/ Total no. of tasks, 2.) Efficiency Improvement Factor (EIF) = No. of people used (earlier) / No. of people used (after outsourcing), 3.) Cost Improvement Factor (CIF)= (Total cost of all tasks-Cost of outsourced tasks + Cost of in house tasks)/Total cost of tasks
BP4	Many supplier issue	Credit Factor (CF)	Credit factor (CF) = Total amount of credit offered / Total no. of days the credit is offered
BP5	Vendor Selection	No. of years of partnership with a vendor (Ny)	No. of years of partnership with a vendor (Ny)
BP6	Cost of Reverse Logistics	1.) Reverse Logistics Cost (CRL), 2.) Idle Stock Percentage	1.) CRL = Price of each product x No. of goods returned, 2.) Idle stock percentage = (Total Stock acquired - Total stock used)/ Total stock
I1	Time taken-Transportation time	1.) Use GPS tracking devices	Use of GPS is either Low, Medium or High
I2	Demand Forecasting	1.) Monthly Product wise quantity (MPQn), 2.) Weekly Product wise quantity (WPQn)	Use is either Low, Medium or High
I3	Depot to Retail transport	1.) Use GPS tracking devices	Use is either Low, Medium or High
I4	Idle Stock	1.) Idle Stock Percentage,	Idle stock percentage = (Total Stock acquired - Total stock used)/ Total stock

I5	Global Issues	1.) Use ERP	Use of ERP to address Global issues is Low, Medium or High
H1	Inventory Holding	1.) Idle Stock Percentage,	Idle stock percentage = (Total Stock acquired - Total stock used)/ Total stock
H2	Sharing of products	1.) Reverse Logistics Cost (CRL), 2.) Idle Stock Percentage	1.) CRL = Price of each product x No. of goods returned, 2.) Idle stock percentage = (Total Stock acquired - Total stock used)/ Total stock
H3	Dynamic Pricing	1.) Use Dynamic pricing software	Use is either Low, Medium or High
H4	Trust and collaboration	1.) Use ERP	Use of ERP to address Trust and Collaboration issues is Low, Medium or High

4.1 Hypothesis Formation

Step 1: Stating the Hypothesis

Null Hypothesis (H0): "The use of Knowledge Management in operationalizing collaborative decision making in the downstream Supply Chain Management of oil companies in western region of Indian operations is not adequate"

Alternate Hypothesis (H1): "The use of Knowledge Management in operationalizing collaborative decision making in the downstream Supply Chain Management of oil companies in western region of Indian operations is adequate"

Step 2: Assumptions: The samples gathered for were uncorrelated and random.

Step 3: The testing of Hypothesis is carried out by performing the z-test. Calculate $Z_{cal.}$ Compare the values with the table values.

Step 4: Accept the null hypothesis or reject it.

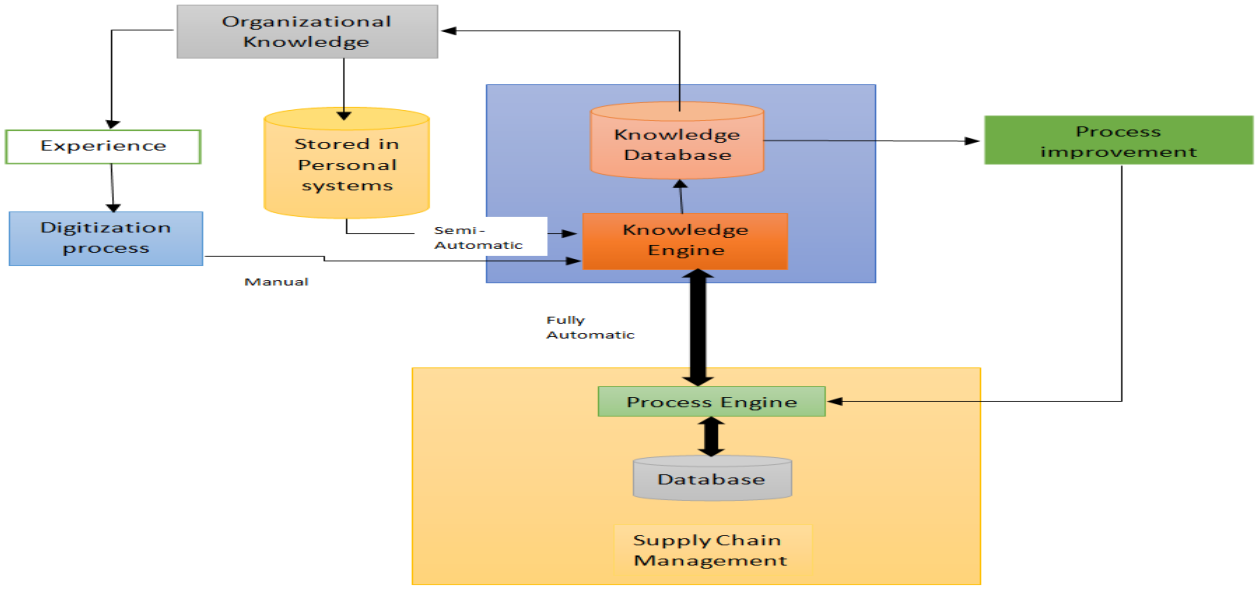


Fig 4.2 Conceptual Model formation

4.2 Model Formation

As were already know, Knowledge is basically of two types namely, tacit and explicit. Tacit knowledge is experiential and need to be converted in to a digital form before it can be actually put to use. Tacit knowledge includes, experience of a person, skills, etc. Explicit knowledge on the other hand is in the record form and can be directly recorded in digital form.

In our model presented above, the organizational knowledge again is tacit and explicit. That is the reason we need to convert the experience of a person in to a digital form by recording the experience gained by the person in audio/video format. Also we can maintain a centralized problem solution database where we can make it available to other users who are facing similar problems. This database is nothing but your knowledge database or knowledge base.

Before storing the actual information in the knowledge base, the knowledge engine will filter out all the irrelevant

information coming in from the tacit and explicit knowledge in the organization. Tacit knowledge needs to be recorded and converted in to digital form manually the process needs human intervention. On the contrary, explicit knowledge needs little or no human intervention to convert in to appropriate information.

The second part of the model includes Supply Chain Management Cycle. At one end of the SCM cycle, it is connected to a process engine. This process engine extracts information from time to time and sends it to the knowledge engine for extracting knowledge from the information provided. This in-turn is stored in the knowledge database.

The knowledge engine can be called as the "heart" of the knowledge management process. This is because it pumps in relevant knowledge into the knowledge base from time to time. The process improvement phase receives this share of relevant knowledge which in turn is passed on to the process engine of the SCM cycle.

E.g. For demand forecasting process, information about goods sold per week, per month, etc. is provided to the knowledge engine. The knowledge engine will segregate the knowledge out of the information provided, which in this case would be the trend of sales for a particular product during a certain time

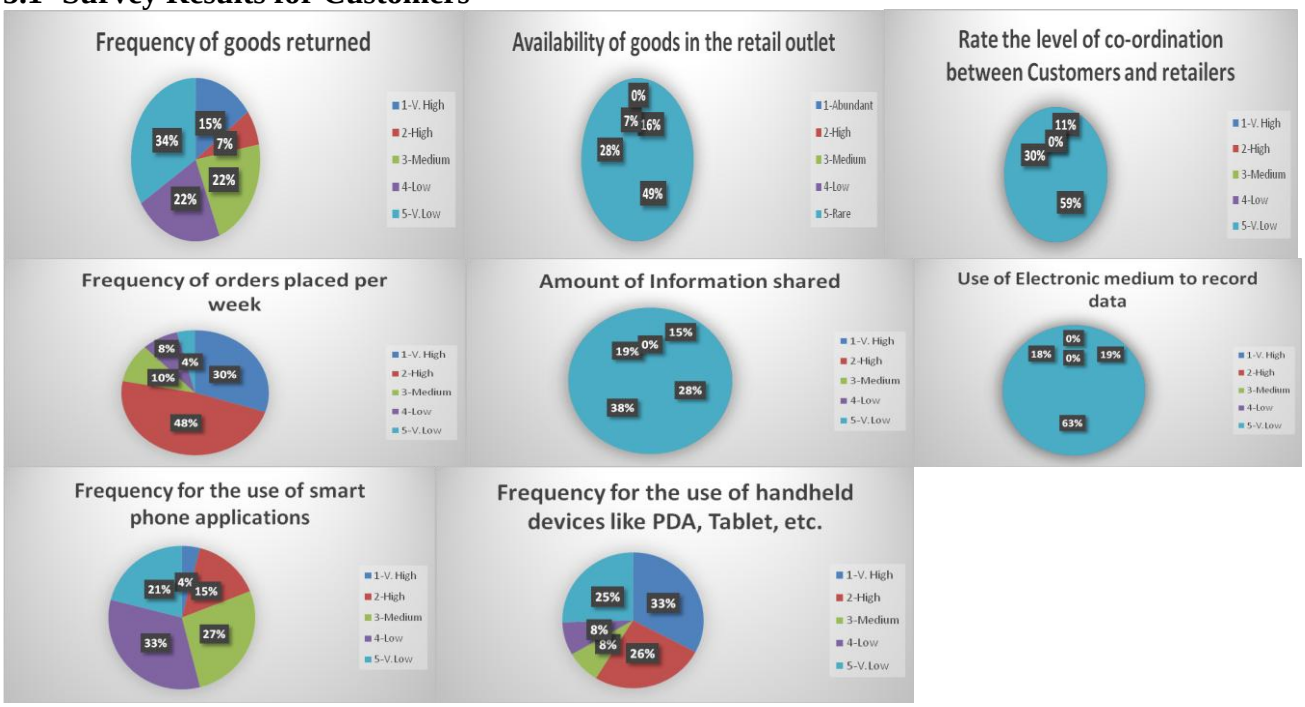
of the year. This knowledge is stored in the knowledge base where it is accessed by the process improvement phase. The improvement suggested could be increase or decrease in the quantity of the product for a particular time of the year, which is then incorporated in the SCM cycle by the process engine of the SCM process.

4.3 Zach man Framework

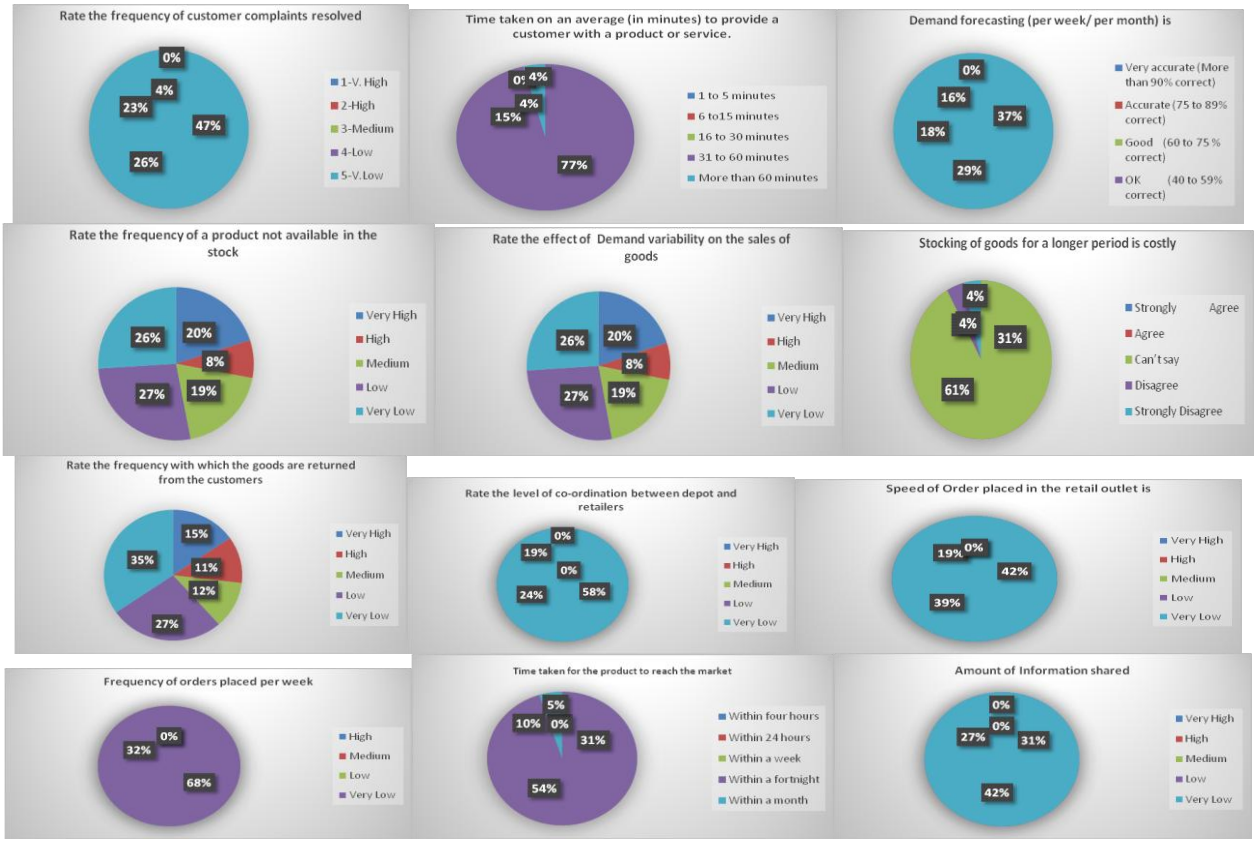
Enterprise Architecture	**Data** ***What***	**Function** ***How***	**Network** ***Where***	**People** ***Who***	**Time** ***When***	**Motivation** ***Why***
Scope (Contextual) ***Board of Directors***	**Things important to the Business. Knowledge**	**Processes Performed. High Level Business Functions.**	**Business Locations. Across the Globe**	**Major Organizations. BPCL, HPCL, IOCL.**	**Events significant to business.**	**Major Business Goals and Strategy.**
Enterprise Model (Conceptual) ***General Manager***	**Semantic Model. Business Information.**	**Business Process Model. Business Process and Resources**	**Business Logistics System. Business Location and Business Linkage**	**Work flow model. People are part of the Organization Unit.**	**Master Schedule. Events for each process and process improvements**	**Business Plan. Policies, procedure and standards for each process.**
System Model (Logical) ***Regional Manager***	**Logical Data Model. Logical data models of data and data relationships.**	**Application Architecture. Application functions and user views. Logical representation of information systems and their relationships.**	**Distributed System Architecture. Logical representation of distributed system architecture.**	**Human Interface Architecture. Logical representation of access privileges.**	**Processing Structure. Logical events and their triggered responses constrained by business events.**	**Business Role Model. Policies, stds. And procedures associated with business rule model.**
Technology Model (Physical) ***Retailer***	**Physical Data Model. DBMS type requirements constrained by logical data models.**	**System Design. Computer function. Specification of applications that operate in particular technology platforms.**	**Technology Architecture. Hardware/ Software. Specification of network devices and their relation within physical boundaries.**	**Presentation Architecture. Users. Access privileges to specific platforms and technologies.**	**Control Structure. Specification of triggers to respond to system events on specific platforms and technologies.**	**Rule Design. Business rules constrained by information systems stds.**
Detailed Representations (Out of Context) ***Customers***	**Data definitions constrained by physical data models**	**Programs coded to operate on specific technology platforms.**	**Network devices configured to conform to node specifications.**	**Access privileges to control access to specific platforms and technologies**	**Timing definitions to sequence activities on specific platforms and technologies.**	**Business rules constrained by specific technology stds.**

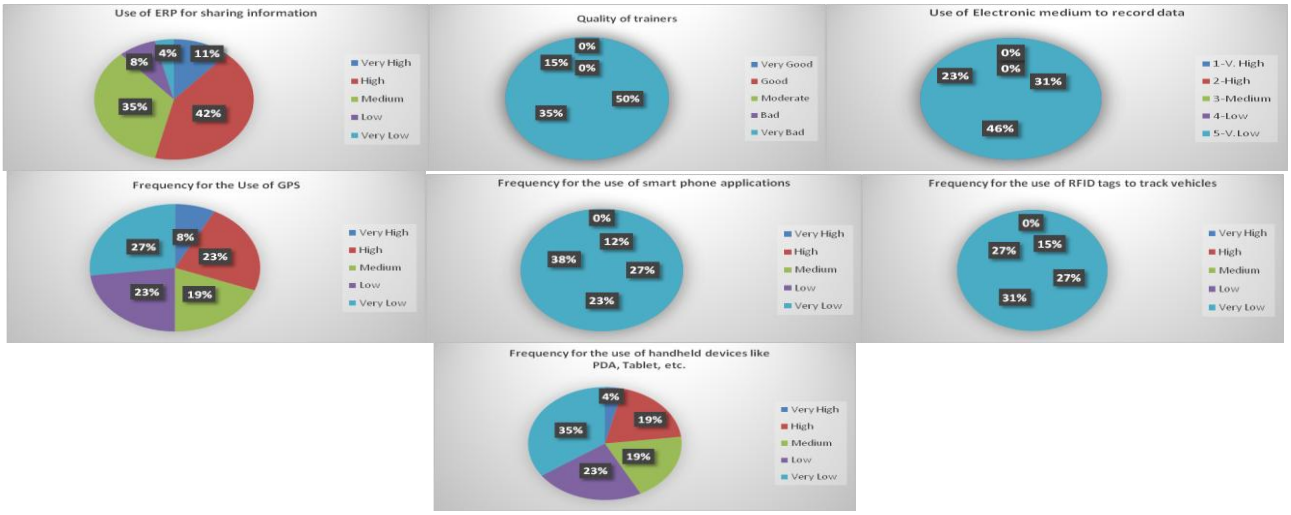
5. RESULTS AND DISCUSSION

5.1 Survey Results for Customers

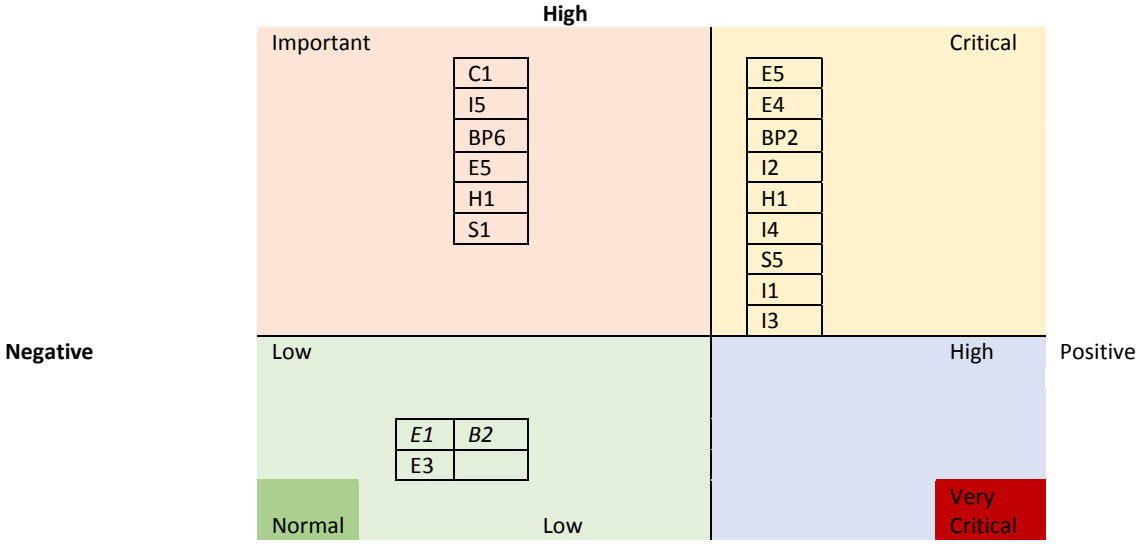


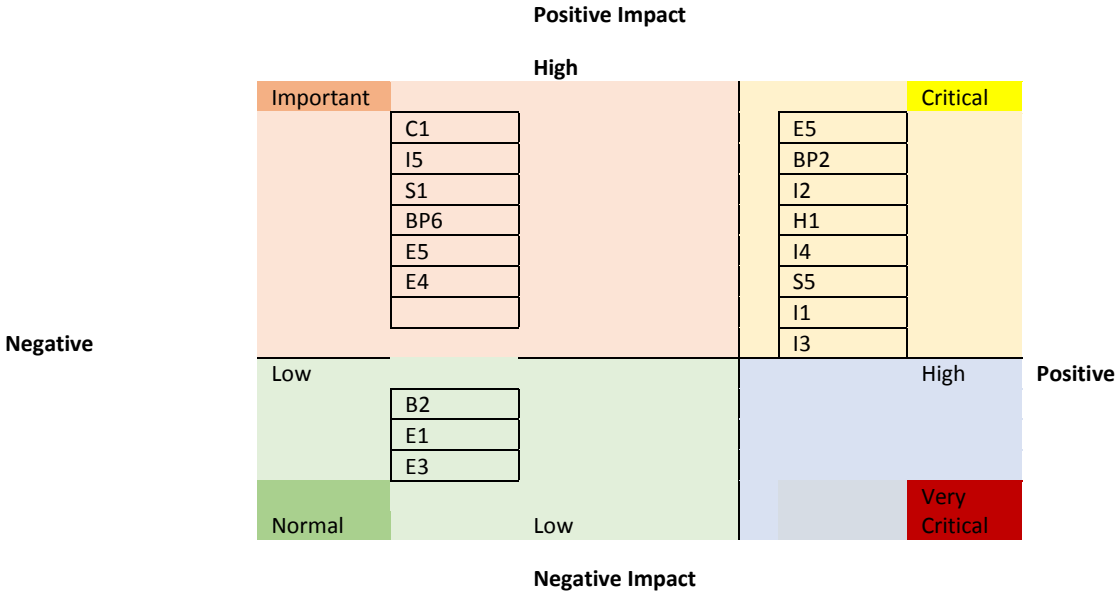
5.2 Survey Results For Retailers





5.3 Mapping Of Issues And Parameters For Customers And Retailers





6. CONCLUSION

The reliability tests on customer and retailer data samples confirm that the data is uniform throughout. The results of the survey and the mapping graph of the issues and parameters suggests that the hypothesis formed is correct. Analyzing the results we can now conclude the Knowledge Management in downstream supply chain management of Indian public sector oil companies helps in collaborative decision making for long term and short term issues.

As a result of this, the issues that are identified will be bridged by focusing on solving the issues.

7. FUTURE SCOPE

The study done in this paper will enable us to move in the direction of using Knowledge Management as a guiding tool in any other sector like retail, FMCG, manufacturing, etc.

Further study can be carried out to resolve the gaps that are identified and various other newly emerging techniques like Business Intelligence and Data Mining can be used for analysis purpose but at a smaller operational level.

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