CHAPTER-1
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INTRODUCTION

1.1 Introduction

Management thoughts developed over years

According to Stoner et al. (1998) management and organizations are the outcomes of their historical and social times and places and the evolutions of management theory in terms of people have dealt with matters of relationships at particular time in history. As a result, early management theories are made of various attempts for knowing these industrial lives over a period that embraces the end of nineteenth century and beginning of the twentieth century in western countries. During this period managers and management experts were developing the management thoughts with little precedent.

Between 1890 and 1930 attempts were made to determine rationally the best performing ways of doing a job. These attempts ended up with the development of scientific management theory that came up in part from the need to increase productivity. Supply of skilled labour at the beginning of the twentieth century was limited in nature in these countries. The only way to increase productivity was to make the workers highly efficient. Researchers like Taylor, Gantt and Gilbreths made contribution towards management theory which is better known as scientific management theory. Taylor propounded his thoughts along four basic principles. First principle was to give shape to the science of management. The second and third principles dealt with scientific selection of workers and their scientific education and development. The fourth principle stressed upon the need for healthy cooperation.
between managers and labours (see Taylor, 1947). For a critical appreciation of Taylor’s thought one may refer to Locke (1982) and Bluedorn et al. (1985).

Taylor’s method quite often resulted in significant increase in productivity and raise in pay packages. However resistance gained momentum, from the side of workers and unions. They thought Taylor’s approach would lead to layoffs due to fast completion of works.

While scientific management concentrated on the increase in productivity of an organization by making individual workers more efficient, classical organization theory grew out to manage complex organizations. It was an attempt by H. Fayol to identify the principles and skills that inspire effective management. But critic of classical organization theory point out that it was more suitable for the past industrial environment with relative stability and predictability. At present, organizational environment are more turbulent, dynamic and competitive.

Unfortunately the classical approach did not realize sufficient production efficiency and workplace harmony (see Stoner, Freeman, Gilbert, Jr., 1998). People did not always adhere to suggested or expected patterns of behaviour and management was at the receiving end. Thus, there was increasing interest in helping manager’s deal more efficiently and effectively with the human aspect of the organization. A group of management experts with exposures in sociology, psychology and related fields made use of their diverse knowledge to propose more effective ways to handle the manpower in organizations. This led to the advancement of behavioural approach.

During the time of Second World War, formation of Operations Research team took place in Great Britain by pooling mathematicians, physicist and other scientists to solve the scarcity problems using mathematical approach. After the end of the war, a
new methodology of problem solving was developed to handle the problems of industry. This approach is called the management science approach where management problems are tackled through mathematical techniques for their formulation, analysis and solution.

The Systems Approach

Later a group of management scientists pointed out the limitation of dealing separately with the various segments of an organization. They introduced the systems approach to management by considering an organization as a unified, purposeful system composed of interrelated subparts. This approach gives managers a way of looking at the organization not only as a whole unit but also as a part of the entire external environment. Systems theory highlights the fact that the activity of any division of an organization affects, in varying degrees, the activity of every other division of it. They have borrowed the concept from physical systems and redefined system as a collection of components that work together to appreciate an objective (see Senn, 1989). A system may consist of any number of subsystems. There are principles concerned with system constitution and its behaviour. One of them is the system boundary. It defines the mechanisms that make up the system. The thing outside of the system boundary is known as system environment.

As far as the subsystems are concerned, each subsystem carries out element of the system function. Subsystems are vital because they can help to handle the intricacy of the system and hence improve understanding about the same. Every subsystem carries out some fraction of the system objectives. The subsystems correspond through passing data as well as information between themselves. A good system will
be made up of highly autonomous subsystems with minimal flow among them. Minimizing flow in turn minimizes difficulty and simplifies the system.

In every organization there is a need for adopting a system approach because it is a holistic approach which believes in the philosophy that an organization will be efficient only when each and every part of it will be efficient. However, in the FMCG industry, consumer durables industry where the competition is very high and the origin of industries is very recent, the application of system approach is essential because of the uncertain nature of the market. Some industries like transportation industry, have made a very little effort in adopting system approach because their origins date back to age old days. However, there will be immense competition in this field in near future because of which we feel the need to develop the system approach. Keeping in mind the time and resource constraints we are unable to consider all these age-old industries and propose to consider only the port activity. Even for port management it may not be possible for us to consider all the subsystems of it. We aim to cover materials, traffic and finance subsystems only. In that sense our system will become a subsystem of the future work that will cover all the activities of a port. We believe that other subsystem can be developed in a similar fashion because the subsystems that we have considered in our study are the most critical and complicated areas of a port and the rest are not that much critical and complicated.

History of the Port of Eastern Region

Bengal port, Tamralipti, introduced the landlubber Mauryan emperors' to oceangoing. In the early phase of Gupta expansion, they defeated Bengal and annexed her and the then two Varman kings of Bangla were defeated. As Bengal
came under the Gupta rule, Tamralipti served as a major port. The ancient western reference to the fabric Muslin shows that the legendary fabric is not a new export of Bangla but ancient through that port.

Kolkata is the oldest major port in our country. But the nucleus of the present day Kolkata Port lies much earlier with the grant of trading rights to the British Settlement in Eastern India by the Moghal Emperor Aurangzeb. The city of Kolkata, has a synergistic linkage with this port.

In course of time, the authority to rule this vast country passed from the East India Company to the British Crown. The dealings of the port were brought under the administrative control of the British Government with the appointment of a Port Commission in 1870. The Kolkata Port was initially conceived to encourage and protect the British colonial interest. But with the advent of freedom in 1947, the port was called upon to play the opposite role to champion the national cause. The port took over additional responsibility in the wake of the aftermath of Second World War and the partition of the country.

The port which was once considered the most important port in the country still remains the premier port which has been rightly called the gateway to Eastern India and is the guiding factor to trade and commerce of vast hinterland comprising the entire Eastern India including Bihar and Eastern Uttar Pradesh and the two land-locked Himalayan Kingdoms of Nepal and Bhutan.

The Commissioners for the Port of Kolkata ran the port till January 1975 when Major Port Trusts Act, 1963, came into force. The history of Kolkata Port has been a continuous story of struggle and success. In the recent past, Kolkata Port has been adjudged as the best managed port in the country.
Despite its being 126 miles away from the sea, Kolkata is, by far, the best choice for eastern gateway to this continental-country. Kolkata Port Trust remains one of the pioneering and most promising ports of India. It commands a vast hinterland that comprises almost half of the Indian states (whole of the eastern and north-eastern regions) and the two neighbouring countries - the Himalayan Kingdoms of Nepal and Bhutan. It has two dock systems - Kolkata Dock System at Kolkata with the oil wharves at Baj Baj and Haldia Dock Complex at Haldia - with a combination of facilities and a lot of attractive packages.

The Information System

An information system is a special system in and for management that uses systems approach. It is widely used in today's multifaced cutthroat competitive world. A proper information system helps the decision maker/taker in making/taking right decision at the right time. Wrong decision may create a problem for the long run survival of the firm. Time specific and efficient utilization of the available resources is the key factor of a firm's success. As a consequence of that an appropriate balance of the internal strengths and weaknesses in the light of outer threats and opportunities is very much important to handle the continuous pressure from the environment (see Roy and Banerjee, 2002).

An information system is a system that provides information to the people who makes or takes decision in an organization. As the wrong information leads to wrong decision this may put an organization in the survival trap. Hence, a proper information system is very much important for an organization to go and grow.

As far as the information system and its design are concerned, fairly large amount of research work has been done. Many methods for development of information system
have been suggested in the literature. The linear cycle (Hawryszkiewycz, 2000), which is a collection of a number of phases, used to construct the system. Those phases are problem definition, developing the system specification, system design, system development, system testing, implementation and post implementation review and maintenance. Every phase in the linear cycle has a clear-cut objective and uses a number of activities to realize that objective.

It is also true that faster the speed of port in adopting and integrating new innovations and reorganization of internal as well as external resources, greater is the chance of successful survival in the market. The present work aims to address these problems. The basic objective of this study is to provide the knowledge to the port management in respect of the cost saving opportunities, improving productivity, strengthening supervision and to benchmarking the organization’s progress in relation to the industry.

The Objectives of Our Study

The main objectives of this study is

- To identify different operational problem of a port,

- To suggest remedial measures and develop models for the purpose of decision-taking.

- To identify different information entities and different information users along with their information requirement

- To develop functional modules to cater to the information needs of the decision-makers, and
• To integrate different subsystems and to present a holistic approach for inducing overall efficiency in the functioning of a port.

A very few works have been carried out in the development of port specific information system and as a result we are going to do an initial work in this field and draw the attention of the future researchers. In the next section we review the literature to indicate early postulations and future directions.

1.2 Review of the Literature

Study on Strategy and Environment

According to Chandler (1962), strategy is the determination of the basic long term goals and objectives of an organization and the adoption of courses of action and the process of allocating resources necessary for carrying out the goals. Bettis and Hitt (1995) advocated that organization's strategies are dynamic and action initiated by one organization may generate a series of actions among the competing organizations. In the studies of Dean et al. (1998), they promulgated that strategy has differential effects on large and small organization. Hofer and Schendel (1978) and Fahey and King (1977) emphasized on the significance of environmental scanning system for the success of the business in a multifaceted and turbulent environment. It is the first responding parameter to feel the pulse of change.

In the context of handling pressure from the environment Thompson and McEwen (1958) proposed two conditions: either a firm has complete dominance over its environment or environment rules the firm. Modern firms are in between these two extremes. In today's situation, to perform in a better way, every firm has to depend on extensive environment analysis and diagnosis. Environment is the first responding parameter where a marketer can feel the pulse of change. Essentially a
firm's performance is primarily a function of the industry environment in which it competes (see Porter, 1980). Economic and Government factors are the most important environmental factors for any business organization (Wadha, 1974; Glueck, 1980 and Bibault, 1982). Aguilar (1967) popularized that market or competitive factor is the prime factor of consideration during environmental analysis.

So far as the internal aspect of a firm is concerned, there are two closely related areas – the knowledge base view (see Kogut and Zander, 1992; Spender and Grant, 1996) and strategic leadership (Cannella & Hambrick, 1993; Finkelstein & Hambrick, 1996; Kenser & Sebora, 1994). This led to debates of environment determinism versus strategic choices.

**Study on Operational Problems**

Very little works have been reported on port management. Gotaas Larsen Shipping Corporation (GLSC), a subsidiary of Internal Utilities (IU), who operates cargo ships all over the world, developed a comprehensive DSS for executing both short term and long term planning in the mid of 1970's. However some specific problems have been examined in the literature in an isolated way. Container Loading Problem is one such example. Its optimum solutions is difficult to obtain mainly because the problem is NP-hard (see Garey and Johnson, 1979). Therefore, the bulk of the researches have focussed on the heuristic methods. Israni and Sanders (1982) presented a recursive heuristic, adopted to personal computers. Their method allows user intervention to place selective pieces in the gaps or waste areas of the computer generated layout. Barkey and Wang (1985) compared a first-fit heuristic algorithm with a best-fit and a next-fit algorithm for finite bin packing problems. Their
investigations led to the conclusion that the best-fit heuristic, which joins individual pieces into strips prior to lay out, is the most efficient for large data sets.

Adamowicz and Albano (1976) combined pieces heuristically into strips, which are then packed optimally using dynamic programming. Albano and Orsini (1980) extended the procedure to incorporate quasi-uniform strips as well as vertical strip orientations. The heuristics of Adamowicz-Albano and Albano-Orsini are computationally efficient, with best results achieved in cases involving large bill-of-materials composed of pieces having low piece-to-stock area ratios.

Bengtsson (1982) proposed a search algorithm suitable for packing pieces with average piece-to-stock area ratios up to 0.15. The algorithm builds sections by placing pieces on top of a selected base piece. This approach works well in cases where only a few stock sheets are sufficient to accommodate the bill-of-materials. Wang’s (1983) approach to the problem was similar to that of Bengtsson where the layouts were built by combining pieces within the boundaries defined by the stock size. In both Bengtsson and Wang’s methods, solution quality can be traded in favour of computational speed by restricting the search time allowed for each stock sheet.


Thiel and Voss (1994) proposed a multi-constraint zero-one knapsack problem where one has to decide on how to make efficient use of an entity which consumes multiple resources. There, they have considered a heuristic procedure to arrive at the
solution. In the same problem they analyzed different operators within genetic algorithms (see Goldberg, 1989 and Liepins et al., 1989) for solving the multi constraint zero-one knapsack problem and compared the results with those of recent investigations of other modern heuristic concept present in the literature.

Pisinger (2002) advocates the knapsack container loading problem. It is the problem of loading a subset of rectangular boxes into a rectangular container of fixed dimensions such that the volume of the packed boxes is maximized. Here he proposed a new heuristic based on the wall-building approach, which decomposes the problem into a number of layers which again are split into a number of strips. The packing of a strip may be formulated and solved optimally as a Knapsack Problem with capacity equal to the width or height of the container. The depth of a layer as well as the thickness of each strip is decided through a branch-and-bound approach where at each node only a subset of branches is explored.

Mack et al. (2004) proposed a parallel hybrid local search algorithm for the three dimensional container loading problem. It that study, they suggested a simulated annealing method for the container loading problem. Then it is combined with an existing tabu search algorithm to form a hybrid metaheuristic. Finally, parallel versions have been introduced for these algorithms. Here the emphasis is given on container loading problem instances with a weakly heterogeneous load, which is the main limitation of such studies. Other operational problems of a port have hardly been addressed by the researchers.

Study on Information Systems

However, ample of works are available in the literature on development of an information systems. According to Senn (1989) information system is to process
inputs, maintain files of data about the organization and to produce information, reports and other outputs. It consists of subsystems, including hardware, software and data storage for files and databases and supports other organization systems.

Seeing the varied business need various types of information system can be developed (Senn, 1989). Those are Transaction Processing System (TPS), Management Information System (MIS) and Decision Support Systems (DSS).

TPS assist in handling the day-to-day activities of the organization. Standard operating procedures that can facilitate managing of transactions are often entrenched in computer programs that control the access of data, processing of details and storage and presentation of data and information.

MIS is decision oriented and makes use of transaction data as well as other information developed within and outside the firm. Because these systems are designed to support the habitual issues of the organization, it is feasible to study the decision factors, variables and develop reports that will be useful in formulating upcoming decision.

In order to make complex decisions Decision Support System (DSS) assist an organization. Little (1970) propagates DSS as a “model based set of procedures for processing data and judgments to assist a manager in his decision-making”. It requires an optimization algorithm to achieve its objectives. Bonczek et al. (1980) advocates DSS as computer based system consisting of three interacting components – a language system, a knowledge system, and a problem processing system.

In the literature it is noticed that DSS are basically experimental in nature, where the user tries different inputs to see their effects. The response is used to try new inputs and the process continues until a satisfactory result is obtained. Some of the DSS’s
are based on a continually refined model. User inputs some possibilities into the model and evaluates it. Successively other possibilities may be tried. A third kind of DSS is of policy nature. Here one develops alternate positions and then justifies them by argumentation. The steps of this method are – defining objectives, defining alternative solution and making arguments for and against each alternative.

Alter (1984), describes a taxonomy of DSS and suggests that any decision system evolves through a number of stages. Those stages are management entity. The suggested stages are

- A data analysis stage to collect data useful to decision making.
- An information analysis phase to automatically extract data needed for decision making.
- A phase to develop a representation model to define the expected system behaviour and
- To develop an optimization model that uses the variations to decide on actions that can optimize future behaviour.

Gotaas Larsen Shipping Corporation (GLSC), a subsidiary of Internal Utilities (IU), who operates cargo ships all over the world, developed a comprehensive DSS for executing both short term and long term planning in the mid of 1970's. The system composed of two major parts – data and model (see Turban, 1993). The main limitation of such a system is the absence of a proper integration.

So far as the literature is concerned, many information systems specialist acknowledge the difficulty of understanding large and complex systems completely. The structured analysis development method is intended to overcome that difficulty.
through separating the system into components and constructing a model of the system (see DeMarco, 1978; Keller, 1983). It consists of elements of both analysis and design. Structured analysis focuses on specifying what the system or application is required to do. It does not state how the requirements should be accomplished or how the application should be implemented. Rather it allows individuals to see logical elements apart from the physical components it uses (see Gane et. al, 1979). Afterwards a physical design is developed that will be effective for the situation in which it is to be used. The major elements of structured analysis are graphic descriptions, data flow diagrams and a centralized data dictionary.

Staged development can be applied where breaking up of the problem into a number of subsystems is feasible. Here the first step may be a global concept phase that decides the size of the development project. Such a study may suggest that the project is extremely big and it should be developed in stages. The next step of this method is to break up the whole project into a number of phases. Each phase is developed using linear cycle and each subsystem is developed separately with its own problem definition phase. It is also necessary to get a detailed assessment and plan for each stage and also to evaluate the feasibility of integrating the module produced in each stage with the module developed in the next stages.

Frequently designers are faced with the difficulty of specifying operations that cannot be specified accurately using models. Imprecise systems occur when it is impossible to develop a exact system specification. This often happens in organizations that are just starting to use computers without having any prior experience. Alternatively it is more appropriate to develop the system gradually, knowing the system capabilities. Prototyping is often used in system development to clarify user requirements in imprecise systems (see Alavi, 1984 and Anriole, 1992).
A decision to use prototyping is usually made in the feasibility phase. It is used to gain a better understanding of possible solutions and the prototype then becomes the requirement model in the system specification phase (see Naumann, 1982).

Evolutionary development is another way to design systems that cannot be accurately specified. It combines the elements of staged design and prototyping. It develops the whole project as a number of stages and the outcomes of one stage serving to identify the conceptual solutions for the next phase. It is therefore often experimental in nature where development starts with some petite part of the system. It does not assume the subdivision the problem into separate and slackly coupled stages and design the system in one pass through these phases, as in the case of staged development. Alternatively, the system is developed gradually. Here, we develop a system component and learn more about the problem from the operation of that component. Subsequently we use knowledge gained from this process to define the next part to be developed. In evolutionary design each step adds a new competence to the system. The experience gained with a system is used to characterize the requirements for the next step. The latter extends system capability a little bit further and the process continues until no further improvement appears possible or sensible. The problem that is particularly vulnerable to the evolutionary approach is decision support systems where the connections used to support the decision-making cannot be precisely predicted and an experimental approach is needed.

Boehm (1988) prescribed one model for evolutionary development and is called spiral model. The design of the spiral model shows the system development procedures by the improvement of successive prototypes, each new prototype adding extra functionality and being integrated with the earlier prototype. The assessment at
this stage can consider the risks and concentrate on eliminating risk in parts at each prototype rather than a whole. The system developed progressively by successive developments of prototypes considering risk analysis to establish the most expected path to successful development.

**From System Design to Human Design**

In the recent days, system development have a propensity to focus more on the business process being supported or redesigned than on the people who will use the product. Perhaps as a result, people often find new systems complicated to use, counterintuitive and annoying. Moreover if we asked people the radical question, how much have information systems increased job satisfaction, we will soon learn that information systems have de-skilled and routinized far more work than they have enriched (Bensaou and Earl, 1998). Our point is not that job enrichment should be the goal of the information system development, but rather the specialists often leave no room in their systems for human judgement or understanding when they become more focused on technological solutions.

For us, building systems is not the ultimate goal, enhancing the involvement and contribution of people is the higher goal. That is why the principle of Human Design is the base to the way that we will develop the information system.

As far as the application of decision support technologies for decision making are concerned, two characteristics of organizational behaviour militate against the practice. The first is the belief that board participation and consensus not only facilitate commitment but also produce better decisions.

The second is the reliance on social and experiential process of knowledge creation (see Nonaka and Takeuchi, 1995). We needs to deeply aware of the importance of
tacit knowledge—knowledge that cannot be fully communicated with words or numbers, such as things we do not know or the things we cannot explain easily. Our information system may be much better suited to process the explicit knowledge than the tacit knowledge. That is why when difficult and heuristic problems arise in designing a system, many big houses uses brainstorming camps rather than data mining, computer-aided design, or simulations.

As far as the success of the system that we have designed is concerned, the port has to make substantial investment in training and supporting the front-line workers in the use of those systems. The overriding importance of using information intelligence is not only lies with information exchange but also with the understanding of the same and proper integration that allow them to work better. In the case of managing information technology the expertise that we have used will fit the people using it rather than the other way around.

Thus we can summaries that main scope of this study is to develop an information system that will help in optimum decision-making and decision-taking in the operating and strategic areas keeping in mind environment as well as people as the main factors.

1.3 Scope of the Present Work

Significance of this research work lies in providing a system that generates the information for the decision-maker and decision-taker of a port. Since it is a system, a holistic approach has been suggested. This study will provide the knowledge to the port management in

> identifying the cost savings opportunities,
- improving productivity,
- strengthening supervision, and
- benchmarking the organization's progress in relation to the industry.

Port exists to create value for their stakeholders that the stakeholders could not create for themselves as individuals. Information systems developed for a port can better create value using their intellectual capital. The goal of designing an information system is to present timely, accurate, and complete information to decision-makers, decision-takers, while minimizing cognitive and economic costs. As such, it is a broad, eclectic field that has addressed issues touching on hardware and software aspects of port. We with the design methodologies for information systems will embrace and address all of these dimensions.

In the unhinged up-coming environment, which is affecting all the competitive organizations, domain offensive actions in the form of new products and services is expected to endanger competitive gain. Environment is the first reacting parameter where a firm can observe the change. Success of strategic planning completely depends on appropriate analysis of the environment. The system that we have developed will definitely provide competitive advantage over others.

In this study we have made an independent endeavor of identifying the influence of each functional management area in strategic decision-making and operational decision-taking. In all the past studies there was no specific guideline for the development of such information system. We have thrown light on this area and provided major guideline in this direction. This system will provide a knowledge-wise, economy-wise and technique-wise competitive advantages over the existing players.
1.4 Preview of the work

We have divided our study according to a few functional management areas that we have undertaken for a port. These functional management areas are materials management, traffic management and finance management. The objective of this section is to give a preview of the work done and conclusions drawn in the subsequent chapters.

Materials Management

In chapter-3, we have presented the information system designed for materials management. There we have developed a very interesting solution for a port specific critical problem called as container loading problem (CLP). The basic objective behind developing such a computerized interactive system is to generate an optimum container loading plan so that maximum load can be carried by the ship. Container loading plan is achieved by the frequency table generated based on the three dimensions of the boxes which the vessel has to carry. However some boxes which cannot be tilted will be initially identified by single dimension. In this way a optimum container loading plan will generated by the system. As a consequence of the same it is expected that which maximum revenue will be generated. Revenue is an integral part of running efficiently and effectively a business organization. Through development of such a system more revenues will be generated which will help smooth functioning of the port and will take the organization in a profitable position. According to Drucker, profit is the least imperfect measure for an organization’s efficiency. Thus we may claim that our suggested solution is in the line with the view of Drucker, the management guru.
For the other areas of materials management like materials procurement, materials receipt, issue and stock management and financial activities, we have also designed the information system and suggested the normalized relations. The implementation of the same can keep track of various inventories, availability and procurement of the same at right time for the right job. By doing all those tasks, the integrated information system will help the decision maker to make proper and economic decisions for port which will induce efficiency into the system.

Traffic Management

So far as chapter-4 is concerned, in this chapter we have presented the information system designed for traffic management. Here we have discussed a very interesting and critical problem called Container Unloading Problem and suggested a reasonable solution based on the five different strategies. As far as utilization of the pilots are concerned we have measured the efficiency of them based their experience and their salary and finally suggested a mathematical measure combining those two parameters. The basic objective behind developing such a computerized interactive system is to generate an optimum container unloading strategy so that maximum load can be carried by the vessel in the existing situation. As a consequence of this minimum cost will be required to bring the vessel/load carried by the vessel at the port. Through development of such a system more profit will be generated, which will help smooth functioning of the port and will take the organization in a profitable position.

For the other areas of traffic management like establishment, Hydrographer's Department, Dredging & Dumping Department, Engineering Superintendent Department, Harbor-in-Charge of Navigational Track Department, Harbor-in-Charge

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Charge of Port Department, Radio Officer's Activities and Vessel Information (New Construction), we have also designed the information system and suggested the input with their sources, output with their frequencies. The implementation of the same can keep track of various tasks, availability and utilization of various resources including human resources to do the right job at right time. By doing all those tasks, the information system will help the decision maker to make proper and economic decisions for port which will induce efficiency into the system. Another important aspect that we have talked about in this chapter is the integration within this functional management area as well as with other external entities. The information system that we have developed needs to be integrated within the functional subsystem and with the other functional subsystem for the proper overall functioning of port.

Finance Management

In chapter-5, we have presented the information system designed for Finance Management of a port. Here we have discussed the purposes of various sub-modules under the said functional management area. The sub-modules under Finance Management are Payroll, Employee Service Records, Loan Fund Accounting, Provident Fund, Bills Recovery, Stores Accounting, Revenue Collection, Management Accounting and Budgeting. The sub modules under Finance, which we have discussed earlier, are general in nature and common to all business organizations. Therefore emphasis has been given only on the sub modules which are specific to port management system. Those are Bills Recovery, Stores Accounting, Revenue Collection and Budgeting.
In the Revenue Collection sub-module of finance subsystem Port collects charges from vessels that arrive at the dock of port. The party (may be an organization or agent or individual customer) makes an application to port for accommodating its vessel at dock for a certain time period. Port prepares an estimate of charge and issues a demand note to the party. The customer pays the amount with the vessel detail in the cash section and obtains a treasury receipt. After production of this treasury receipt to the collection section, the party gets the nod for his vessel to enter dock of port.

The vessel waits at sea where a port pilot boards it and brings it to a berth of dock. Once the vessel finishes its operation, it obtains a no demand certificate from the Collection section and takes it vessel out of dock with the help of the port pilot. Subsequently, Revenue Collection section receives the vessel operation related documents from Traffic Management. Based upon this, Collection section prepares the final bill and sends it to the party. To get exact information in a appropriate and quick manner interconnectivity between Finance and Traffic Management is a must. If traffic subsystem unable to provide the right information then the bill generated from the finance subsystem will an erroneous one and consequently an inappropriate amount will be claimed from the customer and the customer will raise question about the goodwill of the port. Hence the revenue generated out of vessel operations is linked together with the finance subsystem through the variable "Revenue Collection". As far as the allocation of pilot is concern, the Booking Section of Finance Management has to inform Harbor-in-Charge of Navigational Track of Traffic Management that how many vessels has been booked on a particular date with their dimensions. Accordingly Harbor-in-Charge of Navigational Track will allocate the pilots with their time of movement. Here the allocations of pilots to the
vessel are linked with the finance subsystem through the variable “Pilot Log Book Entry”. Hence to complete these tasks in a proper and quick manner integration between Finance and Traffic Management is a must.

In Bills Recovery sub-module we have discussed different activities under this sub-module. These are Issue of Rent Bills, Issue of Electricity Bills and Issue of Miscellaneous Bills. In Stores Accounting the activities like Supplier Bill or Advance Payment from Party Bill or Proforma Invoice, Goods Receipt Note, Issue Challan or Return Challan details, Physical verification report and Adjustment List of store materials, preparation of Supplier Ledger and Stores Ledger have been discussed. In Revenue Collection we have discussed vessel related charges like revenue collection on account of vessel, Opening Import / Export deposit account, Opening Container Cargo deposit account, Revenue collection Process from Import, Revenue collection Process from Export, Revenue Accounting for Import and Export and Revenue collection from License and Permit. In Budgeting we have discussed two units of the same, which are Revenue and Capital Budget unit. We have designed the information system and suggested the input with their sources, output along with their frequencies. The implementation of the same can keep track of different tasks, availability and utilization of various resources including human resources to do the right job at right time. By doing all those tasks, the information system will help the decision maker to make proper and economic decisions for port which will induce efficiency into the system.

Integration of the Functional Subsystems

In the chapter 6, we have proposed the integration of all the different functional subsystem on the basis of variables selected from various sub-modules.
The functioning of materials subsystems are only a part of the complete activities of the port. Hence they are seen to be connected with other subsystems through a set of variables occurring in more than one subsystem. The most important aspect of Materials Management module is the physiological integration within the module as well as with other external entities. The integration among various sections within materials management as well as with other functional management areas like Traffic and Finance Management is extremely important. Because, if proper integration cannot be established, then a suitable on-line transaction processing system can not be achieved. Consequently the effect of a single transaction of one section cannot be viewed in other section as well as in other functional management area.

The container loading plan and the revenue generated out of that are linked together with the finance subsystem through the variable "Revenue Collection". Another linkage with the finance management is through revenue budget for the shipment of cargo. This variable called as 'revenue collection on account of vessel' will generate revenue, contributing Port's annual revenue budget. The income through this activity will then go into the 'original estimate amount of revenue' variable under summary budget statement for revenue report of the budgeting sub-module of finance subsystem.

Actual material procurement, material receipt and available stock are linked together with the finance subsystem through the variables goods receipt note, supplier bill, supplier bill, store ledger of the store accounting sub-module. These variables have monetary value and may be counted towards the assets of the Port. Another linkage with the finance subsystems is through budgeted resource allocation for acquisition of materials, increase and decreases of stocks, modernization of materials
management activities like a computer interactive container loading solution and materials planning and scheduling. All these variables require monetary allocation from the port’s annual budget. The expenditure incurred in these activities goes into ‘total operating expenditure estimates’ variable under analysis of operating type expenditure report of the revenue budget section of finance subsystem.

In connection with the traffic subsystem the linkage is through the variable ‘Navigational Depth’ and supply of required efficient pilot. The traffic subsystem serves as a source for the deployment of pilot in material subsystem for guiding the vessels up to the sea. Another connection with the traffic management is through the variable ‘impact of pilots’ unrest on work, performance and efficiency. The linkages with the traffic subsystem are seen at different points. Management of cargo within the stipulated time to meet the customer order is done by the traffic department and the efficient functioning of the same can reduce delivery delay. The materials management is also affected by another linkage namely saving of time, cost and consequently increasing the movement of fleet, which increases the generation of revenue.

Another linkage that is common to other subsystems also through budgeted resouce allocation of finance submodule. The budgetary allocation in this subsystem is connected with traffic Planning. The dredging and dispatch department of traffic subsystem dedges the different navigational tracks (through which the vessels moves) for the maintenance of those tracks and dispatch the siltation to the specified place. This variable requires monetary allocation towards dredging from the port’s annual budget. The expenditure incurred in these activities goes into ‘total operating expenditure estimates’ variable under analysis of operating type expenditure report of the revenue budget section of finance subsystem. Additional linkages with the
finance subsystem are through the variable financial position of the port and salary, wages and allowances for pilots and other crews. The environment impact may be shown through the exogenous variable ‘competition’.

As far as budgeting is concerned, budget is a short-term financial plan, which guides managers in achieving the objectives of a firm. In other words it can be expressed as a comprehensive and integrated plan expressed in financial terms for the operations and resources of an enterprise for some specific period in the future. It is a strategic area where the decision makers have to make proper decision for the survival of the organization in the long run. In a complex and changing environment, port will benefit immensely in terms of quality of decision making if budgeting decisions are taken in the context of its overall strategy. This approach provides the decision maker a guideline for effective allocation of financial resources. The various outputs of the system that we have designed will definitely help the decision maker of the port to take the right revenue and capital budgeting decisions. The budgeted resource allocation or budget estimate amount sends outputs to the rest of the subsystems in terms of their respective budgetary appropriations. Our information system will help to take the budgeting decisions and allocations of financial resources presenting the activities of the whole system at a glance.

There may be some other linkages besides the preceding in specific port system. In that case the linkages of subsystems with the port’s environment should be indicated in a very synoptic manner through introducing some exogenous variables.

We have noted that in some particular cases optimized decision taking for port is a very difficult task. Sometimes arriving at a solution is near impossible without the help of a proper computational system. The system that we have developed,
especially the loading and unloading solution, will help in those areas to a great extent.

As far as the database integration is concerned, the normalized relation schemes whose tables we have suggested earlier should be integrated within the module first and then those database schemes will be integrated among the various subsystems. Normalization is the process of building database structures to store data in such a way that eliminates data redundancy and promotes integrity. To integrate those relation schemes we have finalized some key attributes (called as primary key) of each scheme, based on which the integration has been done. The structures of those key attributes are exactly similar in various schemes where they are present. Duplication of the key attribute is not at all possible and a single record will be identified by the primary key only. This will reduce the data redundancy in our database, which is a big problem as far as the database is concerned.

The system that we have designed is an extensive information system encompassing all the aspects of the three functional management subsystems of a port. It will fetch a radical change for smooth functioning of the port and help the decision-makers in taking right decision at the right time. In some cases the system itself will take decision. In our view, a port will experience a mammoth change in its competence level if it adopts the suggested information system. Simultaneously it depends on the port's own capabilities in motivating its peoples towards the use of the same. We can see from our study that on-line information system for such industries will be extremely important in near future for the existing as well as new players in this field.