Intelligent Querying for Materials Management using DSS

A Project Report

Submitted by

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BONAFIDE CERTIFICATE

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For SHAMROCK,

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ABSTRACT

Everyday we, as humans, make many decisions, which can have immediate or long-term effects on our lives. A decision in general may be defined as the selection by the decision-maker of an act, considered to be the best according to some pre-designated standard from the available options. To make a perfect decision by an organization, it needs a suitable Decision Support System. DSS are interactive computer-based systems which help decision makers utilize data and models to solve unstructured problem. This project deals with the development of a DSS for a Garment Industry. It implements the Decision Analysis theory to solve the decision-making problem. It can support the managers understand the problems in addition to providing solutions.

A DSS couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of the decisions. The objective of this project is to develop an application for decision support system using Operations Research approach in the area of business with the help of computers. Various problems and the corresponding solutions are studied and analyzed. These are the core data for this DSS. A knowledge-based system is developed for analyzing these data and to make an optimal decision. The system is developed using the software, Java and MS ACCESS. The industrial data are stored in the database and they are effectively retrieved by the technique called Data mining. It implements the method of intelligent search to discover information with in the dataware house. The resulting data is used in the development of decision trees, which is used to calculate the probability of success rate. Using the optimization techniques of OR, databases and programming languages, this system supports decisions concerning daily operations of the industry. It improves the firm's ability to make rapid and better-informed decisions.

திட்டத்தின் சாரம்

நாள்தோறும் மனிதர்களாகிய நாம், பலவிதமான முடிவுகள் எடுக்கின்றோம், அவை நம் வாழ்வில் உடனடி அல்லது நீண்டநாள் விளைவுகளை தருகின்றன. தீர்மானம் என்பது முடிவெடுப்பின் தேர்ந்தெடுக்கும் செயல். அந்த தீர்மானம் முன்கூட்டியே நிர்ணயிக்கப்பட்ட விருப்பங்களின் தேர்வாகும். ஒரு நிறுவனத்திற்கு சிறந்த தீர்மானம் எடுப்பதற்கு, தகுந்த தீர்மானிக்க உதவும் அமைப்பு தேவைப்படுகிறது. இதுவே டெஸிசன் சப்போர்ட் சிஸ்டம் (டி.எஸ்.எஸ்) ஆகும். டி,எஸ்.எஸ் என்பது ஓர் கணிணி சார்ந்த அமைப்பு அந்த அமைப்பு முடிவெடுப்பவர்க்கு தரவுகள் மற்றும் மாதிரிகளை உபயோகப்படுத்தி அமைப்பு இல்லாத பிரச்சினைகளுக்கு தீர்வு காண உதவுகிறது. இது ஆடை உருவாக்கும் தொழிற்சாலைக்கான டி.எஸ்.எஸ் வளர்ச்சிப் பற்றிய திட்டம். இந்த திட்டம் முடிவெடுப்பதில் உள்ள பிரச்சினைகளை தீர்ப்பதற்கு தீர்மானம் ஆய்வு கோட்பாட்டை உபயோகப்படுத்துகிறது. இது பிரச்சினைகளை புரிந்து கொள்வதற்கும், தீர்வுகளை கொடுப்பதற்கும் உதவுகின்றது.

இந்த திட்டத்தின் குறிக்கோள் கணிணிகளை உபயோகப்படுத்தி வணிக துறையில் ஓ.ஆர். அணுகுமுறையை பயன்படுத்தி டி.எஸ்.எஸ் - க்கான செயல் முறையை உருவாக்குதல் ஆகும். பலவிதமான பிரச்சினைகள் ஆராயப்படுகிறது. இவைகளே இந்த டி.எஸ.எஸ் - யின் அடிப்படை தரவுகள் ஓர் சிறந்த தீர்மானம் எடுப்பதற்கும் ஒரு அறிவு - சார்ந்த அமைப்பு உருவாக்கப்படுகின்றது. இந்த அமைப்பு ஜாவா மற்றும் எம்.எஸ். ஆக்சஸ் மென்பொருள்களை உபயோகப்படுத்தி உருவாக்கப்படுகிறது. தொழிற்சாலை தரவுகள், தரவு பதிவு செய்யும் முறையில் சேமித்து வைத்து, சிறந்த முறையில் உபயோகப்படுத்துவதற்கு "டேட்டா மைனிங் " என்று பெயர். தரவுகளை பதிவு செய்யும் இடத்திலிருந்து தகவல்களை கண்டுப்பிடிப்பதற்கு அறிவுசார்ந்த தேடுதல் முறையை இந்த டேட்டா மைனிங் செயல்படுத்துகின்றது. இந்த தீர்வுகளிலிருந்து பெறப்பட்ட தரவுகள் தீர்மான கிளைகளை உருவாக்கப் பயன்படுகின்றது. இந்த தீர்மான கிளைகளை உருவாக்குவதற்கு தீர்மான ஆய்வு கோட்பாடு பயன்படுகிறது. குறிப்பிட்ட குணாதிசயங்களையுடைய சில வகையான பிரச்சினைகளுக்கு சிறந்த தீர்மானம் எடுப்பதற்கு தீர்மான ஆய்வு தொழில் நுணுக்கம் உதவுகிறது. ஒரு தீர்மான கிளை என்பது பல்வேறு வகையான முடிவுகள் மற்றும் நிகழ்வுகளின் தொடர்ச்சிகளின் வரைபடம் ஆகும். பல்வேறு நிகழ்வுகளின் நிகழ்தகவுகள் தெரியுமாயின், அவை அதற்குரிய கிளைகளில் எழுதப்படுகின்றன. செயல் நிகழ்வு தொகுப்பிற்குரிய கூட்டு நிகழ்தகவுகளை பெற கிளைகளின் நிகழ்தகவுகளை பெருக்க வேண்டும், இவ்வாறு இந்த அமைப்பு சிறந்த தீர்மானத்தை வெற்றி சதவீதத்தின் நிகழ்தகவை பொறுத்து தீர்மானிக்கின்றது.

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LIST OF ABBREVIATIONS

API	–	Application Programming Interface
BI	–	Business Intelligence
BWA	–	Business Workflow Analysis
CGI	–	Computer Graphics Interface
DBMS	–	Data Base Management System
DMW	–	Decision Maker's Workbench
DSS	–	Decision Support System
EDI	–	Electronic Data Interchange
EIS	–	Executive Information Systems
EPOS	–	Electronic Point Of Scale
ERP	–	Enterprise Resource Planning
ETL	–	Extracting, Transforming and Loading
GDSS	–	Group Decision Support System
HDSS	–	Holographic Data Storage System
IFPS	–	Interactive Financial Planning System
IIS	–	Internet Information Server
JSP	–	Java Server Page
KS	–	Knowledge System
MBO	–	Management By Objective
MDS	–	Management Decision System
MDSS	–	Multiparticipant Decision Support System
NICs	–	Newly Industrialized Countries
NSS	–	Novell Storage Service
ODBC	–	Open Data Base Connectivity
ODSS	–	Object-Data-Store Segment
OLAP	–	On-Line Analytical Processing
RDBMS	–	Relational Data Base Management System
SQL	–	Structured Query Language
TQM	–	Total Quality Management
URL	–	Uniform Resource Locator

CHAPTER 1

INTRODUCTION

1.1 ABOUT THE PROJECT

Today organizations are facing many problems regarding their business. They are handling large volume of data and a number of transactions. To succeed in this competitive world the organization should be able to take optimal decisions at the right time. This process is aided by a Decision Support System. A decision in general may be defined as the selection by the decision-maker of an act, considered to be the best according to some pre-designated standard from the available options. To make a perfect decision by an organization, it needs a suitable decision support system. DSS are interactive computer-based systems which help decision makers utilize data and models to solve unstructured problem. This paper deals with the development and implementation of a DSS for a Garment Industry. It implements the Decision Analysis theory to solve the decision-making problem. It can support the managers understand the problems in addition to providing solutions.

A DSS couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of the decisions. It is a computer based support system for management decision makers who deal with semi-structured problems. DSS applications are systems and subsystems that help people make decisions based on data that is culled from a wide range of sources. They are not single information resources such as a database or a program that graphically represents sales figures, but the combination of integrated resources working together.

Here the DSS is developed for a Garment industry situated at Tirupur. It is mainly developed for Materials Management and in fixing the lead time. Materials management covers all aspects of materials, cost, materials supply and utilization. It covers the whole range of functions involved in converting raw materials and ancillary supplies into finished products. It is concerned with the planning and programming of materials and equipments, market research for purchase; pre-design value analysis, procurement of all materials including capital goods, raw materials, components and assemblies, finishing materials, packing and packaging materials, stores control and inventory control; transportation of raw material and material handling; value analysis, disposal of scrap, surplus and salvage and operation research for materials.

The objective of this paper is to develop an application for decision support system using OR approach in the area of business with the help of computers. Various styles and the problems regarding the styles are studied and analyzed. These are the core data for this DSS. A knowledge-based system is developed for analyzing these data and to make an optimal decision. The system is developed using the software, Java and Oracle. The industrial data are stored in the database and they are effectively retrieved by the technique called Data mining. It implements the method of intelligent search to discover information with in dataware houses. The resulting data is used in the development of decision trees. Decision analysis theory is used for constructing the decision tree. Decision analysis is a technique, which helps to find the best decision to take in certain types of problems with particular characteristics. A decision-tree is a graphic display of various decision alternatives and the sequence of events. When probabilities of various events are known, they are written along the corresponding branches. Multiplying the probabilities along the branches results in the joint probabilities for the corresponding act-event sequence Depending upon the probability of success rate the system decides whether the decision is optimal or not.

Using the optimization techniques of OR, databases and programming languages, this system supports decisions concerning daily operations of the industry. It improves the firm's ability to make rapid and better-informed decisions.

1.2 COMPANY PROFILE

Shamrock, the flagship company of the Shamrock Group, started out as a tiny trading firm headquartered in Mumbai (Bombay), India, way back in 1984, dealing in knitted garments. The brainchild of Assumption Mendon (Assen), Shamrock grew from strength to strength right through the eighties, with dedicated involvement from the other two Directors of the company--Assen's husband Bhaskar Mendon, and brother Nicholas D'Souza.

With dedication, determination and a relentless pursuit of excellence, Shamrock went into overdrive and quickly transformed itself from a tiny retailer into a major exporter of garments. To ensure quality, consistency and timely delivery, a manufacturing unit was set up in 1990, at Tirupur, in the southern Indian state of Tamil Nadu.

Gradually, the facility was built up and developed to incorporate state-of-the-art machinery, while providing for completely ergonomic working conditions. Simultaneously, the constant endeavor to develop in-house skills and expertise in knitting, dyeing and printing, has resulted in the creation of a loyal, highly-trained workforce. The various facilities are located at Tirupur, New York, Netherlands and Petal Shamrock.

- **Factory at Tirupur in south India**

Shamrock's manufacturing facility at Tirupur (India's main hub for garment production) in the southern Indian State of Tamil Nadu consists of five aesthetically designed buildings spanning a floor area of 90,000 square feet in one compound. The factory is built on 2 acres (8,100 square meters) of land and is surrounded by open land of about 10 acres (40,500 square meters). Aesthetics coupled with ergonomics have been taken into consideration at every stage of the design of the factory, making for efficient and comfortable working conditions. In fact, Shamrock's factory is one of the best modern factory complexes in the area

- **New York office**

Shamrock has recently set up an office in New York, to serve its North American customers better, and execute its expansion plans in the US. Warehousing facilities have been set up for major imports of garments, and home furnishings from the principals in India and redistribute them to clients in the US.

- **Netherlands subsidiary**

Shamrock's director Nicky is now settled in Amsterdam, the Netherlands. He is proprietor of Shamrock B.V. Amsterdam, which acts as agent as well as buyer for products from other concerns of the Group. Shamrock India acts as agent for Shamrock B.V. Amsterdam for its furniture imports from India. Shamrock B.V. also buys stock lots from Group concerns in India as well as from other companies in India. These stock lots are sourced by Shamrock India.

- **Petal shamrock**

In January 1999 a new company, Petal shamrock Pvt. Ltd. was floated by the Shamrock Group, with the objective of adding home furnishings into the Group's product line and expanding into USA in a big way. Petal shamrock too is headquarted in Bombay.

1.3 AREA OF STUDY – DSS

Decision Support Systems (DSS) are a specific class of computerized information system that supports decision-making activities. DSS are interactive computer-based systems and subsystems intended to help decision makers use data, documents, knowledge and/or models to identify and solve problems and make decisions [2]. The five major DSS types or categories are: Communications-Driven DSS, Data-Driven DSS, Document-Driven DSS, Knowledge-Driven DSS and Model-Driven DSS. Decision Support technologies are changing rapidly and a great deal of innovation is occurring related to these types of systems.

Decision support system (DSS) covers a wide variety of systems, tools and technologies. Some may think the term DSS is dated and that it has been replaced by a "new type" of system called on-line analytical processing or OLAP [3]. Others seem to emphasize creating knowledge-based DSS as the "state-of-the-art" in decision support systems. Operations researchers primarily focus on optimization and simulation models as the "real" DSS. But the term decision support system and its acronym DSS remains a useful and inclusive term for many types of information systems that support decision-making.

The two major categories of DSS are: enterprise-wide DSS and desktop DSS. Enterprise-wide DSS are linked to large, data warehouses and serve many managers in a company. Desktop, single-user DSS are small systems that reside on an individual manager's PC. These two categories include a broad range of functionality. Decision makers can drill-down, slice and dice, graph and chart corporate and external data. A highly publicized example is the Decision Maker's Workbench (DMW), developed in 1994 by Mervyn's Department Stores and Micro Strategy.

Enterprise-wide DSS can range from fairly simple systems to complex data intensive and analytically sophisticated executive information systems. From Steven Alter (1980) we can identify enterprise-wide DSS that are primarily file drawer systems that allow for immediate access to data items. At a somewhat more sophisticated level we find data analysis systems that make it easy to manipulate data using computerized analytical tools like statistics packages, data mining, etc. The most sophisticated enterprise-wide analysis systems provide access to a series of decision-oriented databases or data marts, predefined models and charts, and triggers and alerts linked to events or variables in the corporate data warehouse.

The most sophisticated enterprise-wide DSS build on and extend the executive information systems (EIS) advertised in the late 1980s. EIS used "state-of-the-art" graphics, communications, and data storage methods to provide executives easy on-line access to current information about the status of a company.

In most organizations there is a bridge between enterprise-wide DSS, data warehouses, and desktop DSS. Some DSS consultants envision an enterprise-wide DSS that is primarily a file drawer system for providing data that is then analyzed on a PC. This one-way bridge is only one type of DSS architecture. Much thought needs to be given to what data is stored where and how it will be analyzed and displayed. DSS can be both enterprise-wide and on the desktop of a single user. Client-server architecture can create bridges to move data and analyses back and forth from the client desktop and associated DSS tools to server storage and server-based DSS tools. DSS and data can be everywhere and anywhere in an enterprise

Desktop, single-user DSS are not receiving the hype and attention given to enterprise-wide DSS, but they can be especially useful. Sometimes we use spreadsheet programs like Excel or Lotus 1 2 3 for desktop analyses or to develop specific DSS applications for individual managers. Sometimes we purchase specialized DSS packages for an individual PC or for a server. Expert Choice is an example of a specialized package that serves as a desktop DSS.

Expert Choice implements the analytical hierarchy process. This Windows software package can be used to support a number of decision situations, including structuring of complex problems, developing priorities and ranking alternatives, measuring consistency of judgments, allocating resources, and conducting a cost/benefit analysis. The program assists in organizing problem-related information in a hierarchical model consisting of a goal, possible scenarios, criteria, and alternatives. Expert Choice enables the decision maker to systematically make judgments about the relative importance of criteria and the preference for alternatives relative to criteria.

There is also a range of desktop DSS that are available. We can find file drawer DSS on a single executive's PC implemented in Microsoft Access. Accounting and financial models can be implemented as desktop DSS in Microsoft Excel and as programmed components in enterprise-wide DSS. In some organizations analysts prepare a financial analysis using desktop tools and publish the results to the company intranet or EIS. Another DSS tool, simulation, is usually implemented in desktop packages. Optimization software packages and DSS built with them are commonly implemented as single-user desktop packages. In some settings however, a specific DSS optimization model may use live or "real time" data received over a local or wide area network in its calculations. Finally, suggestion model DSS or knowledge-based systems are often implemented as a desktop, single-user application.

Knowledge-based systems are also sometimes called "expert systems". These computer programs analyze data using symbolic logic, have an explicit knowledge base, and have an ability to explain conclusions in a way that users can understand. Knowledge-based systems can be useful to remind an experienced decision maker of options or issues to consider and to help a new manager make a complex decision.

All types of DSS help managers answer questions relevant to a decision situation. The questions may be sophisticated and complex or simple and even somewhat simplistic. For example, a manager might query a database to ask questions like what is total sales for each of the last five years; what items have been out of stock more than 5 days in a month; and which customers had the most orders ($ value) in 1996. Managers may also ask questions like are we meeting profit targets; and what salespersons are meeting their sales goals. A specific DSS may only support operational decision-making or it may support more strategic and long run decision-making and problem solving. DSS have a defined purpose and the subjects or topics covered in the DSS database, the variables included, the time series of data that is available and the tools for retrieving and analyzing data determine the questions we can actually ask and the decision relevant information we can create. The design and capabilities of our DSS influence the fact-based decisions we can make.

DSS designers, builders and users need to be "critical" consumers of DSS. On a more positive note, DSS do NOT have to "do every thing and have all the bells and whistles" to be useful. Decision makers can sometimes benefit greatly from rapidly retrieving a single fact; or benefit from being able to perform a simple ad hoc data analysis; or by viewing data in prespecified reports or "screens" in a rudimentary EIS.

Thus a decision support system (DSS) is an interactive computer-based system intended to help managers make decisions. A DSS helps a manager retrieve, summarize and analyze decision relevant data. It may be primarily a data-oriented DSS or a model-oriented DSS. It may be an enterprise-wide DSS that supports a large group of managers in a networked, client-server environment with a specialized data warehouse or a desktop, single user DSS on the PC in a manager's office. So building a successful decision support system begins with understanding what type of computer-based system we are trying to build and NOT with what we call it.

Decisions are based on information. In most realistic settings, especially in the context of adversarial multi-agent systems, decision-relevant information falls into two categories: (a) measurement-based, e.g., Numerical information about count; and (b) perception-based, e.g., information about intention, likelihood and causal dependencies. Existing methods of systems analysis are based on the assumption that decision-relevant information is measurement-based. What is not widely recognized is that existing methods lack the capability to operate on information, which is perception-based. Development of this capability is one of the principal objectives of Task A. For this purpose, the recently developed methodologies of computing with words and the computational theory of perceptions will be employed.

1.4 DECISION SUPPORT DISCIPLINES

DS encompasses a number of specialized disciplines. Some of them are operations research, decision-analysis, data ware housing, group decision support systems etc.

1.4.1 Operations Research (OR):

OR is the representation of real-world systems by mathematical models together with the use of quantitative methods (algorithms) for solving such models, with a view to optimizing [5].

It can also be defined as mathematical model consisting of:

- Decision variables, which are the unknowns to be determined by the solution to the model.
- Constraints to represent the physical limitations of the system.
- An objective function.
- A solution (or optimal solution) to the model is the identification of a set of variable values which are feasible (i.e. satisfy all the constraints) and which lead to the optimal value of the objective function.

In general terms OR is the application of scientific methods/thinking to decision making. Underlying OR is the philosophy that:

- Decisions have to be made; and
- Using a quantitative (explicit, articulated) approach will lead (on average) to better decisions than using non-quantitative (implicit, unarticulated) approaches (such as those used (?) by human decision makers).

Phases of an OR project:

1. Problem identification

- Diagnosis of the problem from its symptoms if not obvious (i.e. what is the problem?)
- Delineation of the sub problem to be studied.
- Establishment of objectives, limitations and requirements.

2. Formulation as a mathematical model

It may be that a problem can be modeled in differing ways, and the choice of the appropriate model may be crucial to the success of the OR project. In addition to algorithmic considerations for solving the model (i.e. can we solve our model numerically?) we must also consider the availability and accuracy of the real-world data that is required as input to the model.

3. Model validation (or algorithm validation)

Model validation involves running the algorithm for the model on the computer in order to ensure:

- The input data is free from errors
- The computer program is bug-free (or at least there are no outstanding bugs)
- The computer program correctly represents the model we are attempting to validate
- The results from the algorithm seem reasonable

4. Solution of the model

Standard computer packages, or specially developed algorithms, can be used to solve the model. A "solution" often involves very many solutions under varying assumptions to establish sensitivity.

5. Implementation

This phase may involve the implementation of the results of the study or the implementation of the *algorithm* for solving the model as an operational tool (usually in a computer package).

In the first instance detailed instructions on what has to be done (including time schedules) to implement the results must be issued. In the second instance operating manuals and training schemes will have to be produced for the effective use of the algorithm as an operational tool.

1.4.2 Decision Analysis:

A decision is the process of choosing the best from the alternatives [2]. Decision analysis is used to determine optimum strategies where a decision-maker is faced with several decision alternatives. Studies have shown that there are several decision-making situations:

a. Decisions under certainty: it deals with only one outcome for a decision.
b. Decisions under conflict: it is otherwise known as decision-making under partial uncertainty. Here only partial knowledge is available.
c. Decisions under uncertainty: it refers to situations where more than one outcome can result from any single decision.
d. Decisions under risk: it refers to situation where in the decision-maker chooses from among several possible outcomes where probabilities of occurrences can be stated (or determined) objectively from the past data.

Decision-Tree: A decision-tree is a graphic display of various decision alternatives and the sequence of events. A decision-tree diagram is shown in fig1.1:

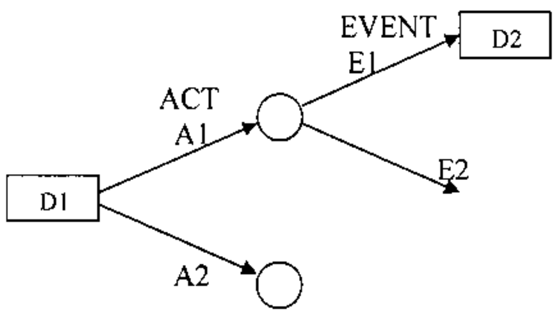


Fig1.1: The Decision Tree

When probabilities of various events are known, they are written along the corresponding branches. Multiplying the probabilities along the branches results in the joint probabilities for the corresponding act-event sequence. Thus in a decision tree the decision-maker lists all possible alternatives, possible events and resulting payoff values along with their probabilities for each act-event sequence. Thus a decision-tree is highly useful to a decision-maker in multistage situations, which involve a series of decisions each dependent on the preceding one.

1.4.3 Data warehousing:

Data warehouse is a repository of multiple heterogeneous data sources, organized under a unified schema in order to facilitate management decision making [18]. Data warehouse technology includes data cleansing, data integration and OLAP, that is, analysis techniques with functionalities such as summarization, consolidation, and aggregation, as well as the ability to view information from different angles. In warehouses, data is typically represented in the form of decision cubes [2].

It is a large store of data for analysis. Organizations use data warehouses (and smaller 'data marts') to help them analyze historic transaction data to detect useful patterns and trends. First of all the data is transferred into the data warehouse using a process called extracting, transforming and loading (ETL). Then it is organized and stored in the data warehouse in ways that optimize it for high-performance analysis. The transfer to a separate data warehouse system, which is usually performed as a regular batch job every night or at some other interval, insulates the live transaction systems from any side-effects of the analysis, but at the cost of not having the very latest data included in the analysis. A data warehouse can be normalized or denormalized. It can be a relational database, multidimensional database, flat file, hierarchical database, object database, etc. Data warehouse data often gets changed. And data warehouses often focus on a specific activity or entity.

Any forecast is subject to uncertainty; however, a database storing weekly forecasts may be generated and compared to actual sales data after the fact. When this process is applied continuously, the result is a dynamic database accumulating uncertain data. Once such a database is generated, managers may use On Line Analytical Processing (OLAP) and data mining techniques to make better decisions. Researchers have proposed several data models based on multiple dimensions, referred to as multidimensional data models. Most of them are based on a concept called *data cube*. Data cubes are primary data structures in OLAP and Data Warehousing (DW) products. Thomas and Datta (2001) proposed one such conceptual multidimensional data model. Advantages of this model include its theoretical framework and associated algebra, which is relationally complete, consistent, and closed.

1.4.4 GDSS:

The first example or application for a groupware is **GDSS**, which stands for Group Decision Support System. A Group Decision Support System (GDSS) is an interactive, computer-based system that helps a team of decision-makers solve problems and make choices [2]. GDSS are targeted to supporting groups in analyzing problem situations and in performing group decision-making tasks. The name is very descriptive. A GDSS is a hybrid system that uses an elaborate communications infrastructure and heuristic and quantitative models to support decision-making.

The GDSS started originally from the Management Information System at University of Arizona. Some kind of problems has always been observed that are associated more with large meetings than with small meetings. By large meetings means meetings with generally more than 15 participants, but can go much beyond that, e.g. 40 or even 50. Some of the identified problems are:

- Time consuming;
- Dominance over the meeting; and
- Honesty and participation.

In a GDSS environment, there is usually a big room with something like 40 seats, which means that 40 people can be at the meeting at any one time. There are not only 40 seats but also 40 microcomputers. This enables every participant to have the use of one microcomputer during the course of the meeting. The reason why each participant needs a microcomputer depends on how GDSS works.

In the GDSS, with special computer software, the facilitator of each meeting will first make the agenda of the meeting, which will be projected onto a big screen that everyone can see. Then the participants will type simultaneously in their ideas of the topic of discussion on the individual microcomputers next to them. Then the computer will sort the ideas, and then the participants will then vote or comment on which ideas they like or they dislike. In the course of the whole meeting, GDSS stores, categorizes and prints out all the ideas, comments and vote tallies, so that each of the meeting participants will get a summary of the meeting when it ends.

GDSS enables meeting participants to simultaneously "talk", when the computer sorts and sends ideas to each of the terminal, all at the same time. That saves a tremendous amount of time, because all these are done electronically instead of manually, and the time saved will enable participants to spend more time manipulating and expressing their ideas. This can consequently increase the productivity and efficiency of the group. The time-consuming benefit also has an added bonus: when productivity and efficiency in meetings increase, it is likely that the team spirit can be consolidated, resulting in an increase of the strength of binding among team members.

Besides, under this GDSS, no one can dominate the meeting. This is because of another feature of GDSS. GDSS provides an anonymous scheme, so that whatever we type in the terminal (i.e. our opinion) will be protected. Under this circumstance, no one really knows who is typing what. Because of this, not a single person can dominate the meetings. In the worst case, we might say "some ideas" are dominating the meeting, but this is perfectly fine because this is as a matter of fact an aim of the GDSS: to help meeting participants voice their opinions from an idea-oriented mindset.

Given the very broad nature of GDSS today, it is impossible to design a perfect GDSS that would be both highly precustomized *and* highly customizable. However, as these two system attributes are well understood in software engineering, it remains possible to apply them to the container of the DSS. To reach that goal, the basic functionalities including those of the user interface—should not depend on any specific contents. This component is called a DSS software framework. For example, the DS laboratory at the University of Fribourg, Switzerland, is working on a Java- and Jini-based software framework for developing distributed cooperative DSS [15].

1.5 LITERATURE SURVEY

Ganapathy, S., Narayanan, S. and Srinivasan, K. (2003) studied the supply chain logistics planning and developed a model. Their study dealt with a simulation based decision support for supply chain logistics. Their model featured a decision support system that aided humans in making decisions and studied the role of a decision support system in enhancing the performance of the supply chain logistics system. The model was object oriented in nature, which helped the rapid prototyping of the different components of the system.

Raj Gopal, K. and Sudhakara Reddy, A. (2004) made a study on productivity measurement and monitoring models of a SSI unit. They had developed a DSS for the SSI unit for generation of dynamic planning.

Retzlaff-Roberts, D.L and Amini, M. (2004) studied the supply chain management and cycle time reduction at the University of Memphis. They developed a DSS, which examined the problem for a major international manufacturer of medical diagnostic equipment. A decision support tool was developed to assist the organization in deciding where service parts should be inventoried and in what quantity to minimize total inventory and logistics cost while meeting a demanding customer service requirement.

An application of DSS to the time table scheduling using goal programming model [12] states that DSS is an integral part of decision maker's approach to "Problem Finding". The DSS with the computer base blends operations research to help the management in solving the problems.

Lehmann, H. and Lehner, F. (2005) made a study on Holistic Perspectives of information sharing and knowledge exchange. The aim of their study is to provide a review – from a predominantly European perspective – that allows an overall evaluation of the state of the literature on this subject. They illustrated with a set of models – selected predominantly for their link to empirical research. They summarized and evaluated with their potential for providing a basis for future research.

Adelina, G.A and Venkataramanaiah, S. (2004) studied the process involved in a food processing industry and developed a database for productivity analysis. Their study focused on the process measurement, evaluation and improvement of labor productivity through human resource planning in a food processing industry. A suitable database was designed to comprehensively and accurately deal with the productivity data for future reference and comparative analysis. Their study has shown 35% average man power productivity growth.

Moole, B.R and Korrapati, R.B. (2004) developed a model for forecasting in inventory management using probabilistic multidimensional data model. An algorithm using mathematical concept based on set theory, probability axioms and the basyesian framework, as well as algebra to manipulate data and a framework to modify data, were developed and a decision support system model for business in the area of inventory management was presented. The DSS model is in continuous process improvement and it has made significant progress over prior models.

The study shows that there is an immense need for further study in respect of materials management for effective planning and decision-making.

CHAPTER 2

BASIC DSS CONCEPTS

2.1 HISTORY OF DSS

Decision Support Systems evolved early in the era of distributed computing. The history of such systems begins in about 1965 [2]. Information Systems researchers and technologists have built and investigated Decision Support Systems (DSS) for more than 35 years.

Prior to 1965, it was very expensive to build large-scale information systems. At about this time, the development of the IBM System 360 and other more powerful mainframe systems made it more practical and cost-effective to develop Management Information Systems (MIS) in large companies. MIS focused on providing managers with structured, periodic reports. Much of the information was from accounting and transaction systems.

In the late 1960s, a new type of information system became practical – model-oriented DSS or management decision systems. Two DSS pioneers, Peter Keen and Charles Stabell, claim the concept of decision support evolved from "the theoretical studies of organizational decision making done at the Carnegie Institute of Technology during the late 1950s and early '60s and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s".

According to Sprague and Watson (1979), around 1970 business journals started to publish articles on management decision systems, strategic planning systems and decision support systems. For example, Scott Morton and colleagues published a number of decision support articles in 1968. In 1969, Ferguson and Jones discussed a computer aided decision system in the journal *Management Science*. In 1971, Michael S. Scott Morton's ground breaking book **Management Decision Systems: Computer-Based Support for Decision Making** was published. In 1966-67 Scott Morton had studied how computers and analytical models could help managers make a key decision. He conducted an experiment in which managers actually used a Management Decision System (MDS). Marketing and production managers used an MDS to coordinate production planning for laundry equipment. MDS ran on an IDI 21 inch CRT with a light pen connected using a 2400 bps modem to a pair of Univac 494 systems. Scott Morton's (1967) dissertation research was a pioneering implementation, definition and research test of a model-driven decision support system.

T.P. Gerrity, Jr. focused on Decision Support Systems design issues in his 1971 **Sloan Management Review** article titled "The Design of Man-Machine Decision Systems: An Application to Portfolio Management". His system was designed to support investment managers in their daily administration of a clients' stock portfolio. DSS for portfolio management have become very sophisticated since Gerrity began his research.

In 1974, Gordon Davis, a Professor at the University of Minnesota, published his influential text on Management Information Systems. He defined a Management Information System as "an integrated, man/machine system for providing information to support the operations, management, and decision-making functions in an organization. By 1975, J. D. C. Little was expanding the frontiers of computer-supported modeling. Little's DSS called Brandaid was designed to support product, promotion, pricing and advertising decisions. Also, Little (1970) in an earlier article identified criteria for designing models and systems to support management decision--making. His four criteria included: robustness, ease of control, simplicity, and completeness of relevant detail. All four criteria remain relevant in evaluating modern Decision Support Systems.

In the late 1970s, both practice and theory issues related to DSS were discussed at academic conferences including the American Institute for Decision Sciences meetings and the ACM SIGBDP Conference on Decision Support Systems in San Jose, CA in January 1977. The first International Conference on Decision Support Systems was held in Atlanta, Georgia in 1981. Academic conferences provided forums for idea sharing, theory discussions and information exchange. MIT researchers including Peter Keen and Michael Scott Morton were especially influential. Keen and Scott Morton's DSS textbook (1978) provided a broad behavioral orientation to Decision Support System analysis, design, implementation, evaluation and development.

By the late 1970s, a number of researchers and companies had developed interactive information systems that used data and models to help managers analyze semi-structured problems. These diverse systems were all called Decision Support Systems. From those early days, it was recognized that DSS could be designed to support decision-makers at any level in an organization. DSS could support operations, financial management and strategic decision-making. DSS could use spatial data in a system like Geodata Analysis and Display System

(GADS), structured multidimensional data and unstructured documents. A variety of models were used in DSS including optimization and simulation. Also, statistical packages were recognized as tools for building DSS. Artificial Intelligence researchers began work on management and business expert systems in the early 1980s.

Financial planning systems became popular decision support tools. The idea was to create a "language" that would allow executives to build models without intermediaries. A popular financial planning systems called IFPS, an acronym for interactive financial planning system, was originally developed in the late 1970's by Gerald R. Wagner and his students at the University of Texas. Wagner's company, EXECUCOM Systems, marketed IFPS until the mid 1990s. One major advantage that a planning language has over a spreadsheet is that the model is written using natural language and the model can be separated from the data. In the early 80s, spreadsheets were also used for building model-driven DSS.

In the early 1980s, academic researchers developed a new category of software to support group decision-making. Mindsight from Execucom Systems, GroupSystems developed at the University of Arizona and the SAMM system developed by University of Minnesota researchers were early Group DSS. Dickson, Poole and DeSanctis (1992) report that Brent Gallup, a Ph.D. student at Minnesota, decided in 1984 "to program his own small GDSS system in BASIC and run it on his university's VAX computer". That system was the start of the Minnesota GDSS studies.

Nylund (1999) traces the developments associated with Business Intelligence (BI) to Procter & Gamble's efforts in 1985 to build a DSS that linked sales information and retail scanner data. Metaphor Computer Systems, a spinoff of researchers from Xerox's Palo Alto Research Center (PARC), built the early P&G DSS. Metaphor alumni latter founded many of the BI vendors: Richard Tanler founded Information Advantage and Katherine Glassey co-founded Brio Technologies. The term BI is a popularized, umbrella term supposedly introduced by Howard Dresner of the Gartner Group in 1989. BI describes a set of concepts and methods to improve business decision making by using fact-based support systems. BI is sometimes used interchangeably with briefing books, report and query tools and executive information systems. Business Intelligence systems are data-driven DSS.

Beginning in about 1990, Bill Inmon and Ralph Kimball actively promoted DSS built using relational database technologies. For many MIS practioners, DSS built using Oracle or DB2 were the only decision support systems they were exposed to in the popular computing literature. Model-driven DSS were in the domain of operations research and were not part of Information Systems. Ralph Kimball was "The Doctor of DSS" and Bill Inmon was the "father of the data warehouse". Inmon defined decision support system (DSS) as "a system used to support managerial decisions. Usually DSS involves the analysis of many units of data in a heuristic fashion. As a rule, DSS processing does not involve the update of data. "Inmon and Kimball focused on building data-driven DSS.

In the early 1990s, a major technology shift occurred from mainframe-based DSS to client/server-based DSS. Some desktop OLAP tools were introduced during this time period. In 1992-93, some vendors started recommending object-oriented technology for building "re-usable" decision support capabilities. In 1994, many companies started to upgrade their network infrastructures. DBMS vendors "recognized that decision support was different from OLTP and started implementing real OLAP capabilities into their databases". Paul Gray asserts that around 1993 the data warehouse and the EIS people found one another and the two niche technologies have been converging. In 1995, data warehousing and the World Wide Web began to impact practitioners and academics interested in decision support technologies. Web-based and web-enabled DSS became feasible in about 1995.

The Internet and Web have speeded-up developments in decision support and have provided a new means of capturing and documenting the development of knowledge in this research area.

2.2 DECISION MAKING AND KNOWLEDGE

For today's aspiring managers, a practical grasp of computer-based decision support is essential. The decision support systems store and process certain kinds of knowledge at much higher speeds than the human mind. In addition to such efficiency advantages, they can also be more effective in certain kinds of knowledge handling because they are not subject to such common human conditions as oversight, forgetfulness, miscalculation, bias, and stress. Failure to appreciate or exploit such decision support possibilities can put managers and their organizations at a major disadvantage.

Decision support systems can fit into a manager's activities [9]. Decision making can have far reaching impacts on a manager's efforts to excel. As a decision maker, the manager is very much concerned with handling knowledge. This is exactly where decision support systems can help. They automate various knowledge management tasks. Decision support systems are fundamentally concerned with improving the effectiveness and efficiency of knowledge management activities, which occur in the course of decision-making.

Decision-making is an activity culminating in the choice of a course of action. It can also be seen as a manufacturing activity that produces a new piece of knowledge committing us to a course of action.

Decisions are not manufactured in a vacuum. They are made within some setting or context. We can consider contextual differences in terms of such factors as management level, situation maturity, decision concurrency, and organization design. All decisions are not of the same type. They can be classified according to such factors as managerial levels, managerial functions, functional area distinctions, degree of structured ness, and presence of negotiation. An appreciation of decision contexts and types can help us understand what features would be useful to have in a decision support system. The same can be said for an appreciation of decision makers and decision processes.

All decision makers are not alike. Some are individuals. Others have multiple participants. Some multi- participant decision makers are teams, others are groups, and yet others are organizations. Differences in decision contexts, types, and makers suggest that there may also be differences in decision support systems.

There are certain common traits that decision-making processes tend to exhibit. They typically involve the phases of intelligence, design, and choice. They are very much concerned with the recognition and subsequent solution of problems. A decision-making episode is a flow of problem solving episodes [9]. Decision-making processes are based on strategies to guide the flow. Some common strategies include optimizing, satisfying, and incrementalism. Decision support systems can help in any of the phases, in problem recognition and solution efforts, and in the implementation of various strategies.

The need for decision support systems stems from the realities of cognitive, economic, and temporal limits. The capacity for having decision support systems stems from ongoing technological advances that put inexpensive, yet powerful, computers on our desktops, in our vehicles, and even in our pockets. It also stems from conceptual and software advances made by decision support researchers and practitioners. The nature of support that can be furnished by a DSS has progressed rapidly over the past decade and is likely to make continued advances. Because knowledge forms the fabric of decision-making, all the various kinds of support that a DSS can provide are essentially exercises in knowledge management.

The topic of knowledge is often taken for granted in discussions of decision-making, problem solving, decision support, and computer systems. It is sometimes vaguely equated with the notion of information, masking important distinctions between information and other types of knowledge. Also knowledge is the object of decision-making and problem solving.

There are various states of knowledge that result from acquisition and derivation. Knowledge production involves stocks and flows of knowledge. The flows are concerned with acquiring knowledge and deriving knowledge [3]. Both are typically interspersed in a decision-making process and there can be tradeoffs between acquiring and deriving needed knowledge. The source of knowledge can influence its quality. Validity and utility are two major aspects of knowledge quality.

Knowledge management is a field of study, which is concerned with the representation and processing of knowledge. It is related to investigations in the field known as cognitive science [3]. Knowledge management can be focused from two angles. First, there are a number of computerized techniques that have arisen with their own distinctive approaches to representing and processing knowledge. A good grounding in decision making and problem solving principles is essential for appreciating the roles of each technique. Second, the six important types of knowledge that decision makers need to manage.

Knowledge-based systems are also sometimes called "expert systems". These computer programs analyze data using symbolic logic, have an explicit knowledge base, and have an ability to explain conclusions in a way that users can understand. Knowledge-based systems can be useful to remind an experienced decision maker of options or issues to consider and to help a new manager make a complex decision. All types of DSS help managers answer questions relevant to a decision situation. The questions may be sophisticated and complex or simple and even somewhat simplistic. For example, a manager might query a database to ask questions like what is total sales for each of the last five years; what items have been out of stock more than 5 days in a month; and which customers had the most orders ($ value) in 1996. Managers may also ask questions like are we meeting profit targets; and what salespersons are meeting their sales goals. A specific DSS may only support operational decision making or it may support more strategic and long-run decision making and problem solving. DSS have a defined purpose and the subjects or topics covered in the DSS database, the variables included, the time series of data that is available and the tools for retrieving and analyzing data determine the questions we can actually ask and the decision relevant information we can create. The design and capabilities of our DSS influence the fact-based decisions we can make.

DSS designers, builders and users need to be "critical" consumers of DSS. On a more positive note, DSS do NOT have to "do every thing and have all the bells and whistles" to be useful. Decision makers can sometimes benefit greatly from rapidly retrieving a single fact; or benefit from being able to perform a simple ad hoc data analysis; or by viewing data in prespecified reports or "screens" in a rudimentary EIS.

2.3 FOUNDATIONS OF DECISION SUPPORT SYSTEMS

The purpose of a DSS can be viewed as facilitating one or more of a decision maker's abilities, aiding in one or more of the three decision-making phases, improving the flows of problem solving, assisting decision makers in dealing with unstructured and semi structured decisions, or helping decision makers manage knowledge. The main traits of DP and MIS forerunners are the foundation for understanding what characteristics a DSS shares with other kinds of computer systems and what characteristics distinguish a DSS from the others.

The benefits provided by a particular DSS depend not only on specific features of that DSS, but also on the natures of the decision maker and the decision situation. Even though they may offer many benefits, DSSs are not panaceas. They do have limits of various kinds.

Four behavioral categories that can be expected from a DSS are identified: accepting requests, making responses, possessing knowledge, and processing [9]. For each supporting behavior of a HDSS, there are comparable behaviors for a DSS. Some of these are commonly observed in today's DSSs. Others are rarer or only partially exist in DSSs. Further technological advances will determine the extent to which DSSs can more fully provide the services of HDSSs. From the perspective of generic DSS framework, a decision support system can be studied in terms of four interrelated elements: a language system, a presentation system, a knowledge system, and a problem processing system. The first three of these are systems of representation: the set of all requests a user can make, the set of all responses the DSS can present, and the knowledge representations presently stored in the DSS. The problem processor is a dynamic system that can accept any request in the LS and react with a corresponding response from the PS. Which response corresponds to which request is determined by the PPS, often in light of the knowledge available to it in the KS. That is, a change in the KS could very well yield a different response for the same request. As in the case of a HDSS, some DSSs can even produce responses without having received a corresponding request. In addition to reacting to users, they take initiative in the processing of knowledge. There are many special cases of the generic DSS framework, each characterizing a distinct class of decision support systems. They differ in terms of their emphasis on one or another popular knowledge management technique.

The survey of specialized frameworks serves several purposes. First, it reinforces an understanding of the generic framework, by illustrating what is meant by a KS, PPS, LS, and PS. Second, it offers an overview of important kinds of DSSs. Third, the survey gives a brief introduction to various knowledge management techniques: text management, database management, spreadsheet management, solver management, and rule management. Fourth, it provides a helpful background for building decision support systems.

The practice of building Decision Support Systems can benefit in many ways from the availability of Web technologies. These technologies provide platform-independent, remote, and distributed computation and the exchange of complex multimedia information. The state of practice has benefited considerably from these technologies but much, in our view, remains to be done. While there is significant promise in the idea of Web-Based Decision Support Systems there are also some important challenges that must be overcome. We need to resolve technological, economic and social and behavioral challenges to realize the benefits the Web can provide as a platform for building Decision Support Systems.

Decision support capabilities are of great interest to a broad range of stakeholders and enormous resources have been and will be committed to building systems that promise to improve the quality, speed and effectiveness of specific decisions. We see the Web as a technology that can help realize these goals, but expectations need to be managed "downward" and we need to restrain the hype about creating intelligent enterprises and putting decision information at the "decision-makers finger tips". We have not answered all of the questions about how to support decision makers. We need to do much more than implement our technologies to build effective Decision Support Systems.

2.4 KNOWLEDGE MANAGEMENT TECHNIQUES FOR DECISION SUPPORT

There is four knowledge management techniques that can be usefully employed in decision support systems: expression management, text management, hypertext management, and database management [9]. Problem processors that implement expression management are valuable for helping decision makers with ad hoc calculations that arise in the course of decision making. The main objects of interest with this technique are expressions, variables, functions, and macros. These can also be manipulated within the scope of other knowledge management techniques.

A problem processor that implements text management gives decision makers the ability to work with electronic documents. These are not restricted to representing any particular kind of knowledge. However, such representations are processed simply as documents, without concern for the type of knowledge held. In cases where knowledge represented in one document is logically related to that in others, a PPS that implements hypertext management is valuable. This allows knowledge to be organized into an interconnected network of documents called a hyper document. The decision maker can follow markers or a map to navigate through the network to access those documents that seem relevant to the decision at hand.

Database management gives a comparatively structured way for organizing knowledge and has historically been used primarily for descriptive knowledge. When a PPS implements database management, it will contain software known as a database control system and the KS will hold one or more databases. Using the relational approach to database management, each database is composed of one or more tables. Each table has a structure defined in terms of fields and a content organized into records. With a query facility, decision makers can extract desired data from a database on the spur of the moment.

2.5 BUILDING OF DECISION SUPPORT SYSTEMS

The spectrum of DSS developers ranges from novice do-it-yourself developers to experienced professional developers. In either case, successful DSS development depends on understanding what the end user needs, familiarity with the problem domain, knowledge source access, appropriate tool selection, and skill in using computer technology. The latter two are typically strengths of a professional developer, while the others tend to be the strongest points of a do-it-yourself developer. The technical skills of do-it-yourself developers can be strengthened by books and supplemented by technical assistance from information centers.

The process of do-it-yourself development begins with the recognition of a need or opportunity for decision support. This leads to a setting of broad objectives and evaluation standards for the envisioned DSS, plus a plan for the DSS development project. A typical development project includes the phases of analysis, design, and implementation. Analysis involves the production of a detailed set of requirements that the prospective DSS should meet. These include functional, interface, and coordination requirements.

The design phase is an exercise in figuring out how the system requirements can be satisfied, usually with respect to the facilities furnished by a selected development tool(s). One-way to structure the design effort is in terms of DSS architectural elements: LS design, PS design, KS design, and PPS design. Often, because of the tool used, there is no PPS design needed and LS or PS design tends to be minimal.

In the implementation phase, a developer uses a selected tool(s) to transform DSS designs into an operational system. This usually concentrates on depositing knowledge into the KS according to the KS blueprints. Before the DSS is operational, a developer tests it to check whether it behaves as expected. If it does not, corrective action is taken. Implementation also entails documentation of the DSS to aid in smooth operation. An implemented DSS becomes operational when it is installed for use in a work environment. During the operational phase of its life, a DSS can undergo incremental modifications and redevelopment. It is also subject to general administration. For a do-it-yourself developer, some or most parts of the development process outlined here may be carried out more or less informally.

Development tools are essential for building DSSs. The tool(s) chosen for developing a particular DSS strongly influences not only the development process, but also the features that the resultant DSS can offer to a user. Available tools can be examined from several vantage points that help in understanding their influences on the process and product of DSS development. Four of these perspectives are: technique orientation, role in development, interface styles allowed, and integration approaches.

A particular tool is oriented toward one of more knowledge management techniques. Conversely, a particular technique (in its many possible variants) is offered by more than one development tool. Thus, tools can be categorized in terms of the knowledge management techniques they furnish. A spreadsheet tool offers some variant of the spreadsheet technique for knowledge management; a database tool provides some variant of a database technique for managing knowledge, and so on. Although many tools tend to emphasize one technique or another, vestiges of additional techniques are often apparent. Some tools furnish healthy doses of multiple techniques (e.g., as with a spreadsheet tool that is also a database tool).

A different way to classify tools is based on their roles in a development process. We can distinguish among 1) an intrinsic tool, which will serve as the PPS of the developed DSS, 2) a partially intrinsic tool, which will serve a part of the DSS's problem processor, and 3) an extrinsic tool, which does not participate in that PPS. An extrinsic tool helps the developer produce all or part of the PPS or to create some portion of the KS contents. Do-it-yourself development trends to rely primarily on intrinsic tools. Tools in the other two categories are primarily of interest to experienced or professional developers.

Development tools can be differentiated with respect to interface styles they allow to be incorporated in DSSs. A DSS's interface is defined in terms of its LS, its PS, its PPS facilities for interpreting, assisting, and packaging, and its linguistic or presentation knowledge held in the KS. With respect to the LS, an interface style refers to the means available for user to make requests. Possibilities include command-oriented, natural language, menu-driven, form-oriented, question/answer, various kinds of direct manipulation, and combinations of these. With respect to the PS, assistance messages can follow the foregoing styles. Results messages can be classified as textual (free-form and structured) versus graphical. Developers are well advised to be familiar with all of these possibilities and to pay close attention to which of them a tool allows.

Another important angle from which to know about development tools involves the types of integration they permit within DSSs. This is relevant whenever multiple knowledge management techniques are employed within the bounds of a single DSS. These techniques may be integrated within a single tool or across multiple tools. In the former case, nested and synergistic integration are distinct possibilities. In the latter case, integration can be via a direct format conversion, clipboard, or confederation approach. These five integration styles have various advantages and disadvantages relative to each other. It is not unusual for more than one of them to be employed in a single DSS.

Modern decision support systems (DSS) provide a wide range of capabilities. Computerized systems support decision tasks like information gathering, model building, sensitivity analysis, collaboration, evaluation and implementation. DSS are often integrated in business decision processes and the primary enabling technology for delivering decision support is now the global Internet and the World-Wide Web. The two most widely implemented approaches for delivering decision support are Data-Driven and Model-Driven DSS. Data-Driven DSS help managers organize, retrieve, and synthesize large volumes of relevant data using database queries, OLAP techniques, and data mining tools; Model-Driven DSS use formal representations of decision models and provide analytical support using the tools of decision analysis, optimization, stochastic modeling, simulation, statistics, and logic modeling. Three other approaches have become more wide spread and sophisticated because of Web technologies.

2.6 COMPUTER-BASED SYSTEMS THAT SUPPORT THE DECISION-MAKING

Computer-based systems that support the decision-making efforts of decision makers are composed of multiple participants. These multiparticipant decision support systems (MDSSs) can be categorized into those that support groups (GDSSs) and those that support more complex organizations of decision-making participants (ODSSs). Cutting across these two categories are MDSSs specifically oriented toward supporting negotiated decisions (NSSs). Depending on the organization infrastructure of a decision maker, one or another of these MDSS types will be most appropriate. The appropriateness of a MDSS's fit with a particular decision maker can be gauged in terms of the natures of the roles, relationships, and regulations that make up its infrastructure.

MDSSs do have various traits in common. All fit into one or more of the time/place categories. That is, every MDSS is oriented toward some arrangement of decision-maker participants in time and space. All MDSSs adhere to the generic DSS architecture. With this architecture, four potential kinds of users are identified. The PPS and/or KS can be distributed across multiple linked computers. The LS and PS can have public and private messages. The KS can hold system knowledge, domain knowledge, and relational knowledge. The KS can hold public and private knowledge. The PPS has participant coordination ability in addition to knowledge acquisition, selection/derivation, and presentation abilities. Some PPS abilities may be exercised by individuals doing individual work, while others involve joint work.

Group decision support systems have been the most extensively studied and widely implemented type of MDSS. Relative to individual work, group work has the potential for certain gains and losses. GDSSs are intended to help the potential gains from group work to become actual gains, while helping prevent potential losses due to group work. GDSSs can be classified into various types based on their architectural features, the time/place categories into which they fit, levels of support they offer to a decision maker, or available technologies that can be applied.

Tools for building GDSSs encompass a considerable variety of processors that are ready-made for inclusion in PPS. Choosing an appropriate tool(s) is one of a variety of factors that have been found to be important for GDSS success. Unlike DSSs for individuals, usage of a GDSS often involves a facilitator who can strongly influence group performance with the GDSS. Researchers have discovered that effects of GDSS usage depend on situational factors as well as the technology itself.

Organizational decision support systems are for multiparticipant decision makers that are more complex than groups. ODSS research and practice are not as well developed as in the case of GDSSs. Yet, different types of ODSSs have been identified, specialized ODSS architectures have been advanced, development guidelines have been recommended, and candidate technologies for use in ODSS development have been identified. In the case of negotiation support systems a wide range of support possibilities have been recognized and a number of them have been implemented and studied in NSSs. Also, a way for categorizing NSSs has been advanced. Exploration of the diverse kinds of ODSSs and NSSs that are possible is still in an early stage, but is likely to mature rapidly in the years ahead.

CHAPTER 3

MANUFACTURING INFORMATION SYSTEMS

3.1 INTRODUCTION TO MANUFACTURING INFORMATION SYSTEMS

Manufacturing management uses the computer both as a conceptual system and as an element in the physical production system [6]. The evolution of the computer as a conceptual manufacturing system is easiest to handle the inventory problems. Initially there were systems that keyed on reorder points. Then came the MRP concept-first applied as material requirements planning and then as manufacturing resource planning. The MRP systems are one approach to inventory management. Another is Just-In-Time (JIT). JIT is unique among modern production concepts in that it does not rely heavily on computer technology.

The manufacturing information system consists of three input subsystems and four output subsystems. The accounting information system captures data in real time, describing the utilization of the physical resources. The industrial engineering subsystem provides production standards that facilitate management by exception. The manufacturing intelligence subsystem enables management to stay current on activities of its labor unions and suppliers.

This input data is transformed into information by the output subsystems. The production subsystem enables management to both build and operate manufacturing facilities. The inventory subsystem uses mathematical formulae for when to reorder and how much. The quality subsystem is based on the fundamentals of total quality management (TQM), and it enables the firm to achieve product quality by monitoring the flow of materials, beginning with its receipt from suppliers, through the production process, and ending with consumption or use by the firm's customers. The cost subsystem permits management to control the cost of these production activities by means of information feedback.

3.2 COMPUTERS AS AN INFORMATION SYSTEM

The term manufacturing information system describes the CBIS subsystem that provides information concerning the production operations [6]. The output from the manufacturing information system is used to both create and operate the physical production system. After the first computers were successfully applied in the accounting area, they were given the task of managing the firm's inventory. The simplest approach is a reactive one waiting for an item balance to reach a particular level, which then triggers a purchase order or a production process. The item level that serves as the trigger is called the reorder point (ROP) and a system that bases the purchasing decision on the reorder point is called a reorder point system. Much has been accomplished in the use of computer-controlled machines in the production area. These machines can do jobs that were formerly done by workers. The machines cost less than the workers and are capable of performing better. Attempts to automate the factory initially met with resistance from organized labor. Overtime, however, resistance has diminished as it has become clear that a firm must take advantage of computer technology if it is to survive in the world market.

The manufacturing information system encompasses all of the applications of the computer in the manufacturing area as a conceptual system [6]. A model of such a system is illustrated in the following figure:

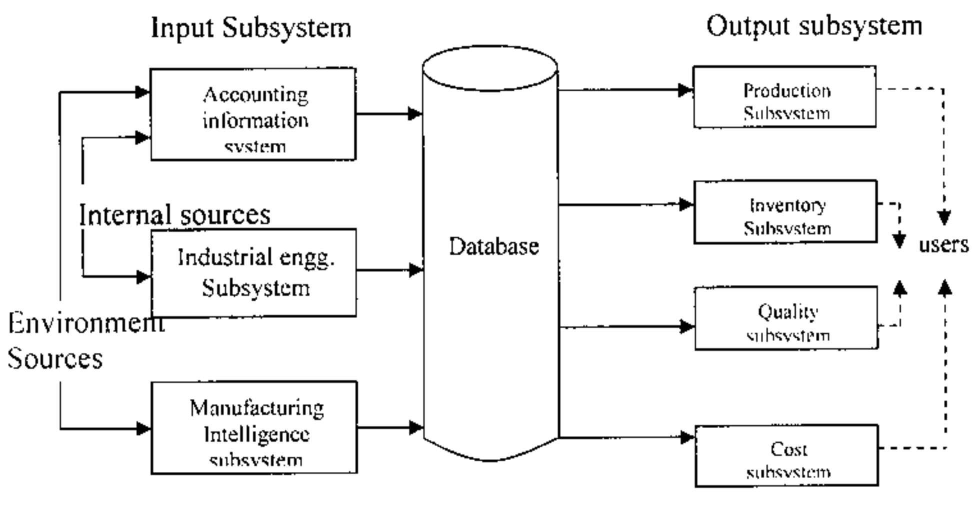


Fig 3.1: A Model of a Manufacturing Information System

Input Subsystem:

The accounting information system gathers internal data describing the manufacturing operation and environmental data that describe the firm's transactions with its suppliers.

The industrial engineering subsystem is like the marketing research subsystem in so far as it consists primarily of special data-gathering projects. The two subsystems are dissimilar in that the industrial engineering subsystem gathers data from inside the firm rather than from the environment.

The manufacturing intelligence subsystem gathers data from the environment. Suppliers and labors are the special responsibility of manufacturing.

Output Subsystem:

The four output subsystems measure separate dimensions of the production process. The production subsystem measures the process in terms of time - tracking the workflow from one step to the next. The inventory subsystem measures the volume of the production activity as the inventory is transformed from raw materials into work-in-process and finally into finished goods. The quality subsystem measures the quality of the materials as they are transformed. The cost subsystem measures the costs that are incurred in the production process.

CHAPTER 4

MATERIALS MANAGEMENT

4.1 AN INTRODUCTION TO MATERIALS MANAGEMENT

Materials management covers all aspects of materials, cost, materials supply and utilization. It covers the whole range of functions involved in converting raw materials and ancillary supplies into finished products. It is concerned with the planning and programming of materials and equipments, market research for purchase; pre-design value analysis, procurement of all materials including capital goods, raw materials, components and assemblies, finishing materials, packing and packaging materials, stores control and inventory control; transportation of raw material and material handling; value analysis, disposal of scrap, surplus and salvage and operation research for materials [14].

Materials management can be defined as a body of knowledge which helps the manager to improve the productivity of capital by reducing materials costs, preventing large amounts of capital being locked up for long periods and improving the capital turn over ratio [7]. The prime objective is to supply the user department with the required quantity at a constant rate with uniform quality, so that production or service rendered is not held up. Materials management objective should be balanced and responsibility for achievement should be delegated to a materials manager who has authority to do the job. The materials manager should always reevaluate the objective when business conditions change.

The inter-related functions of materials management are normally looked after by individuals. As the activities expand, the functions of each individual become more and more specialized. The integrated materials management requires central coordination of all these inter-related activities. Therefore the internal structuring of the various functions as well as the relationship of the materials management division with the other divisions – technical, finance and marketing – in the overall organization becomes critical. The materials management function ought to be headed by a competent professional who must be a member of the top management team as managing materials is a critical function.

Broadly, the materials management will have to work in close coordination with production, marketing and finance departments. Only an atmosphere of mutual trust will ensure that these departments will work towards the total organizational objectives. For instance, production will have to keep the materials management department informed about its plans and schedules. Even the adjustments in the sales forecasting, or the changes in the schedules must be duly conveyed to materials management. In the same way, the materials management department must keep the production department informed about the list of suppliers, availability of new products and anticipated delays so that rescheduling of production could be done and costly stock-outs avoided.

In many organizations formal committees consisting of executives drawn from marketing, production, finance and materials management departments are formed to finalize (periodic) annual targets, production programmes, total budget, etc. Now-a-days computerized support is used by these departments to coordinate the entire work.

Business automation, zero inventory and greater Return on Investment are the target benefits and goals of any Materials Management system. However, software packages cannot change business management problems or negotiate business collaboration on your behalf. Therefore, two key issues often arise

- Resistance to change

  Staff, suppliers and customers may be accustomed to the conventional business process, for example, using phone calls, fax and paper invoice. Suppliers may not be willing to assume more responsibility for inventory management. Therefore, communication, compromise and full training assistance are needed to ensure all participants understand the benefits of Materials Management System and avoid unnecessary resistance to change management.

- Mistakes and mistrust

  Materials Management system processes data by internal program logics. However, technology cannot completely adapt to individual business process and workflow in the first few months after implementation. Company staff and external participants need to be fully aware of the possible errors and patiently wait for adjustment if flaws are found. If not properly communicated, newly established systems could be mistrusted by users and left obsolete.

4.2 MATERIALS MANAGEMENT IN GARMENT INDUSTRY

The process starts with the fiber producer, and ends with the retailer who adds an entirely new dimension of experience, and delivers the product to the customer in an entirely new context. Fiber becomes the raw material for fabrics which, in turn, becomes the raw material for garments. The garment industry then makes a garment as appealing to a global customer as to a domestic customer. This process is illustrated with the following figure. This structure is called Fashion Funnel [11].

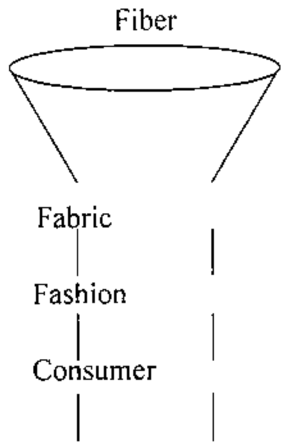


Fig 4.1: Sophisticated Garment Industry

The garment industry is of major importance to Third World trade, especially to the NICs (Newly Industrialized Countries). Exports of clothing from these countries increased exponentially in the post-war period. The comparative cost argument for a global market, with each country producing what they can do cheapest, has supported such a trade pattern on the basis of cheap labor. But this assumption is being eroded by a number of factors, the chief of which is the application of microelectronics (accompanied by concentration in the OECD and a measure of protectionism). The assembly of clothes requires a lot of manual manipulation because of the limp nature of the material. For over fifty years the technology has been based on dexterous workers and robust flexible sewing machines. Dexterous means having the sort of skill acquired by motor training, contrasted with skill which is knowledge based. This production technique allowed for the easy entry of small firms and resulted in high levels of competition.

4.2.1 Normal Garment Factory

The following four activities are head-office functions that proceed in parallel with the next three shop-floor activities.

· DESIGN (CAD)

· ORDERING MATERIALS (MIS)

· PRODUCT ENGINEERING (MIS)

· PRODUCTION SCHEDULE MONITORING (MIS)

Computer Aided Design (CAD) and Management Information Systems (MIS) are the automation techniques used. The complexity of the process and the extremely rapid changes induced by fashion make this one of the most difficult business to manage and therefore the management information systems (MIS) are likely to be of considerable complexity. The last few years have seen a strong move to design-intensive products with a very rapid response to market demand. At Benetton, in Italy, the factory order system is directly linked to point-of sale data collection. A significant swing in color preference is known within hours at the factory and finds a response in production scheduling.

The revolution in the garment industry took place as a result of the introduction of CAD\CAM techniques which had been developed in the metals industry. The technology is particularly well adapted to a fashion-controlled industry because it favors a multitude of short production runs. It is equally suitable for footwear. For example Terra Footwear at Grace Harbour Newfoundland has an automatic digital sewing machine invented in Israel receiving instructions from a computer monitor. Their Austrian CAD CAM system cost 750 000 $. They are linked by computer to the designers at the Markham ON plant.

The revolution in the garment industry took place as a result of the introduction of CAD\CAM techniques which had been developed in the metals industry. The technology is particularly well adapted to a fashion-controlled industry because it favors a multitude of short production runs. It is equally suitable for footwear. For example Terra Footwear at Grace Harbour Newfoundland has an automatic digital sewing machine invented in Israel receiving instructions from a computer monitor. Computerization has become a prevalent corporate response to free-trade related clothing import competition as deregulation and the drying up of subsidies to support a Canadian clothing industry. By the mid 1980s the E-ton sewing assembly line from Sweden had become fairly common in the Canadian Garment industry. It has more than fifty individually engineered re-programmable work stations with a monorail type line for moving materials from one station to the next, each one equipped with sensor controlled gates that cause the material to stop or to pass by, depending on the instructions keyed into the system.

At each work station the individual operator receives the garment off the monorail conveyor, feeds it through the sewing operation, and loads it back onto the conveyor unit with the other hand. At each work station the most sophisticated E-ton 2001 system incorporates a computer-monitoring device that can relay information on the operator's work both for materials management and for calculating wages.

4.2.2 Steps Involved In Making Garment Patterns

The business of turning fashion designs into working patterns was originally of course a purely manual craft [11].

Step 1. The pattern makers use cardboard master patterns (called blocks) representing the standard garments such as "ladies blouse with set-in sleeve". They adapt the designer's sketch to these and make a complete pattern on thin card for the standard size of garment, accompanied by detailed patterns for each of the parts: sleeve, cuff etc. with allowances for seams. This is called "splitting" in the shoe industry. Incidentally, the process is just the same for shoes as for garments.

Step 2. A standard pattern goes to a grader who adapts it to the full range of sizes using "grading rules" codified in a set of written tables based on experience of human anatomy. Obviously, if a person is a centimeter taller it doesn't mean they are a centimeter wider. For each size, separate patterns are made for each of the parts of the garment: collar, cuffs etc. As many as a hundred parts may be created. This job is, the key to customer satisfaction in fit.

Step 3. These parts then go to the marker or lay-maker who lays them out like a jigsaw puzzle on a table which may be 30 m long. The marker's job is to maximize the utilization of a bolt of cloth while observing certain constraints such as the direction of the pattern or the weave. Fabric costs amount to, on average, 50% of the costs of making a garment. Therefore this job has key economic importance.

4.3 CRITICALITY OF NETWORKING TECHNOLOGY IN MATERIALS MANAGEMENT

In view of the complexities involved in managing a multiple supply chain – such as in the garment industry – importance of right information at the right time all along the value chain cannot be over emphasized. Clearly this need makes the use of modern networking technology critical to a effective materials management technique. State-of-the-art computer and networking systems is the backbone of effect materials management and deserves a special mention from among the seven principles outlined above. Electronic Data Interchange (EDI), Electronic Point of Scale (EPOS), Enterprise Resource Planning (ERP), Bar-coding etc have ushered in an era of information revolution. The Internet has vastly increased the potential of 'global reach'. There exist over 50 million Internet users globally. E – Commerce is growing rapidly. It would be pertinent to note that the business-to-business portion of E-commerce constitutes the lion's share in the total E-commerce sales. Business-to-Consumer sale still account for a small proportion. Business-to-Business E-commerce was US$7.8 billion in 1998 and is expected to grow to US$10.8 billion in the coming years. This would constitute 6% of all US retail spending. Including the business- to-consumer sales, the total e-commerce sales would be US$ 3.2 trillion in the coming years [7].

CHAPTER 5

MANAGEMENT INFORMATION SYSTEMS

5.1 AN INTRODUCTION TO MIS

Management information systems (MIS) are information systems, typically computer-based, that are used within an organization [6]. WordNet describes an information system as "a system consisting of the network of all communication channels used within an organization". A management information system may also be defined as "a system that collects and processes data (information) and provides it to managers at all levels who use it for decision making, planning, program implementation, and control" [6]. An information system is comprised of all the components that collect, manipulate, and disseminate data or information. It usually includes hardware, software, people, communications systems such as telephone lines, and the data itself. The activities involved include inputting data, processing of data into information, storage of data and information, and the production of outputs such as management reports.

As an area of study it is commonly referred to as Information Technology Management. The study of information systems is usually a commerce and business administration discipline, and frequently involves software engineering, but also distinguishes itself by concentrating on the integration of computer systems with the aims of the organization. The area of study should not be confused with computer science which is more theoretical in nature and deals mainly with software creation, or computer engineering, which focuses more on the design of computer hardware. In business, information systems support business processes and operations, decision-making, and competitive strategies.

5.2 THE FUNCTIONAL SUPPORT ROLE

Business processes and operations support function are the most basic. They involve collecting, recording, storing, and basic processing of data. Information systems support business processes and operations by:

- recording and storing accounting records including sales data, purchase data, investment data, and payroll data.
- processing such records into financial statements such as income statements, balance sheets, ledgers, and management reports.etc.
- recording and storing inventory data, work in process data, equipment repair and maintenance data, supply chain data, and other production/operations records
- processing these operations records into production schedules, production controllers, inventory systems, and production monitoring systems
- recording and storing such human resource records as personnel data, salary data, and employment histories,
- processing these human resources records into employee expense reports, and performance based reports
- recording and storing market data, customer profiles, customer purchase histories, marketing research data, advertising data, and other marketing records
- processing these marketing records into advertising elasticity reports, marketing plans, and sales activity reports
- recording and storing business intelligence data, competitor analysis data, industry data, corporate objectives, and other strategic management records
- processing these strategic management records into industry trends reports, market share reports, mission statements, and portfolio models

The information systems use all of the above to implement, control, and monitor plans, strategies, tactics, new products, new business models or new business ventures.

5.3 THE DECISION SUPPORT ROLE

The business decision-making support function goes one step further. It becomes an integral part -- even a vital part -- of decision -making. It allows users to ask very powerful "What if...?" questions: *What if* we increase the price by 5%? *What if* we increase price by 10%? *What if* we decrease price by 5%? *What if* we increase price by 10% now, then decrease it by 5% in three months? It also allows users to deal with contingencies: If inflation increases by 5% (instead of 2% as we are assuming), then what do we do? What do we do if we are faced with a strike or a new competitive threat? An organization succeeds or fails based on the quality of its decisions. The enhanced ability to explore "what if" questions is central to analyzing the likely results of possible decisions and choosing those most likely to shape the future as desired. "Business decision-making support function" is a phrase likely to quicken the pulse of no one but an accountant, but, in fact, it is all about turned wonderful dreams into solid realities [6].

5.3.1 The Communication Decision Support System Role

Information systems can support a company's competitive positioning. Here are three levels of analysis:

1. The supports for help in piloting the chain of internal value. They are the most recent and the most pragmatic systems within the reach of the manager. They are the solutions to reductions of costs and management of performance. They are typically named "Business Workflow Analysis" (BWA) or of "Business Management Systems p2p" [6]. Tool networks, they ensure control over piloting the set functions of a company. The real-time mastery in the costs of dysfunctions cause distances from accounts, evaluation and accounting that are presented in the evaluation and qualitative reports.

2. All successful companies have one (or two) business functions that they do better than the competition. These are called core competencies. If a company's core competency gives it a long term advantage in the marketplace, it is referred to as a sustainable competitive advantage. For a core competency to become a sustainable competitive advantage it must be difficult to mimic, unique,

sustainable, superior to the competition, and applicable to multiple situations. For a small or medium business a nice alternative is a MSP or a Managed Service Provider such as Virtual IT Solution. This is a cost effective solution compared to paying for a IT staff or local technicians. Other examples of company characteristics that could constitute a sustainable competitive advantage include: superior product quality, extensive distribution contracts, accumulated brand equity and positive company reputation, low cost production techniques, patents and copyrights, government protected monopoly, and superior employees and management team. The list of potential sustainable competitive advantage characteristics is very long. However, some experts hold that in today's changing and competitive world, no advantage can be sustained in the long run. They argue that the only truly sustainable competitive advantage is to build an organization that is so alert and so agile that it will always be able to find an advantage, no matter what changes occur.

3. Information systems often support and occasionally constitute these competitive advantages. The rapid change has made access to timely and current information critical in a competitive environment. Information systems, like business environmental scanning systems, support almost all sustainable competitive advantages. Occasionally, the information system itself is the competitive advantage. One example is Wal-Mart [4]. They used an extranet to integrate their whole supply chain. This use of information systems gave Sam Walton a competitive advantage for two decades. Another example is Dell Computer. They used the internet to market custom assembled PC's. Michael Dell is still benefitting from this low-cost promotion and distribution technique. Other examples are eBay, Amazon.com, Federal Express, and Business Workflow Analysis.

5.3.2 The Performance Monitoring Role

MIS are not just statistics and data analysis. They have to be used as an MBO (Management by objectives) tool. They help

- to establish relevant and measurable objectives
- to monitor results and performances (reach ratios)
- to send alerts, in some cases daily, to managers at each level of the organisation, on all deviations between results and pre-established objectives and budgets.

Businesses today are recording volumes of data reaching terabytes in size. Millions of transactions among retail chains, utility companies, banks, and insurance companies take place each day. Representative financial transactions of the International Technology Group (ITG) report indicate that a telecommunications company receives over 80 million transactions a month, or approximately 2.6 million transactions per day (ITG, 2000). It would be humanly impossible to interpret these transactions to find, for example, which class of customers makes more long distance calls. Similarly, a representative retail chain with 63 supermarkets selling 19,000 products can record a staggering 3.6 million transactions per day (SUN-Microsystems, 1999). Even a small percentage of waste or fraud will result in a loss of millions of dollars and, consequently, higher prices to customers. At same time, manual inspection of these data is not possible, as they are imprecise and change continuously. Decision Support Systems (DSS) are used to support managerial decisions. Usually DSS involves analyzing many units of data in heuristic fashion (Inmon, 1990). To make optimal decisions using large volumes of data, managers of large enterprises need decision support Systems that interpret huge volumes of uncertain data as well as handle data modifications.

5.4 POTENTIAL BENEFITS OF MIS INVESTMENTS

Investing in information systems can pay off for a company in many ways.

- Such an investment can supports core competency [6]. Great companies invariably have one or two core competencies, something they can do better than anyone else. This could be anything from new product development to customer service. It is the heart of the business and no matter what it is, information technology can support that core competency. An IT investment in a company's core competency can create a significant barrier to entry for other companies, defending the organization's primary turf and protecting its markets and profits.
- It can build supply chain networks [6]. Firms that are a part of an integrated supply chain system have established relationships of trust with suppliers. This means faster deliver times, problem-free delivery and an assured supply. It can also mean price discounts and other preferential treatment. The inability of new entrants to get onto a supply chain/inventory management system can be a major barrier to entry.
- It can enhance distribution channel management [6]. As with supplier networks, investment in distribution channel management systems can ensure quicker delivery times, problem free delivery, and preferential treatments. When the distribution channel management system is exclusive, it can mean some control over access to retailers, and, once more, a barrier to entry.
- Such an IT investment can help build brand equity [6]. To build a brand, firms often invest huge sums in advertising. A huge brand name is a formidable barrier to entry and sustaining it can be facilitated by investment in marketing information systems and customer relationship management system.
- Information systems can mean better production processes [6]. Such systems have become essential in managing large production runs. Automated systems are the most cost efficient way to organize large scale production. These can produce economies of scale in promotion, purchasing, and production; economies of scope in distribution and

promotion; reduced overhead allocation per unit; and shorter break-even times more easily. This absolute cost advantage can mean greater profits and revenue.

- IT investment can boost production processes [6]. Information systems allow a company flexibility in its output level. This is because, a company producing at a point on the long-run average cost curve where economies of scale exist has the potential to obtain cost savings in the future, and this potential is a barrier to entry.
- Implementing IT experience can leverage learning curve advantages [6]. As a company gains experience using IT systems, it becomes familiar with a set of best practices that are more or less known to other firms in the industry. Firms outside the industry are generally not familiar with the industry specific aspects of using these systems. New entrants will be at a disadvantage unless they can redefine the industries best practices and leap-frog existing firms.
- IT investment can impact mass customization production processes [6]. IT controlled production technology can facilitate collaborative, adaptive, transparent, or cosmetic customization. This flexibility can increase margins and increase customer satisfaction.
- Leverage IT investment in computer aided design [6]. CAD systems facilitate the speedy development and introduction of new products. This can create proprietary product differences. Product differentiation can be a barrier to entry. Proprietary product differences can be used to create incompatibilities between competing products. These incompatibilities increase consumers' switching costs. High customer switching costs is a very valuable barrier to entry.
- It means expanded E-commerce [6]. Company web sites can be personalized to each customers interests, expectations, and commercial needs. They can also be used to create a sense of community. Both of these tend to increase customer loyalty. Customer loyalty is an important barrier to entry.

- Information systems leverage stability [6]. Technologically sophisticated firms with multiple electronic points of contact with customers, suppliers, and others enjoy greater stability. This monumental appearance of stability can be a barrier to entry, especially in financial services.

The simple fact that IT investment takes a significant amount of money makes it a barrier to entry. Anything that increases capital requirements is -- a barrier to entry.

CHAPTER 6

WEB-ENABLED DSS

6.1 AN INTRODUCTION TO WEB-ENABLED DSS

The World-Wide Web has created a major opportunity to deliver more quantitative and qualitative information to decision-makers. Client-server architecture and networks permit Information Systems professionals to centralize and control information and yet easily distribute it in a timely manner to managers who need it. Also, intranets or company Internets are providing many opportunities for securely delivering information from data warehouses and external databases to a manager's desktop in a format that permits and encourages frequent use and follow-on analysis.

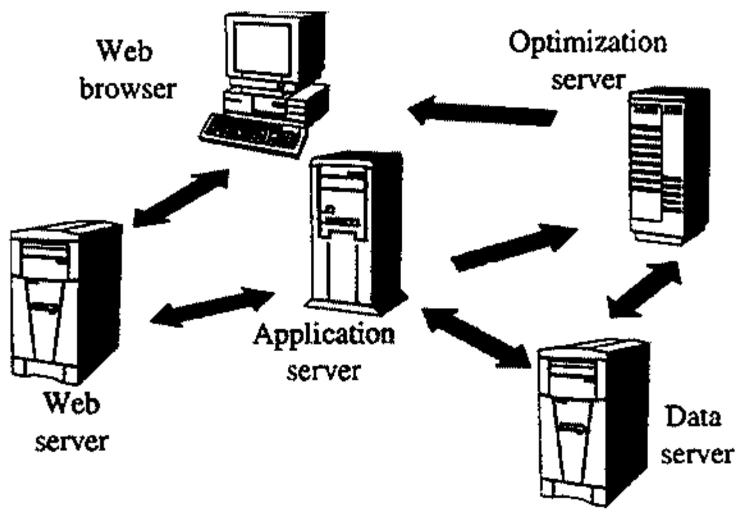


Fig 6.1: Web-Based Application

The World-Wide Web is where the action is in developing enterprise-wide decision support systems [12]. The computer server that is hosting the DSS application is linked to the user's computer by a network with the TCP/IP protocol. In many companies, a Web-based DSS is synonymous with an enterprise-wide DSS that is supporting large groups of managers in a networked client-server environment with a specialized data warehouse as part of the DSS architecture.

This technology is developing rapidly so there is a need to monitor and explore the possibilities of Web-based DSS. Web-based DSS have reduced technological barriers and made it easier and less costly to make decision-relevant information available to managers and staff users in geographically distributed locations. Because of the World-Wide Web infrastructure, enterprise-wide DSS can now be implemented in geographically dispersed companies and to geographically dispersed stakeholders including suppliers and customers at a relatively low cost. Using Web-based DSS, organizations can provide DSS capability to managers over an intranet, to customers and suppliers over an extranet or to any stakeholder over the global Internet.

The Web has increased access to DSS and it should increase the use of a well-designed DSS in a company. Using a Web infrastructure for building DSS improves the rapid dissemination of "best practices" analysis and decision making frameworks and it should promote more consistent decision making on repetitive decision tasks across a geographically distributed organization. The Web also provides a way to manage a company's knowledge repository and to bring knowledge resources into the decision making process. Web-based delivery of DSS capabilities will promote and encourage ongoing improvements in decision-making processes.

Also, the Web can reduce some of the problems associated with the competing "thick client" enterprise-wide DSS design where special software needs to be installed on a manager's computer. Web-based DSS should reduce IT management and support costs and end user training costs.

With many Web-DSS and OLAP products, managers with a browser and access to a Web-based DSS have the same type of ad-hoc reporting and interactive data analysis capability as that provided by "thick client" on-line analytical processing (OLAP) tools. Web technology is and will continue to change the way organizations deliver all types of documents and data.

6.2 THE CLIENT SERVER ARCHITECTURE

The Internet revolves around the client-server architecture. Computer runs software called the client and it interacts with software known as the server located at a remote computer [12]. The client is usually a browser such as Internet Explorer or Netscape Navigator. Browsers interact with the server using a set of instructions called protocols. These protocols help in the accurate transfer of data requests made through requests from a browser and responses from the server. There are many protocols available on the Internet. The World Wide Web, which is a part of the Internet, brings all these protocols under one roof. We can thus use HTTP, FTP, Telnet, email etc. through browser.

Some common protocols of the Internet are:

- HTTP (Hypertext transfer Protocol): used on the World Wide Web (WWW) for transferring web pages.
- FTP (File Transfer protocol): employed for transferring files from one machine to the other.
- SMTP (Simple Mail Transport Protocol): used for email.
- Telnet Protocol: Used to open telnet sessions.

The Internet is a connection-less protocol, which means that after every client-server interaction the connection between the two is lost.
Three models of client-server intercommunication:

Case #1 of the client-server architecture

The client (browser) requests for an HTML file stored on the remote machine through the server software. The server locates this file and passes it to the client. The client then displays this file on your machine. In this case, the HTML page is static. Static pages do not change until the developer modifies them.

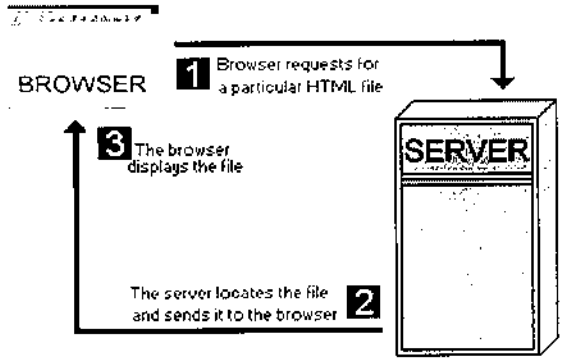


Fig 6.2: Case #1 of the client-server architecture

Case #2 of the client-server architecture

The scenario is slightly different for CGI applications. Here the server has to do more work since CGI programs consume the server machine's processing power. When the browser sends request to the server for a particular search, the server checks the headers and locates the necessary CGI program and passes it the data from the request. The CGI program processes this data and returns the results formatted in HTML. The server sends this to the browser and it in turn displays the HTML page.

Thus the CGI program generates a dynamic HTML page. The contents of the dynamic page depend on the query passed to the CGI program.

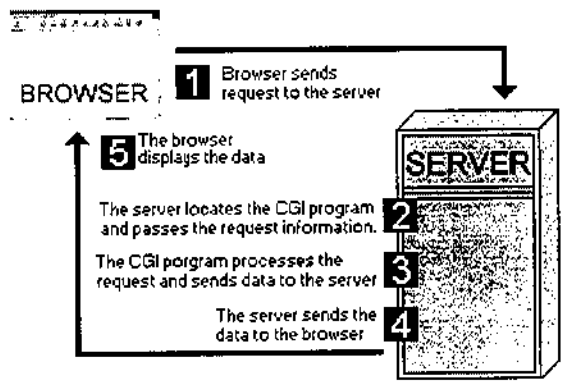


Fig 6.3: Case #2 of the client-server architecture

Case #3 of the client-server architecture

The third case also involves dynamic response generated by the use of server side technologies. There are many server side technologies today. Active Server Pages (ASP): A Microsoft technology with extension .ASP pages. Personal Home Pages (PHP): An open source technology. A PHP page will either have .php or .php3 (depending on how the server has been configured) extension. Java Server Pages: .jsp pages contain Java code. Server Side Includes (SSI): Involves the embedding of small code snippets inside the HTML page. An SSI page has .shtml as its extension.

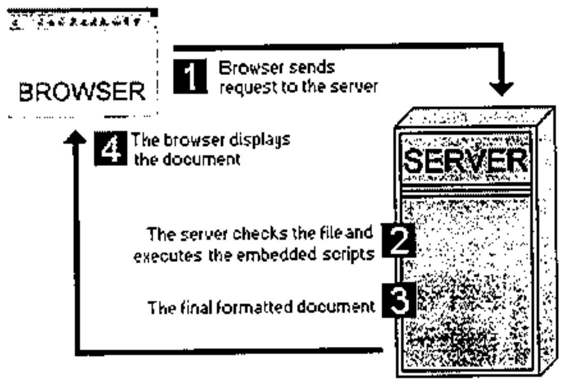


Fig 6.4: Case #3 of the client-server architecture

6.3 DATA TRANSFER OVER THE WEB AND CLIENT-SERVER INTERACTION

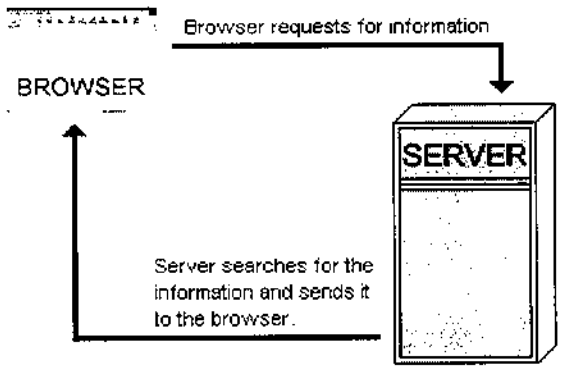


Fig 6.5: Data transfer over the web and client-server interaction

Data transfer over the Internet starts with an event. The event can be of human origin, for example, we can start the browser (a *client* program) on our computer and request for some information, say an HTML file, located on a remote computer. There are two important ways in which information is requested from a browser, a hyperlink is clicked or a URL is entered in the "Address" or "Location" field [12]. The event can also be generated from the instructions in a program. Thus, we can automate uploading and downloading of files (data transfer) with the help of a program.

Suppose we have requested for an HTML document from a remote computer using a web browser. The browser searches for the remote computer and on locating it, passes the request to a program called the **server** running on this distant computer. The **server** then checks up your request and tries to locate the HTML file on its hard disk. On finding it, the **server** sends this file to the computer. If this HTML document has embedded image, video, and/or sound files, the information and the content of such files are also passed to the browser.

On receiving data from the server, the **client**, a browser in this case, starts to display the HTML page. The client (e.g.: browser) holds the sole prerogative on document display, with no involvement from the servers' side. Once it sends the data to the remote computer, the server, so to say, washes its hands off it. On receipt of all requested data, the client-server connection is lost. Thus, the next time this client asks for some information from the server, the server will treat it as a new request without any recollection of previous requests. This means that client-server interaction is "stateless" with every new request generating a new response [12].

To understand how Web technologies can influence the development, deployment and practice of Decision Support Systems, we consider the major tasks at various stages of using and building a DSS. The role of Web technologies then is in making it possible to perform some or all of these tasks via a remote Web client. In thinking of such tasks, it is useful to recall the distinction made by Sprague about application-specific DSS that consist of software, data, and models for a specific decision problem and DSS generators that provide tools and algorithms for building a variety of specific DSS. Application-specific DSS are far easier to build, but rarely reusable; DSS generators are far more complex to build but can be adapted to build many specific systems. For example, using a Model-driven application-specific system, a user would be given the relevant decision models and algorithms, and would focus on tasks such as model execution, development of reports, or data visualization. Using a corresponding DSS generator, on the other hand, would require the performance of additional tasks such as model definition and creation of a custom user interface. Model-driven DSS involve all the tasks in the model rows as well as the ones in the data-driven rows.

DSS firms may also use the "Web as media" capabilities to engage in electronic retailing that is completing the order fulfillment and payment phases over the Web, and distributing DSS products as downloadable software. In the area of Data- Driven DSS, most vendors appear to make substantial use of Web technologies for disseminating company and product information, and in the product sales functions. In the case of Model-Driven DSS, however, there is surprising lack of activity in the area of Web-enabled sales. Few companies offer order placement and payment over the Web; fewer still allow buyers to download decision support software over the Web rather than wait for a package to arrive in the mail.

6.4 DBMS FOR DSS

To handle large volume of data by the DSS, we use Database Management System to store the data and handle it efficiently. A DBMS is a software program for entering information into the database. It can update, delete, manipulate and retrieve information [2]. Here data are transformed and integrated into a consistent structure. Thus a DSS can be developed by the combination of a DBMS and a modeling language.

ODBC: ODBC -Open Database Connectivity is again a set of rules introduced by Microsoft to solve many problems involved in database management. Initially, all applications were monolithic and had everything built into it. A minor change was asking for too much from the programmer. A database application would contain code to display user interfaces like reports, data entry forms etc. as well as perform database administration task. Plus RDBMS' like ORACLE, SYBASE, INGRES, etc. had their own set of rules and their own proprietary language to communicate with their large databases [1].

Everybody realized that these RDBMS' performed their job of database administration flawlessly and were superb at it. Since there was no option available, they also worked on user interfaces, obviously not as impressive as it should have been. The point is that the server and the client both these programs were in the same package or were coupled in the same application.

Microsoft decoupled the client and the server. They introduced rules by means of which any client could retrieve data from any database back-end. They worked on the assumption that every database uses SQL for communicating with the databases and released a set of APIs which closely worked with SQL. ODBC is this set of APIs and is used in most of the Microsoft Products that need database communication.

6.5 INTELLIGENT DATA MINING

The intelligent data mining technique searches the information the information with in data ware houses that queries and reports cannot effectively reveal [4]. It finds patterns in the data and infers rules from them. The five common type of information that can be yielded by data mining are association, sequence, classification, clusters and forecasting [17]. There are some common tools used in data mining. They are,

- Case-based reasoning
- Neural computing
- Intelligent agents

Other tools such as decision-trees, rule induction, and data visualization are used. The relation between the data and the knowledge management technique can be shown by the following diagram.

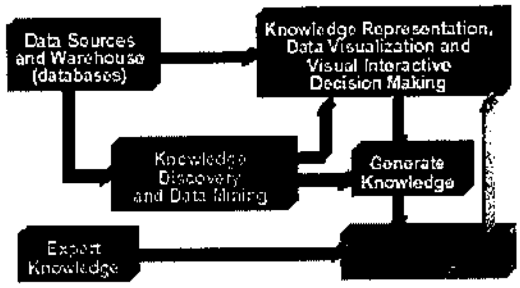


Fig 6.6: The Data and knowledge management

The data and knowledge management model includes the following components:

- Knowledge discovery and data mining – using search engines, data bases, data mining and online analytical processing the proper knowledge must be found, analyzed and put into proper context.
- Organize knowledge bases – it stores organizational knowledge and best practices.
- Knowledge acquisition – determines what knowledge (information) is critical to decision making.
- Knowledge representation – target audiences are defined and technologies are put into places to enable knowledge delivery when needed.

CHAPTER 7

DSS MODEL DESCRIPTION

7.1 DSS MODEL DESCRIPTION

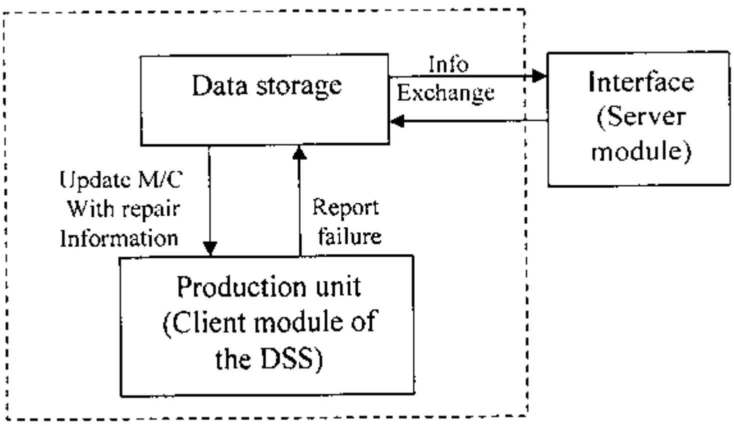


Fig 7.1: The DSS Model

The DSS model represents a system involving interactions between a production unit, simulation component, and an interface component. The production unit consists of various departments. The client module of the DSS software is installed in these departments. The interface component has the server module, which is controlled by the manager. When the production unit encounters any problem it reports the failure to the manager through this DSS interface. The DSS searches the optimal solution for the problem from the dataware house by the technique called intelligent data mining [4].

All the modules are implemented in Java Server page (JSP) and the database is connected using ODBC connection object. The manager updates their database as soon as they encounter a new problem.

CHAPTER 8

FLOWCHART

8.1 FLOWCHART DESCRIBING THE PROCESS

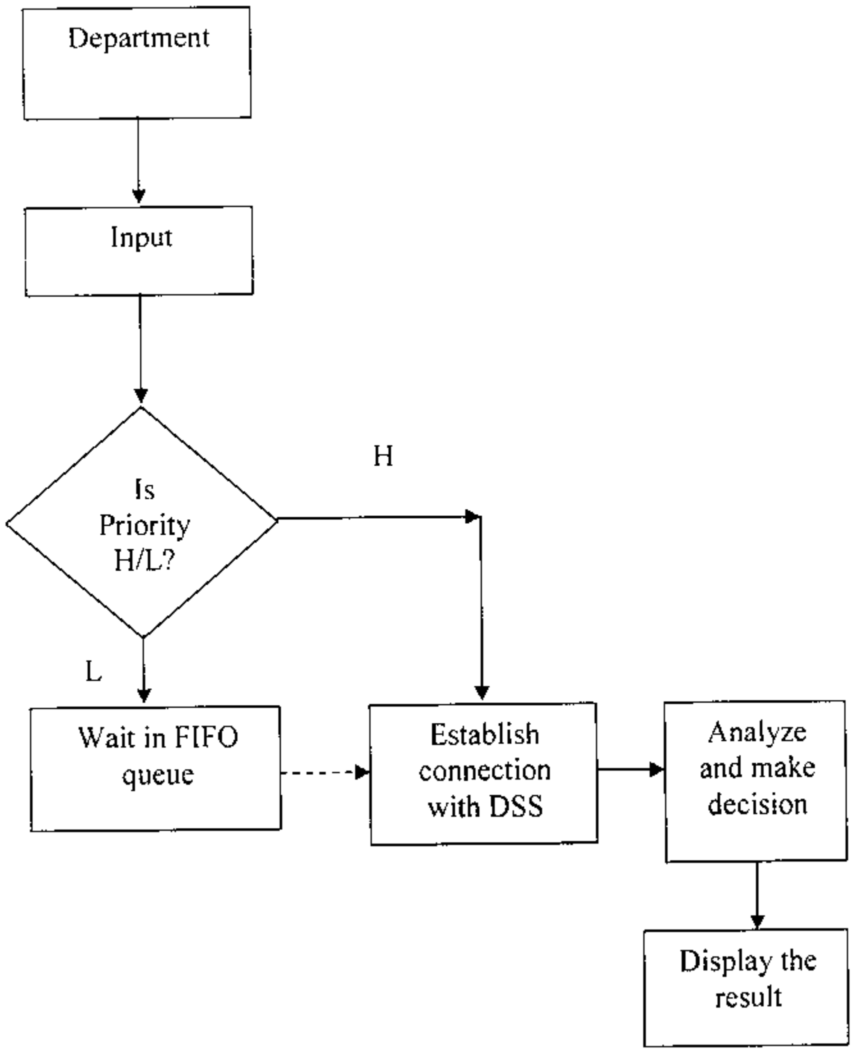


Fig 8.1: Flowchart of the decision process

The flowchart describes the decision-making process. Here the department represents any department with in the production unit e.g. knitting dept. When a department encounters a problem it communicates with the DSS software. When there are more problems, First Come First Serve technique is used. The first entered problem has the highest priority and the connection is established with the server.

The objective of this package is to give optimal and quicker solution to all the departments connected to the network. This helps in reducing the time while making a critical decision. The information is exchanged through the computer and the failure is recovered easily and quickly.

CHAPTER 9

SOFTWARE TOOLS

9.1 JAVA SERVER PAGE

Java Server Pages (JSP) is a technology based on the Java language and enables the development of dynamic web sites. JSP was developed by Sun Microsystems to allow server side development. JSP files are HTML files with special Tags containing Java source code that provide the dynamic content.

The following Fig 9.1 shows the Typical Web server, different clients connecting via the Internet to a Web server. In this, the Web server is running on UNIX and is the very popular Apache Web server.

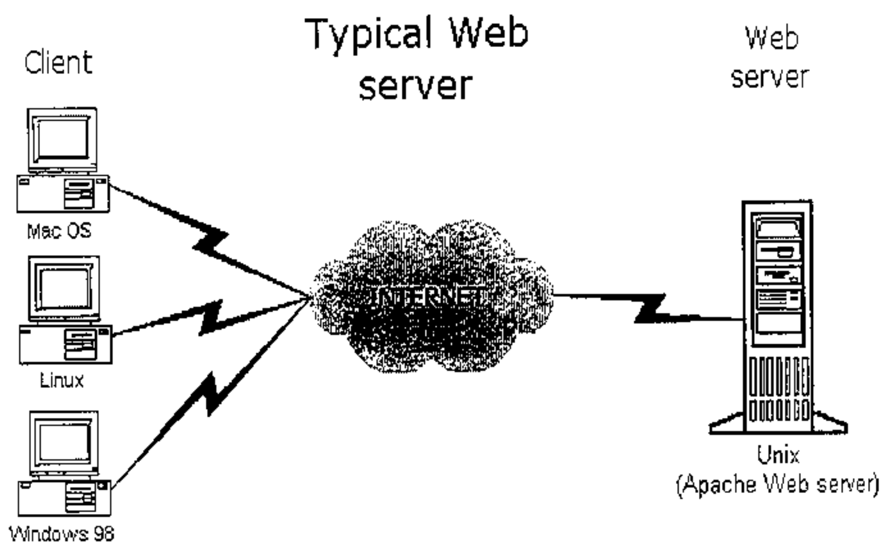


Fig 9.1: A typical Web Server

First static web pages were displayed. Typically these were people's first experience with making web pages so consisted of My Home Page sites and company marketing information. Afterwards Perl and C were languages used on the web server to provide dynamic content. Soon most languages including Visual basic, Delphi, C++ and Java could be used to write applications that provided dynamic content using data from text files or database requests. These were known as CGI server side applications. ASP was developed by Microsoft to allow HTML developers to easily provide dynamic content supported as standard by Microsoft's free Web Server, Internet Information Server (IIS). JSP is the equivalent from Sun Microsystems. The following Fig 9.2 shows a web server that supports JSP files. The web server also is connected to a database.

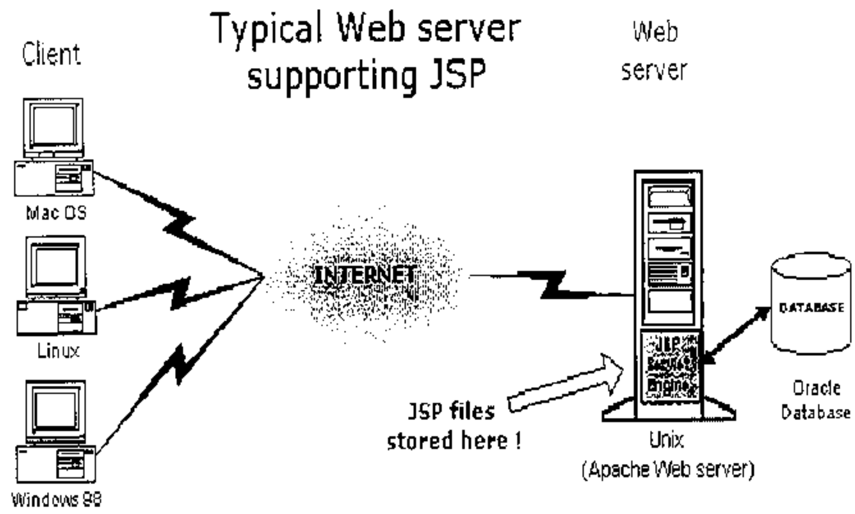


Fig 9.2: Web Server Supporting JSP

JSP source code runs on the web server in the JSP Servlet Engine. The JSP Servlet engine dynamically generates the HTML and sends the HTML output to the client's web browser.

9.1.1 Why use JSP?

JSP is easy to learn and allows developers to quickly produce web sites and applications in an open and standard way. JSP is based on Java, an object-oriented language. JSP offers a robust platform for web development. Main reasons to use JSP:

1. Multi platform
2. Component reuse by using JavaBeans and EJB.
3. Advantages of Java.

We can take one JSP file and move it to another platform, web server or JSP Servlet engine. It means we are never locked into one vendor or platform. HTML and graphics displayed on the web browser are classed as the presentation layer. The Java code (JSP) on the server is classed as the implementation. By having a separation of presentation and implementation, web designer's work only on the presentation and Java developers concentrate on implementing the application.

9.2 MS-ACCESS

A database manager is a computer program for storing information in an easily retrievable form. It is used mainly to store text and numbers (for example, the Library catalogue, which includes the author, title, class number and accession number for each book). Most modern database managers also allow the storage of other types of information such as dates, hyperlinks, pictures and sounds. As well as being able to store data, a database allows to select information quickly and easily. Finally, it also allows producing printed summaries (reports) of the information selected.

Microsoft Access is a relational database management system (which allows to link together data stored in more than one table). It is fully supported by IT Services and is available for departmental purchase under the Microsoft Select Agreement.

Access allows you to bring in information from other sources - this is called importing. Databases vary on how they bring in the data and on which sort of files they can import. If we have a really large dataset, it is a good idea to try importing a small section to a new table first and only if that works successfully try to import it all.

Access can import data in various formats, including Dbase (another widely-used database) and HTML (from web pages). Microsoft Excel spreadsheet files can be imported directly. Here, the data has been saved as tab-separated values, which is a standard format, which any spreadsheet (or indeed word processor) should be able to produce. Other basic formats include comma separated values and just plain text. One thing to note when importing a file is that the first line may contain headings - Access has an option to cope with this and can use them for field names.

We can also export data from Access for another package to read using **Export...** from the **File** menu. Amongst the formats available is Excel and character or tab delimited (suitable for many applications, including SAS, SPSS and Minitab).

CHAPTER 10

HARDWARE & SOFTWARE REQUIREMENTS

10.1 HARDWARE SPECIFICATION

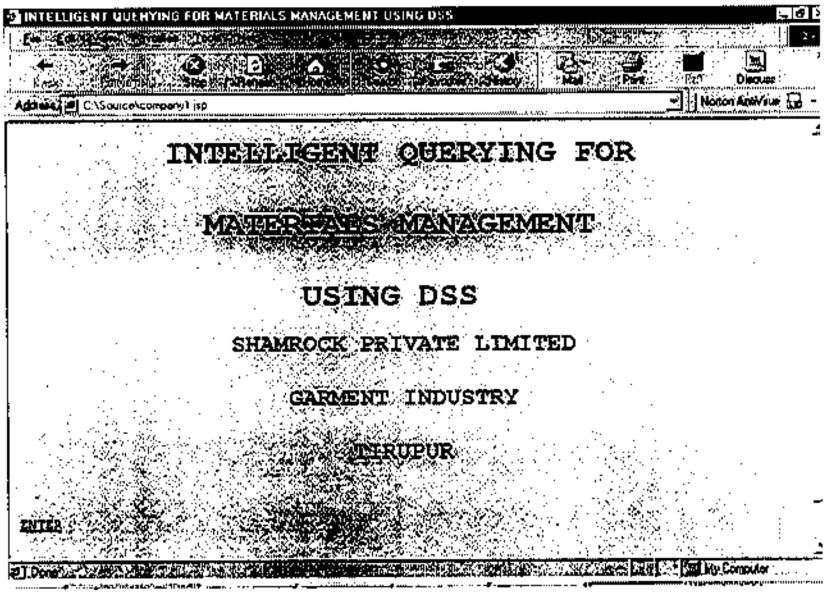
- Intel Pentium III or Higher Processor
- RAM 256 MB
- Hard disk 10 GB
- Networking Support (Network card, cables etc)

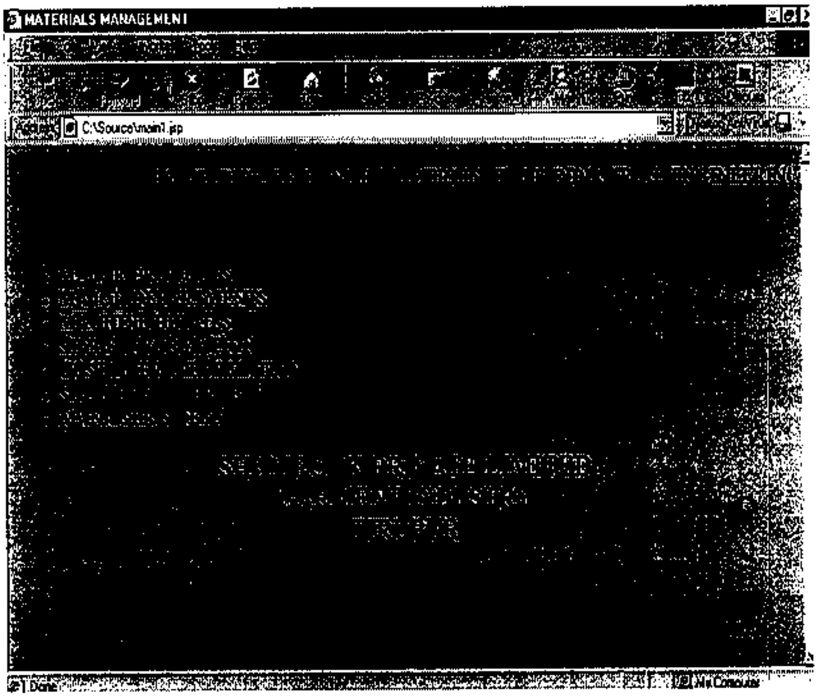
10.2 SOFTWARE SPECIFICATION

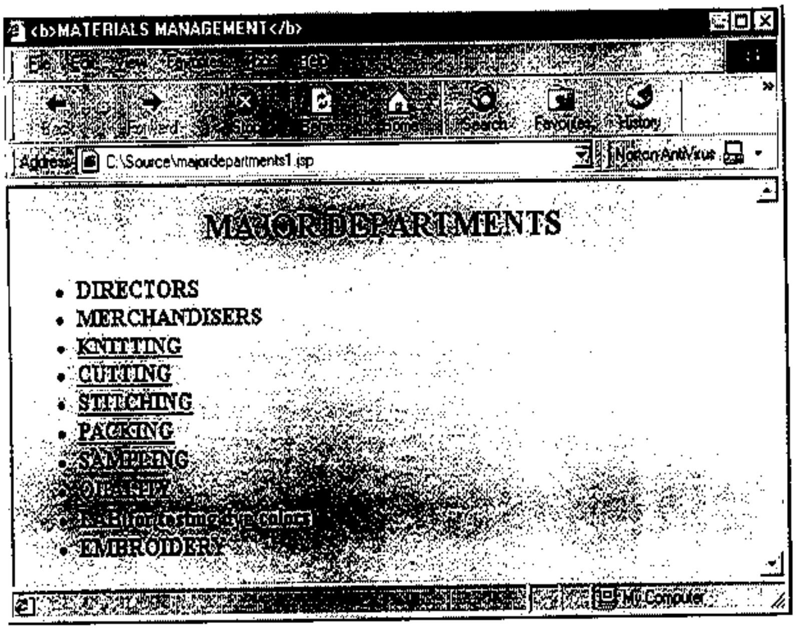
- Operating Systems – Windows NT / Windows XP or higher versions
- Java Development Kit (JDK 2.0)
- Java Web Server2.0
- MS Access
- Networking Support (Client-Server)

CHAPTER 11

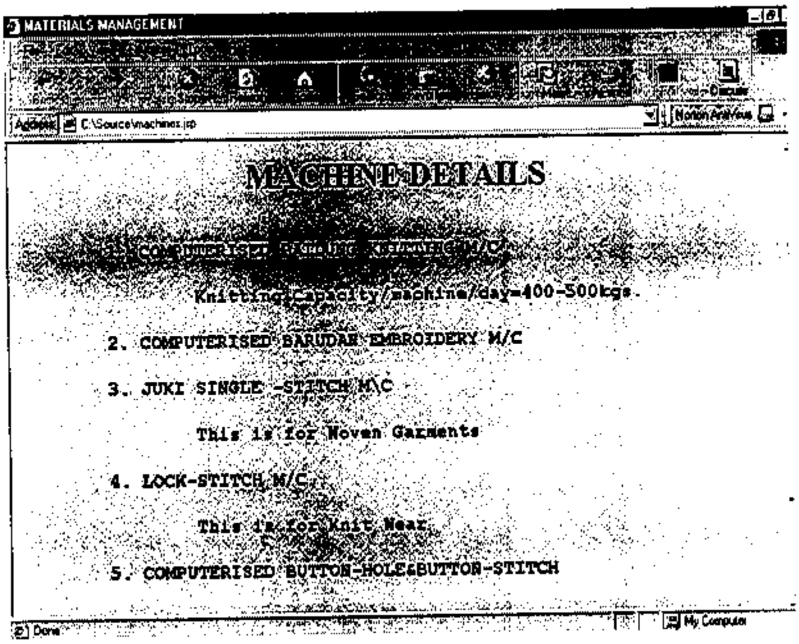
OUTPUT LAYOUTS


INTELLIGENT QUERYING FOR MATERIALS MANAGEMENT USING DSS
C:\Source\company1.jsp
INTELLIGENT QUERYING FOR
USING DSS
SHAMROCK PRIVATE LIMITED
GARMENT INDUSTRY
My Computer

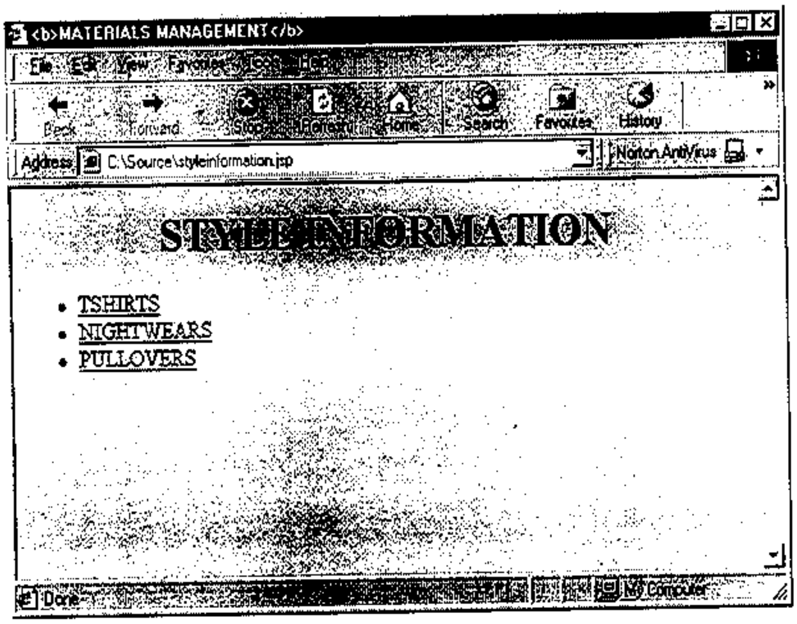

MATERIALS MANAGEMENT
C:\Source\main1.jsp

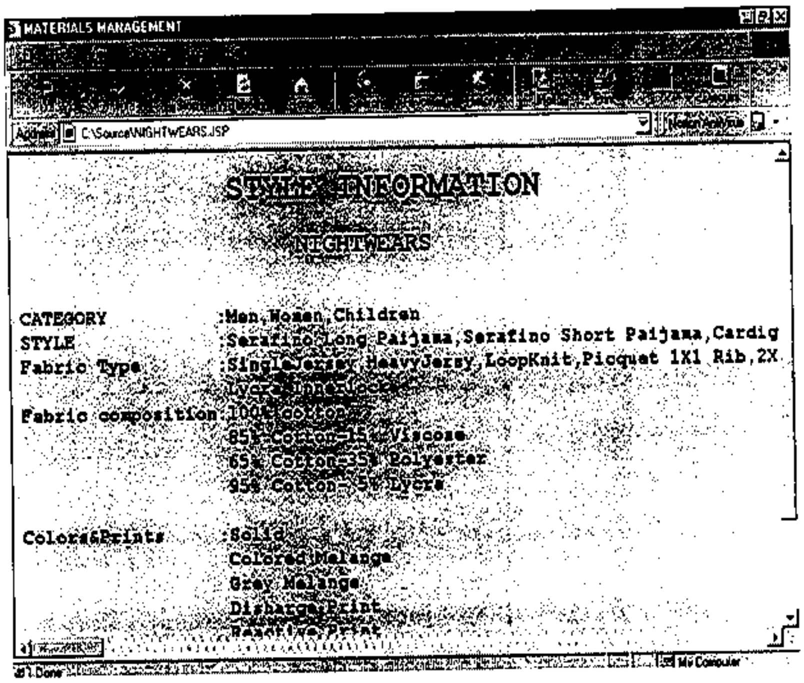


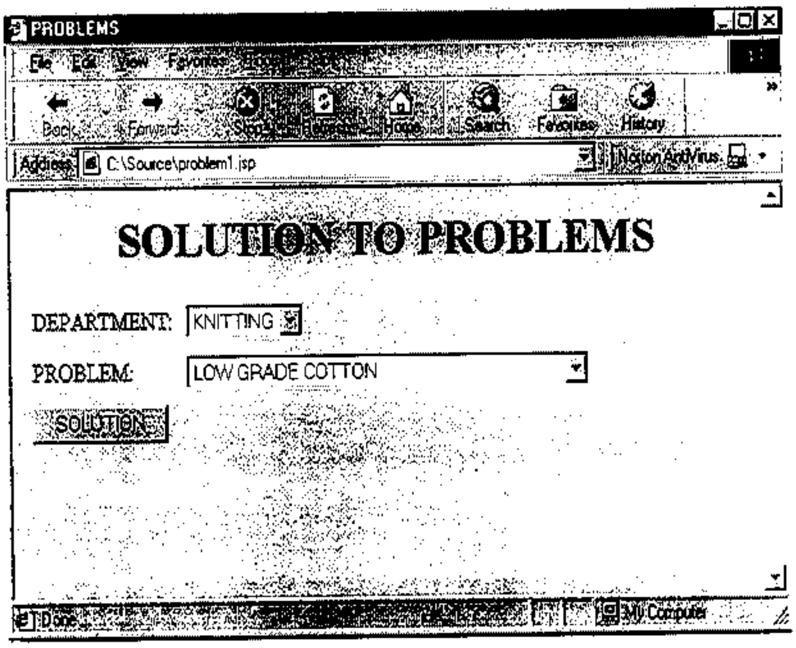
MATERIALS MANAGEMENT
C:\Source\majordepartments1.jsp
Norton AntiVirus
MAJOR DEPARTMENTS
DIRECTORS
MERCHANDISERS
KNITTING
CUTTING
STITCHING
PACKING
SAMPLING
QUALITY
EMBROIDERY
My Computer

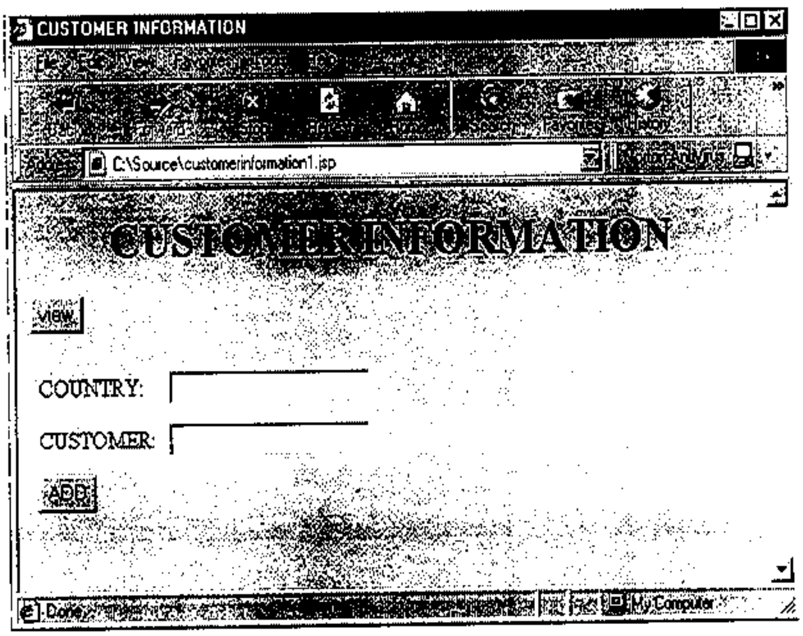


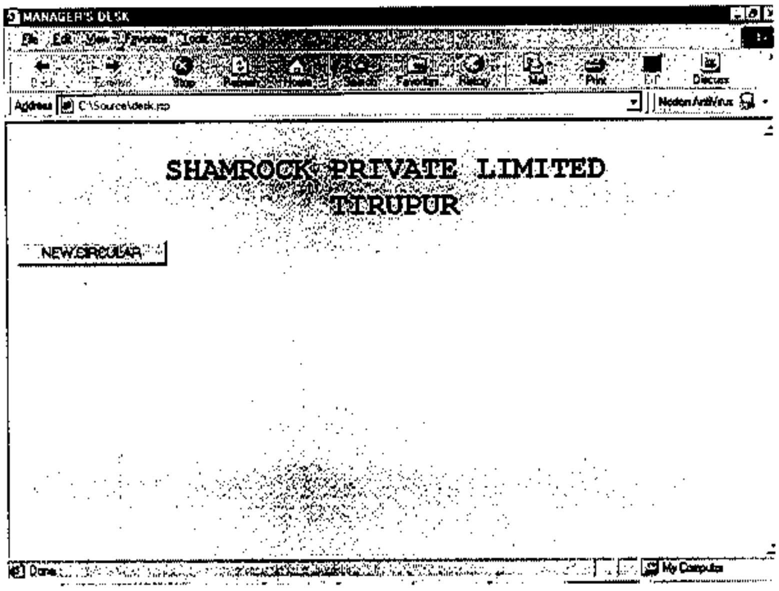
MATERIALS MANAGEMENT
C:\Source\machines.jsp
MACHINE DETAILS
Knitting Capacity/machine/day=400-500kgs.
2. COMPUTERISED BARUDAN EMBROIDERY M/C
3. JUKI SINGLE -STITCH M\C
This is for Woven Garments
4. LOCK-STITCH M/C
This is for Knit Wear
5. COMPUTERISED BUTTON-HOLE&BUTTON-STITCH
Done
My Computer

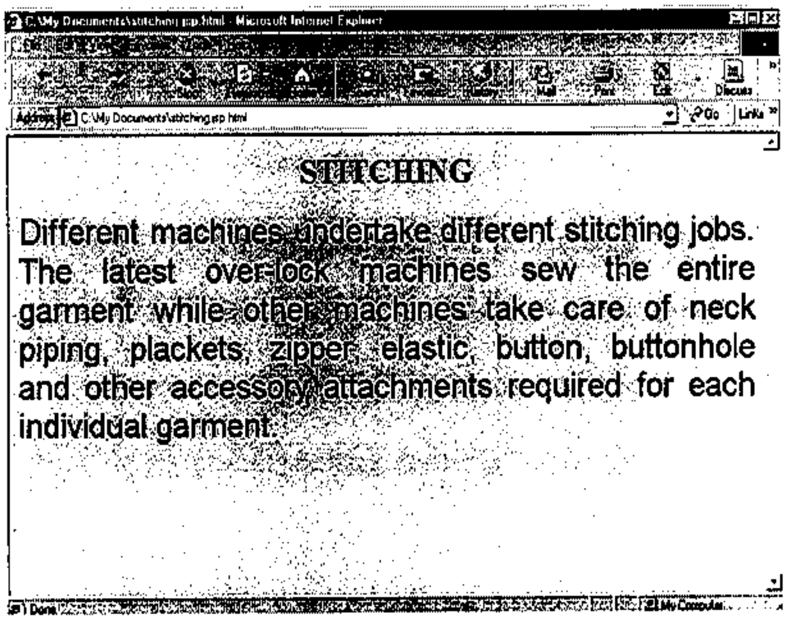

MATERIALS MANAGEMENT
Address C:\Source\styleinformation.jsp
Norton AntiVirus
STYLE INFORMATION
TSHIRTS
NIGHTWEARS
PULLOVERS
Done
My Computer

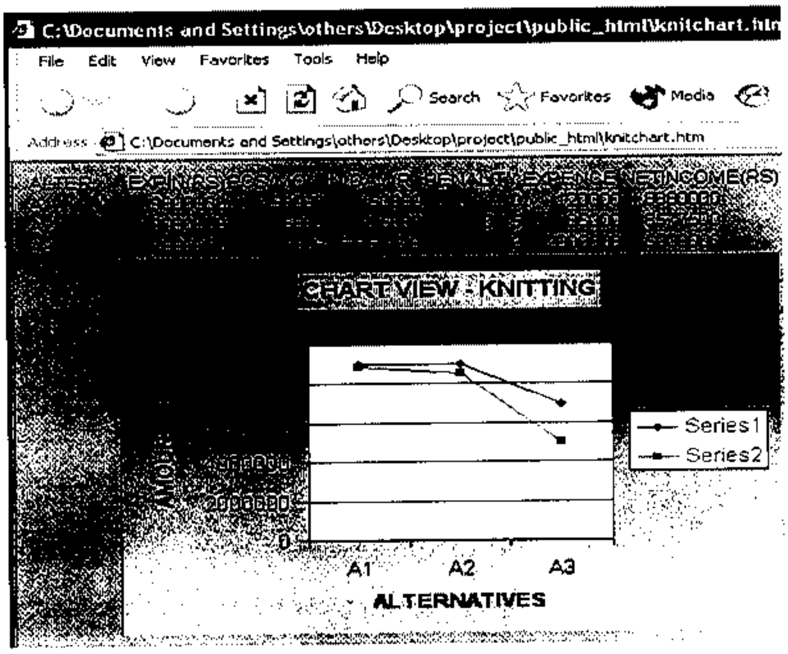

MATERIALS MANAGEMENT
Address C:\Source\NIGHTWEARS.JSP
STYLE INFORMATION
NIGHTWEARS
CATEGORY :Men,Women,Children
STYLE :Serafino Long Paijama,Serafino Short Paijama,Cardig
Fabric Type :SingleJersey HeavyJersy,LoopKnit,Picquet 1X1 Rib,2X
Fabric composition
85% Cotton-15% Viscose
65% Cotton-35% Polyester
95% Cotton-5% Lycra
Colors&Prints :Solid
Colored Melange
Grey Melange
Done
My Computer


PROBLEMS
C:\Source\problem1.jsp
SOLUTION TO PROBLEMS
DEPARTMENT:
KNITTING
PROBLEM:
LOW GRADE COTTON
SOLUTION
Done
My Computer


CUSTOMER INFORMATION
C:\Source\customerinformation1.jsp
CUSTOMER INFORMATION
view
COUNTRY:
CUSTOMER:
ADD
Done
My Computer


MANAGER'S DESK
SHAMROCK PRIVATE LIMITED
TIRUPUR
NEW CIRCULAR


STITCHING
Different machines undertake different stitching jobs. The latest over-lock machines sew the entire garment while other machines take care of neck piping, plackets, zipper, elastic, button, buttonhole and other accessory attachments required for each individual garment.


C:\Documents and Settings\others\Desktop\project\public_html\knitchart.htm
File Edit View Favorites Tools Help
Search Favorites Media
Address C:\Documents and Settings\others\Desktop\project\public_html\knitchart.htm
CHART VIEW - KNITTING
Series1
Series2
0
A1 A2 A3
ALTERNATIVES

CHAPTER 12

CONCLUSION

Intelligent Querying for Materials Management using Decision Support System gives an opportunity for the Shamrock Pvt Ltd to perceive methodologies to automate the decision making process. This will improve the capability to make an optimal and quicker decision at the right time by all the employees of various departments in the industry. Here all the departments are connected through the client server network controlled by the manager at the server side. The information is exchanged through the network and the decision is fixed very easily from the corresponding departments itself. This will help to reduce the wastage of time in decision-making process. Thus the production can be completed in time and the product can be delivered with in the lead-time with out penalty. As it is a web-based DSS, any user can access this package from any authorized department.

But there are some limitations with Web-based DSS User expectations may be unrealistic, especially in terms of how much information they want to be able to access. There will be technical implementation problems especially in terms of peak demand/load problems; training decision support content providers and providing them with tools and technical assistance may be costly; the continuing "browser wars" between Microsoft and Netscape are also a potential problem; and using the Web may result in accumulation of obsolete materials.

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