CHAPTER I
INTRODUCTION
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1.1 PREFACE

Business intelligence, or BI, is an umbrella term that refers to a variety of software applications, used to analyze an organization’s raw data for intelligent decision making for business success [14, 20]. BI, as a discipline is made up of several related activities, including Data mining, Online Analytical Processing (OLAP), Querying and Reporting. Techniques include Multidimensional analyses, Mathematical projection, BI modeling, Ad-hoc queries and 'canned' reporting [65].

BI leads to:

- fact-based decision making
- single version of the truth

The main purpose of BI systems is to provide Decision makers the necessary tools and methodologies that allow them to make effective and timely decisions [99].

1.2 EFFECTIVE DECISIONS

The application of rigorous analytical methods allows decision makers to rely on information and knowledge which are more dependable. As a result, they are able to make better decisions and devise action plans that allow their objectives to be realised in a more effective way. Indeed, turning to formal analytical methods force decision makers to explicitly describe both the criteria for evaluating alternative choices and the mechanisms to regulate the problem which is under investigation. Furthermore, the ensuing in-depth examination and thought lead to a deep awareness and comprehension of the underlying logic of the decision-making process.
1.3 TIMELY DECISIONS

Enterprises operate in economic environments characterized by growing levels of competition and high dynamism. As a consequence, the ability to react rapidly to the actions of competitors and to new market conditions is a critical factor in the success or even in the survival of a company.

With the help of mathematical models and algorithms, it is actually possible to analyze a large number of alternative actions, achieve more accurate conclusions and reach at effective and timely decisions. We may conclude that the major advantage derived from the adoption of the business intelligence system is found in the increased effectiveness of the decision-making process.

In a 1958, IBM researcher Hans Peter Luhn used the term business intelligence. He defined intelligence as: "the ability to apprehend the inter-relationships of presented facts in such a way as to guide action towards a desired goal".

Business intelligence as it is understood today is said to have evolved from the decision support systems which began in the 1960s and developed throughout the mid-80s. Decision Support System (DSS) originated in the computer-aided BI models created to assist with decision making and planning. From DSS, data warehouses, Executive Information Systems, OLAP and business intelligence came into focus beginning in the late 80s.

In 1989 Howard Dresner (later a Gartner Group analyst) proposed "business intelligence" as an umbrella term to describe "concepts and methods to improve business decision making by using fact-based support systems". It was not until the late 1990s that this usage was widespread.
Followed by these studies, a great number of researchers involved in examining to create a huge amount of valuable information in the form of examples such as e-mails, memos, notes from call-centers, news, user groups, chats, reports, web-pages, presentations, image-files, video-files, marketing material and news etc... However, organizations often use these documents only once.

According to Merril Lynch, more than 85 percent of all business information exists in various information types as before mentioned. These information types are called either semi structured or unstructured data. The management of semi-structured data is recognized as a major unsolved problem in the information technology industry. According to projections from Gartner (2003), white collar workers will spend anywhere from 30 to 40 percent of their time in searching, finding and assessing unstructured data.

1.4 DEFINITION OF BI

Business Intelligence or BI in short, as the name suggests corresponds to business and similar to many terms in this area, do not have a standard definition like that of many scientific terms. However, most of the BI literature has come from within the business world, the IT industry, and vendors [53,125].

Devanport [28] “BI is a set of technologies and processes that use data to understand and analyze organization performance”.

Platon [97] the term BI covers “the use of information to drive business insight. Basically it’s about providing a better foundation for decision makers by providing information in the right form, in the right quality and at the right time”.

Elizabeth Vitt et al [34] the term BI is “used by different pundits and software vendors to characterize a broad range of technologies, software platform, specific applications, and processes”. Thus it is clear that many people have viewed or expressed BI differently and from various contexts.
According to Turban et al [112] BI has several meanings for different individuals and is therefore an alleged content-free expression. Turban et al [112] also say that the most important purpose of BI is to provide business managers and analyzers the required instruments to conduct analysis. This is done through interactive access to existing and historical information, circumstances, and executions, which all supply perception in the organization and makes capable intelligent decisions. BI can be served as architecture, tool, technology, or system that collects, stores, and analyses data by analytical tools, facilities reporting, querying and delivers information that eventually lets organizations to enhance decision-making [113]. The BI systems contribute to enhancement and precision of information flows, and knowledge management and they make capable organizations to [70, 88]:

- pursue profitability of their goods sold;
- analyze costs;
- monitor incorporated environments; and
- Detect business anomalies and frauds

Cui et al. [25] consider BI as a way and a technique of developing business performance by supplying influential supports for managerial decision maker to let them to have liable information at hand. BI tools are viewed as technology that facilitates the effectiveness of business function by giving an enhanced value to the enterprise information and therefore the way this information is used.

One of the most complete definitions of the business intelligence can be found on the IBM Website [48].

"Business intelligence is the gathering, managing, analyzing, and sharing of information in order to gain insights that can be used to make better decisions. Business intelligence turns information into knowledge, and knowledge in turn became wisdom. Combining advanced techniques such as data warehousing, data mining, and decision-making.
support, business intelligence systems offer the ability to transform information into powerful customer relationship management systems that can help create stronger, more profitable relationships, identify new business opportunities even anticipate customer demands."

**Table 1.1 Summary of varied BI definitions**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>AUTHOR</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>1</td>
<td>IBM (Hans Peter Luhn)</td>
<td>The ability to apprehend the inter-relationships of presented facts in such a way as to guide action towards a desired goal.</td>
</tr>
<tr>
<td>2</td>
<td>Howard Dresner (later a Gartner Group analyst)</td>
<td>Business intelligence” as an umbrella term to describe &quot;concepts and methods to improve business decision making by using fact-based support systems.</td>
</tr>
<tr>
<td>3</td>
<td>Kulkarni &amp; King [67]</td>
<td>A product of analyzing business data using business intelligence tools. It emerges as a result of this analysis.</td>
</tr>
<tr>
<td>4</td>
<td>IBM [119]</td>
<td>An umbrella term that broadly covering the processes involved in extracting valuable business information from the mass of data that exists within a typical enterprise.</td>
</tr>
<tr>
<td>5</td>
<td>Adelman &amp; Moss [2]</td>
<td>A term encompasses a broad range of analytical software and solutions for gathering, consolidating, analyzing and providing access to information in a way that is supposed to let an enterprise’s users make better business decision.</td>
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<tr>
<td>6</td>
<td>Moss &amp; Atre [88]</td>
<td>It is an architecture and a collection of integrated</td>
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<td></td>
<td>Reference</td>
<td>Description</td>
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<tr>
<td>7</td>
<td>Gangadharan &amp; Swami [36]</td>
<td>The result of in-depth analysis of detailed business data, including database and application technologies, as well as analysis practice.</td>
</tr>
<tr>
<td>8</td>
<td>Moss, L &amp; Hoberman S [88]</td>
<td>The processes, technologies, and tools needed to turn data into information, information into knowledge and knowledge into plans that drive profitable business action. BI encompasses data warehousing, business analytics tools and content/knowledge management.</td>
</tr>
<tr>
<td>9</td>
<td>Chang [19]</td>
<td>The accurate, timely, critical data, information and knowledge that supports strategic and operational decision making and risk assessment in uncertain and dynamic business environments. The source of the data, information and knowledge are both internal organizationally collected as well as externally supplied by partners, customers or third parties as a result of their own choice.</td>
</tr>
<tr>
<td>10</td>
<td>Turban et al [112]</td>
<td>An umbrella term that encompasses tools, architectures, databases, data warehouses, performance management, methodologies, and so forth, all of which are integrated into a unified software suite.</td>
</tr>
<tr>
<td>11</td>
<td>Gartner Research [47]</td>
<td>An umbrella term that includes the analytic applications, the infrastructure and platforms, as well as operational as well as decision-support applications and databases that provide the business community easy access to business data.</td>
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<tr>
<td>No.</td>
<td>Company</td>
<td>Description</td>
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<tr>
<td>12</td>
<td>Business Objects [13]</td>
<td>The use of an organization’s disparate data to provide meaningful information and analysis to employees, customers, suppliers, and partners for more effective decision making.</td>
</tr>
<tr>
<td>13</td>
<td>Cognos [23]</td>
<td>Business intelligence brings people and data together, offering a variety of ways to see the information that backs fact-based decision-making.</td>
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<tr>
<td>14</td>
<td>SAS Institute [105]</td>
<td>Delivering the right information to the right people at the right time to support better decision making and to gain competitive advantage.</td>
</tr>
<tr>
<td>15</td>
<td>Oracle [93]</td>
<td>A portfolio of technology and applications that provides an integrated, end-to-end Enterprise Performance Management System, including financial performance management applications, operational BI applications, BI foundation and tools, and data warehousing.</td>
</tr>
<tr>
<td>16</td>
<td>Informatica, Teradata, MicroStrategy [84]</td>
<td>An interactive process for exploring and analyzing structured, domain-specific information (often stored in a data warehouse) to discern trends or patterns, thereby deriving insights and drawing conclusions.</td>
</tr>
</tbody>
</table>

### 1.4.1 BUSINESS INTELLIGENCE ARCHITECTURE

As per David Loshin [29], the objective of the business information analysis was, to find out, the ability to evaluate how efficiently the organization operates and subsequently seek out opportunities for manipulating actionable knowledge. This notion of performance management and improvement through reporting and analytics has
evolved into what is commonly referred to as “business intelligence.” While many front-end presentation, reporting, and visualization products help in communicating the results of this analysis, business intelligence remains inextricably linked to the technical infrastructure of the data warehouse.

The tactical challenges for providing a framework for business intelligence involve collecting data from disparate distributed systems, consolidating that data into a centralized model, and organizing the data to feed the front-end applications for driving business analysis and reporting. As is seen in Figure 1.1, this requires data connectors to extract data from the sources, integration tools to assimilate and consolidate the data. Servers and storage are used to house the data warehouse and its database management system, and feeding the front-end application architecture for reporting, dashboards, data mining, and dimensional analysis [29].

Figure 1.1 Traditional BI Architecture
1.4.2 TRADITIONAL BI TOOLS: LATE IS USELESS

Does your enterprise have the right information, at the right time, to make the right business decisions? Every month, a chief planning officer at an international company with operations across 18 countries faces that question. And every month, his job is on the line as a result. A security company experiences rising telecom costs among the seven different providers it contracts with, but lacks the means to quickly pinpoint where each cost stems from. Two different scenarios, yet for many enterprises, each points at one equally common challenge: the need to gather actionable analytics in real time and in a cost-effective manner.

For many enterprises, traditional business intelligence (BI) tools increasingly spell frustration, not only but also revenue loss and shrinking competitive advantage which finally led to taking strong measures to protect business interest in the midst of economic recession. Indeed, many enterprises are finding it increasingly difficult to justify the huge systems footprint and IT investment that typically accompany traditional BI approaches.
mouse game ensues to determine which of the various data warehouses and dashboards holds the right information. But there’s a silver lining to the BI status quo.

1.4.3 THE FIVE STEPS OF BUSINESS INTELLIGENCE ADOPTION

Step 1: A company with a database of customer transactions will often want to examine particular data, like revenue and unit sales during the last period for each product and territory. To do this, they probably use simple SQL queries or stored procedures to produce data on demand.

Step 2: The results from step one are saved in an Excel document, so business users can analyse them, using with filters or pivot tables. Alternatively, SQL Server Reporting Services (SSRS) might be used to generate a report of the SQL query for display on an intranet page.

Step 3: If these queries are run frequently, or business users want to explore data from multiple sources more freely, it may become necessary to create a new database structure for analysis rather than CRUD (create, retrieve, update, and delete).

For example, data from more than one system plus external information may be incorporated into a data warehouse. This can become ‘one source of truth’ for the business operational activities. The warehouse will probably have a simple ‘star’ schema, with fact tables representing the measures to be analysed (e.g. unit sales, revenue) and dimension tables defining how this data is aggregated (e.g. by time, region or product). Reports can be generated from the warehouse with Excel, SSRS or other tools.

Step 4: Not too long ago, Microsoft introduced an Excel plug-in, PowerPivot, which allows users to bring larger volumes of data into Excel documents and create links between multiple tables. These Business Intelligence Semantic Model (BISM) Tabular
documents can be created by the database owners or other expert Excel users and viewed by anyone with Excel PowerPivot.

Sometimes, business users may use PowerPivot to create reports directly from the primary database, bypassing the need for a data warehouse. This can invite some problems when there is so misunderstanding in the identification of data structure or no single ‘source of truth’ for key data.

**Step 5:** Steps three or four are often enough to satisfy business intelligence needs, especially if users are sophisticated enough to work with the warehouse in Excel or SSRS. However, sometimes the relationships between data are too complex or the queries which aggregate across periods, regions etc are too slow. In these cases, it is necessary to formalise how the data should be and opt for inbuild option to do the necessary aggregations. To do this, a business intelligence professional will typically use SQL Server Analysis Services (SSAS) to create a multidimensional model or “cube” that more simply represents key measures and aggregates them across specified dimensions.

Step five is where our tool, becomes useful, as it helps review and deploy changes from development to production. Breaking the BI status quo: Data discovery tools as traditional BI tools lose their power to pack a powerful BI punch due primarily to high costs and lengthy timeframes associated with BI project implementation a new generation of BI tools is emerging. Data discovery tools offer a small systems footprint versus a complex stack of modules and layers that accompany traditional BI products. Rather than leveraging a costly stack of BI product modules to solve one given problem, a “mini” data discovery tool offers a single, detailed view into an organization’s entire sweep of data, providing flexibility, ease of use and productivity at a fraction of the time and less cost.
1.4.4 COMPONENTS OF BI ARCHITECTURE

The components of the above technical architecture are described as follows [61]

SOURCE SYSTEMS

It consists of all the data that an organization might require for the analysis. It may consists of data from a source database, external data derived from the partners in XML format, data from the click-stream analysis, captured from the organizational website based on customer behavior, a connection from application server level ERP connection and data from Excel files and many more sources [61].

ETL TOOLS

ETL is a process to extract data, mostly from different types of system, transform it into a structure that’s more appropriate for reporting and analysis and finally load it into the database. The above Figure displays the steps involved in the process.

DATA QUALITY

According to Passionned Nederland B.V [96], today ETL does much more than what it is known for. It also covers data profiling, data quality control, monitoring and cleansing, real-time and on-demand data integration in Service Oriented Architecture (SOA), and Metadata Management.

DATA MINING

As per Kurt Thearling [66], Data mining, the extraction of hidden predictive information from large databases, is a powerful new technology with great potential to help companies focus on the most important information in their data warehouses. Data mining tools predict future trends and behaviors, allowing businesses to make proactive,
knowledge-driven decisions. The automated, prospective analyses offered by data mining move beyond the analyses of past events provided by retrospective tools typical of decision support systems. Data mining tools can answer business questions that traditionally consuming a lot of time to resolve.

**Figure 1.3 ETL Process**

DATA STAGING

In the data warehousing process, the data staging area is composed of the data staging server application and the data store archive (repository) of the results of extraction, transformation and loading activity. The data staging application server temporarily stores and transforms data extracted from OLTP (Online Transaction Processing) data sources and the archival repository stores cleaned, transformed records and attributes for later loading into data marts and data warehouses.
OPERATIONAL DATA STORE (ODS)

According to Inmon [50, 51], an ODS is an integrated, subject-oriented, volatile (including update), current-valued structure designed to serve operational users as they do high performance integrated processing. The essence of an ODS is the enablement of integrated, collective on-line processing. An ODS delivers consistent high transaction performance – two to three seconds. An ODS supports on-line update. An ODS is integrated across many applications. An ODS provides foundation for collective, up to the second views of the enterprise. And, at the same time, the ODS supports decision support processing.

MULTI-DIMENSIONAL DATA WAREHOUSE

As per kJube [61], the multi-dimensional data warehouse is the core of the business intelligence environment. Basically it is a large database containing all the data needed for performance management. The modelling techniques used to build up this database are crucial for the functioning of the BI solution. Typical characteristics of multi-dimensional data warehouse are that it contains invariant, integrated, and atomic data. A good understanding of multidimensional modeling techniques is necessary for better understanding of such data warehouse.

DATA MART:

A data mart is a smaller version of a data warehouse, typically containing data related to one functional area of the firm or with limited scope in some other way. It can be a useful step to a full-scale data warehouse [101].

OLAP

According to Rai & Storey [101], Online Analytical Processing or OLAP as it is popularly known, is a technology for real-time ad-hoc data access and analysis. It is a
vendor driven solution to meet business needs. The OLAP software may require scheduling, queuing, monitoring capabilities to handle thousands of users.

**SEMANTIC LAYER**

According to Vezzosi [114], Semantic layer reduces time to Business Intelligence. It provides a secured access to data with simple business terms. It can open access to any client and user, data type. It can combine with Data Federation for more agility. Semantic layers acts as a intermediary between presentation layer, which normally is the user interface for all end-users, business analysts, and administrators and the data storage area.

**SINGLE POINT OF INFORMATION ACCESS**

As a BI solution can generate various types of outputs such as reports, dashboards, scorecards etc. These outputs may sometimes contain tags, comments, interpretations etc which is in multiple forms and needs to be stored in a storage location which can be attached to these reports and hence may consume huge amounts of data storage space. So it is often advisable to have a single point of access through a portal solution, where it is also possible to attach a business user, scope of the report along with accessibility options [61].

**1.4.5 CYCLE OF A BUSINESS INTELLIGENCE ANALYSIS**

Each business intelligence analysis follows its own path according to the application domain, the personal attitude of the decision makers and the available analytical methodologies. However, it is possible to identify an ideal cyclical path characterizing the evolution of a typical business intelligence analysis, as shown in Figure 1.4, even though differences still exist based upon the peculiarity of each specific context.
**ANALYSIS**

During the analysis phase, it is necessary to recognize and accurately spell out the problem at hand. Decision makers must then create a mental representation of the phenomenon being analyzed, by identifying the critical factors that are perceived as the most relevant. The availability of business intelligence methodologies may help already in this stage, by permitting decision makers to rapidly develop various paths of investigation.

**INSIGHT**

The second phase allows decision makers to understand the problem which is in hand, in a better way. For instance, the analysis carried out in the first phase shows that a large number of customers are discontinuing an insurance policy upon yearly expiration, in the second phase it will be necessary to identify the profile and characteristics shared by such customers. The information obtained through the analysis phase is then transformed into knowledge during the insight phase. On the one hand, the extraction of knowledge may occur due to the intuition of the decision makers and therefore be based on their experience and possibly on unstructured information available to them.

![Figure 1.4 Cycle of a Business Intelligence](image-url)
DECISION

During the third phase, knowledge obtained as a result of the insight phase is converted into decisions and subsequently into actions. The availability of business intelligence methodologies allows the analysis and insight phases to be executed more rapidly so that more effective and timely decisions can be made to meet out the strategic priorities or a given organization in a better way. This leads to an overall reduction in the execution time of the analysis–decision–action–revision cycle, and thus makes a decision-making process a better quality one.

EVALUATION

Finally, the fourth phase of the business intelligence cycle involves performance measurement and evaluation. Extensive metrics should then be devised that are not exclusively limited to the financial aspects but also take into account the major performance indicators defined for the different company departments.

1.4.6 DEVELOPMENT OF A BUSINESS INTELLIGENCE SYSTEM

The development of a business intelligence system can be assimilated to a project, with a specific final objective, expected development times and costs, and the usage and coordination of the resources needed to perform planned activities. Figure 1.5 shows the typical development cycle of business intelligence architecture. Obviously, the specific path followed by each organization might differ from that outlined in the figure. For instance, if the basic information structures, including the data warehouse and the data marts, are already in place, the corresponding phases indicated in Figure 1.5 will not be required.
Figure 1.5 Phases in the development of a business intelligence system

Analysis
- Identification of business needs

Design
- Infrastructure recognition
- Project macro Planning

Planning
- Detailed Project requirements
- Development of a prototype
- Identification of the data Definition of data warehouses and data marts

Implementation and control
- Development of data warehouses and data marts
- Development of metadata
- Development of ETL tools
- Development of applications
- Release and testing
ANALYSIS

During the first phase, the needs of the organization related to the development of a business intelligence system should be carefully identified. This preliminary phase is generally conducted through a series of interviews held among workers and the knowledge ascertained in these interview serve as source of information. It is necessary to clearly describe the general objectives and priorities of the project, as well as to determine the costs and benefits derived from the development of the business intelligence system.

DESIGN

The second phase includes two sub-phases and is aimed at deriving a provisional plan of the overall architecture, taking into account any development in the near future and the evolution of the system in the mid-term. First, it is necessary to make an assessment of the existing information infrastructures. Moreover, the main decision-making processes that are to be supported by the business intelligence system should be examined, in order to adequately determine the information requirements. Later on, using classical project management methodologies, the project plan will be laid down, with full focus on phases, priorities, expected execution times and costs, together with the required roles and resources.

PLANNING

The planning stage includes a sub-phase where the functions of the business intelligence system are defined and described in greater detail. Subsequently, existing data as well as other data that might be retrieved externally are assessed. This allows the information structures of the business intelligence architecture, which consist of a central data warehouse and possibly some satellite data marts, to be designed.
Simultaneously with the recognition of the available data, the mathematical models to be adopted should be defined, ensuring the availability of the data required to feed each model and verifying that the efficiency of the algorithms to be utilized will be adequate for the magnitude of the resultant problems. Finally, it is appropriate to create a system prototype, at low cost and with limited capabilities, in order to uncover any discrepancy between actual needs and project specifications.

IMPLEMENTATION AND CONTROL

The last phase consists of five main sub-phases. First, the data warehouse and each specific data mart are developed. These represent the information infrastructures that will create business intelligence system. Moreover, ETL procedures are set out to extract and transform the data existing in the primary sources, loading them into the data warehouse and the data marts. The next step is aimed at developing the core business intelligence applications that allow the planned analysis to be carried out. Finally, the system is released for test and usage.

1.4.7 BENEFITS OF BI SYSTEMS

As per Dr. Saadia Asif [32], implementation of a BI system can offer

1. Enhanced Revenue
   - Through new customer acquisitions
   - Cross selling and up selling to existing customers

2. Reduced operating costs
   - Reallocate resources to low cost channels
   - Lowering the operating cost
   - Enhance product offerings and improve customer service

3. Competitive advantage
Greater share of customers mind and wallet by identification of key customer needs and service opportunities.

According to Schiff [106], implementing a BI system in an organization also helps:

- Improve the overall efficiency and effectiveness of your organization
- Help organization make better decisions by the provision of customized applications or tools aimed at users of various cadres.
- Allow business users to analyze and better understanding in their organization’s plans and results.
- Alert organizations to potential issues when exceptional conditions occur such as sales dropping 20% below forecast or inventory falling below a threshold value.

AREAS AND BENEFITS OF USING BI SYSTEM

The importance of BI for organization is mainly articulated in the fact that BI systems cast some light on information that may serve as the base for accomplishing radical changes in a specific enterprise, i.e. creating new cooperation, attracting new clients, developing new markets, offering products [18, 92, 103].

It is claimed that BI may uphold decision making on all managerial levels. The varieties of decisions range from ad hoc (strategic) to operational and tactical [94, 59].

The benefits that one can enjoy when BI is applied in the following three areas are cleanly categorized and tabled for further analysis.

Table 1.2 Area of usage and benefits of BI system in retailing

<table>
<thead>
<tr>
<th>AREA OF USAGE</th>
<th>ACTIVITIES</th>
<th>BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer relationship</td>
<td>• Define marketing strategy and activities</td>
<td>• Superior decision on marketing program and strategy</td>
</tr>
<tr>
<td>management</td>
<td>✔ Segmentation</td>
<td>• Improving customer</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Targeting</th>
<th>Supplier relationship management</th>
<th>Store operation management</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>✓ Targeting</td>
<td>✓ Evaluate vendors’ performance</td>
<td>• Working hours</td>
</tr>
<tr>
<td></td>
<td>✓ Shopping behavior analysis</td>
<td>✓ Evaluate product quality and profitability</td>
<td>• Evaluate salespersons’ performance</td>
</tr>
<tr>
<td></td>
<td>• Evaluate customer satisfaction</td>
<td>✓ Evaluate brands and products</td>
<td>• Staffing</td>
</tr>
<tr>
<td></td>
<td>• Evaluate effectiveness of marketing activities</td>
<td>Popularity</td>
<td>• Managing inventory</td>
</tr>
<tr>
<td></td>
<td>• Predict customer demand</td>
<td>• Information exchange with suppliers</td>
<td>✓ Stock level</td>
</tr>
<tr>
<td></td>
<td>• Insight into market trend</td>
<td></td>
<td>✓ Order level</td>
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<td></td>
<td></td>
<td></td>
<td>• Sales analysis</td>
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<tr>
<td></td>
<td></td>
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<td>• Better insight on revenue against cost of operation</td>
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<tr>
<td></td>
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<td>• Cost effective decision regarding to the number of available staff during rush and quiet hours.</td>
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<td></td>
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<td>• Insight on staffs’ performance</td>
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<td></td>
<td></td>
<td></td>
<td>✓ identify, reward, and retain competent staff</td>
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<td></td>
<td>✓ improve staff competency</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ improve total revenue</td>
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</tbody>
</table>
CUSTOMER RELATIONSHIP MANAGEMENT

According to the empirical findings, The BI system is utilized by the company to facilitate marketing and sales activities and manage interaction with clients. On strategic level, BI helps the organization to evaluate effectiveness of different promotions, offers, and marketing campaign to formulate best marketing strategy. It also provides information that can help managers to decide on any one market which may be profitable and service oriented one. This information help the company to segment market more effectively then target potential customers according to their buying preferences and patterns. In addition, it makes it easier for the company to predict future market trends and change in customers well in advance and help us to decide market strategy to woo the customer towards us in a planned way.

Strategic decision about marketing, as well as range and quality level of products can provide bases for making specific tactical decision in sales and marketing such as offering discount, promotions on certain products in certain period of years, selecting products/ brands, etc. Information organized and delivered by the BI system provides a better insight into customer demands and best way of fulfilling their needs, which in turn contributes in improving customer satisfaction and loyalty.
SUPPLIER RELATIONSHIP MANAGEMENT

As it illustrated in table 1.2, the BI system facilitates the evaluation of suppliers’ performance in terms of quality, price, profitability, speed of delivery, and popularity of the products. This helps the company to make tactical decision on selecting most profitable and preferred supplier. On the other hand, when the result of evaluation shows poor performance, managers can decide to terminate the contract or negotiate to cut the price. Therefore, the evaluation of suppliers’ performance can improve business by offering best deal in terms of price and quality to the consumers. In addition, using BI in conjunction with extranet technology can grant suppliers access to the analyses of sales. Hence, they will be able to adjust their production level and decide on shipping time according to the customer demands and tend to have some alert system. This will help both sides to coordinate and collaborate with each other and increase the performance of supply chain by delivering the right product at the right time and at lowest cost to the customers.

STORE OPERATION MANAGEMENT

On the operational level the BI system are employed to fulfill sale analysis. The analysis of sales information, such as units per transaction and analyzing amount of sale at different time of day against cost of operation, assists managers to decide on operational issues includes working hours, number of staff that must be available, salespersons’ performance, and managing inventory. Moreover, this information provide basis to calculate safety stock level and order level more accurately which consequently reduces the probability of being either out-of-stock or over stock and removes unnecessary inventory expenses. The system is also able to analyze the performance of each salesperson by analyzing number of working hours in each month, number of clients that receive advice, as well as amount and revenue of sales from each salesperson.
Insight on staffs’ performance helps to identify, reward, and retain competent staff as well as encourages employees to improve their performance and competency. This way of dealing with employees can have significant contribution on bottom line improvement of the company. To sum up, during the analysis of empirical findings, we noticed that large amount of information flows in the supply chain of the company from suppliers, and stores toward customers and vise versa. The BI system organizes and represents information from different sources in the form of tables or charts, which make it easier to understand and interpret. In addition, the BI system enables them to analyses complex information from different perspective easily.

Accurate and up to date information delivered by the system help the Sharvand Company to make correct and timely strategic, tactical, and operational decisions. Making the consistent, suitable, and right decision helps the company to make a better relationship with suppliers and improving merchandising process. On the other hand improved merchandising in conjunction with analyzing market needs and trends assists them to have better insight into popular products/brands, expected level of quality and purchasing power of consumers. Therefore, it would be possible to segment market more effectively and formulate best marketing strategies that can fulfill exact customers’ need from different market segment, which in turn increases customer satisfaction and loyalty as well as the company’s profitability and market share.

1.5 MATERIAL MANAGEMENT

Engineering product offer the best scenario for implementing ERP especially when it goes with Material requirement Planning.

Material management is a scientific technique, concerned with Planning, Organizing & Control of flow of materials, from their initial purchase to destination.

Materials Management is simply a process by which an organization is supplied with the goods and services that it needs to achieve its objectives of buying, storage and
movement of materials. Materials Management is related to planning, procuring, storing and providing the appropriate material of right quality, at right quantity and at right place in right time so as to co-ordinate and schedule the production activity in an integrated way for an industrial undertaking. Most industries buy materials, transport them to the plant, change the materials into parts, assemble parts into finished products, sell and transport the product to the customer. All these activities of purchase of materials, flow of materials, manufacture them into the product, supply and sell the product at the market requires various types of materials to manage and control their storage, flow and supply at various places. It is only possible by efficient materials management.

The material management requires planning, purchasing, inventory planning, storage, inventory control, materials supply, transportation and materials handling are the activities of materials management.

About 20-25 years ago, there was no cut-throat competition in the market to sell the various consumer items manufactured by different industrial undertakings and the availability of materials to manufacture these items was not scarce. Therefore, materials management was not thought to be so important and its separate identity in the organization was not felt. But today it has become an important management activity to streamline production. Actually before the production begins it is necessary to ensure availability of all the types of materials needed for production and its supply at the various production centers. Planning, purchasing and scheduling are the main functions of materials management. It aims at improved productivity. It is used to reduce the cost, which increases profitability and streamlines the production. Apart from management of material cost and its supply helps in its proper utilization, transportation, storage, handling and distribution.

The market research and forecasting both for sales of company’s product and purchasing of various materials required for producing the product are needed at the
planning stage. Purchasing, procurement of materials, transportation, storage, inventory control, quality control and inspection of materials and goods supplied at various production centers before production are also managed as routine work. Materials handling, packaging, warehouse planning, accounting, scrap, surplus and obsolete materials disposal, finished goods safety and care are the activities covered by the materials management department. Selection of personnel for marketing, purchasing, inventory control, stores management and materials handling and their training and placement is also to be seen by the materials management department.

This indicates that it is very essential to have a materials management department in any organization to support the management in the production activities. It also helps in the marketing, sales promotion and control of all the types of materials for its quantity, quality and cost.

1.6 OBJECTIVES AND FUNCTIONS OF MATERIALS MANAGEMENT

The objectives and functions of material management can be categorized in two ways as follows:

(I) Primary objectives

(II) Secondary objectives

![Figure 1.6 Objectives of materials management](image)

They are discussed below:

**PRIMARY OBJECTIVES**

Which can be classified as:

- Efficient materials planning
• Buying or Purchasing
• Procuring and receiving
• Storing and inventory control
• Supply and distribution of materials
• Quality assurance
• Good supplier and customer relationship
• Improved departmental efficiency

SECONDARY OBJECTIVES

There can be several secondary objectives of materials management. Some of them are given below:

• Efficient production scheduling
• To take or buy decisions
• Prepare specifications and standardization of materials
• To assist in product design and development
• Forecasting demand and quantity of materials requirements
• Quality control of materials purchased
• Material handling
• Use of value analysis and value engineering
• Developing skills of workers in materials management
• Smooth flow of materials in and out of the organization

To fulfill all these objectives, it is necessary to establish harmony and good co-ordination among all the employees of material management department and this department should have good co-ordination with the other departments of the organization to serve all production centers.

The basic objectives of management in an organization are:
• Sales increase through sales promotion
• Profit maximization
• Improvement in customer services
• Globalization of its product sales
• Meet the technological changes
• Good relationship between employer and employee
• Selection of alternative materials
• Reduction in manufacturing and other cost.
• Social objectives

In order to fulfill these basic objectives of management the objectives of materials management should be set in such a way that they should totally help to meet ultimate goals. The functions of materials management are discussed below:

In order to fulfill the objectives of materials management as stated above to meet the basic objectives and goals, the functions of the materials management are also categorized as primary and secondary functions.

**PRIMARY FUNCTIONS**

To meet the primary objectives, the primary functions of the materials management are given as follows:

(I) Primary functions

(II) Secondary functions

![Figure 1.7 Functions of materials management](image-url)
They are discussed below:

**MATERIALS REQUIREMENTS PLANNING (MRP)**

Planning of materials requirements in manufacturing is a necessary function in any organization, as inventory of materials involve about 60% of the total investment of the organization. The profit earned depends on the utilization of these materials and reducing the inventory of the materials.

The latest technique used is called Just in Time (JIT) is referred practically to no inventory. However, in the present situations in any of the organization particularly manufacturing organization, it is not absolutely possible to keep no inventory of materials required for production. The MRP is a technique used to plan the materials starting from the raw materials, finished parts, components, sub-assemblies and assemblies as per Bill of Materials (BOM) to procure or produce them to support a Master Production Schedule (MPS). It is used on computers productively by any company that uses a MPS to manufacture products that require assemblies, components and materials to produce the final products. The MPS is exploded using the bills of materials to determine requirements of lower-level assemblies, components, finished parts and raw materials. It plans orders to meet these needs.

**PURCHASING**

All the organizations needs an efficient and economic purchasing and procurement of its various supplies of materials from the suppliers. The materials management department has to perform this function of purchasing and procurement of materials very efficiently. Since 50% to 60% of sales turnover is spent on the purchase of various materials, the amount of profit earned on this sales very much depends how economically the materials are purchased and utilized in the organization. The profitability depends on the efficiency by which this particular function of purchasing
and procuring the requisite materials at appropriate time will be done and its availability is assured.

The function of purchasing can be stated as follows:

- The requisition of material is necessary by proper authority to initiate its purchase.
- To select proper supplier for the materials requisitioned, before placing an order.
- To negotiate about the price of the material from the supplier and it will be purchased at the cheapest price.
- The quality of material must be assured and should not be compromised with the cost of the material at any cost.
- The material should be purchased in right quantity and at right quality and at proper time and at the cheapest cost.
- Formulate proper purchase policy and procedure.

INVENTORY PLANNING AND CONTROL

The modern concept of inventory planning is that the materials should be purchased and brought to the stores just before it enters the production or sold out so that inventory cost is negligible. The zero inventories are the ideal planning.

There are three types of inventories.

- Raw materials
- Purchased goods
- Finished parts and components

The inventory control of these various materials lies with the materials management department, production department and sales department. Inventory at different levels is necessary to make sure about the availability of all these types of materials and goods and their proper flow from one facility to another at different levels.
of production centers in a manufacturing concern. The storing of various types of materials and parts as inventory is therefore very essential before its delivery and use at different production centers. This involves inventory planning and control of materials in the stores department. Many a time, the supplier may not be in a position to supply the materials of the ordered quantity at the proper time. To maintain the continuity in production and line balance in assembly work, the various types of inventories are necessary to be maintained and kept in the stores.

The raw materials before being supplied to a production process, some of it is sent to store as inventory and rest is sent to production facility as per its requirements and in the same way, various parts manufactured and assembled as components and assembled products are also stored as finished parts inventories at different places in the stores. The final products before being supplied to the customers are also stocked as inventory of the final products of the organization to meet the fluctuating demand and to regularize the supplies in the market. Thus, the inventory control is a very important function of the materials management department. The various types of inventory models are developed for the different materials to economise the purchase, supply, inventory control and production control to analyze and optimize the costs involved in ordering, set-up and inventory carrying of materials required in the production.

**ASCERTAINING AND MAINTAINING THE FLOW AND SUPPLY OF MATERIALS**

Distribution of materials requisitioned by the various production centers and other departments must be ascertained and its flow and continuity of supply must be maintained by the materials management department. Insufficient or zero inventories many times create the situations of stock-outs and leads to stoppage of production. Failure of materials handling devices is also responsible for disruption of material
supplies. Alternatives or emergency supply systems can be used for assuring production lines to continue.

Uncertainty in demand and production quantity is the main factor. Customer needs one subject to change and it should be kept in mind. The management has to maintain continuity in production to meet this uncertainty in demand and control the situation by ensuring proper flow of materials supply and distribution at various production facilities and other departments as situation warrants.

**QUALITY CONTROL OF MATERIALS**

The quality of the product manufactured by the organization depends upon the quality of the materials used to manufacture that product. It is a very important and necessary function of materials management to purchase the right quality of materials. The inspection, quality control, simplification, specification, and standardization are the activities which are to be meticulously watched to ensure good quality, devoid of any defect. The quality assurance is decided by inspection and checking. The various properties of materials as per their specifications and standard are checked properly. The size and dimensional measurements prescribed within limits assures the reliability of components and parts. Quality is largely determined by consumer taste and liking. The market is under buyer’s control. Customer decides the quality of the product. Material quality control aims at delivering product with higher at low cost. The product will be specified not only by its dimensional accuracy but its quality standards, durability and dependability, high performance, reliability and aesthetic value. Each of this factor aids cost to the product. In order to achieve high quality, the materials input to the product should be of high quality, which will have higher cost. The performance decides the reliability, which is obtained through high quality production. The performance is checked by qualified inspection team with good accuracy. This also aids cost to the product. The quality of the materials also decides the selection of vendors and the
relationship between buyers and suppliers. The specifications, size and quality of materials must be referred and if possible the standard should be followed for specifications and sizes. The types of tests required for assuring the quality should be specified and conducted to establish the standards.

**DEPARTMENTAL EFFICIENCY**

The objective of this function is to ensure the efficiency of the system adopted. If the system and procedure adopted for materials management are inefficient or faulty, none of the objectives mentioned above can be fulfilled, howsoever the procedure may be good. Management Information System (MIS) and feedback control at every stage of working must be adopted to control and make the management and employee work as efficiently as possible to achieve the best results.

**SECONDARY FUNCTIONS**

There can be number of secondary functions. Some of them are discussed below:

**STANDARDIZATION AND SIMPLIFICATION**

The standards and specifications of various types of materials are fixed by design and technical department of the organization and they are followed by production department. Standards define the quality, reduction in sizes and variety, interchangeability of parts and products. It ensures efficient utilization of materials and reduces wastages. Standard materials are always available at reasonable cost. It also helps purchasing department in selection of materials and vendors. If less variety of items purchased and put in the stores the types of inventories will be reduced and in this way the cost of carrying the inventories in the stores will be reduced. The objective of this function is to produce qualitative product at minimum cost.
DESIGN AND DEVELOPMENT OF THE PRODUCT

The variety in product and functionality are the important factors to promote the sales of a product. The new techniques of designing a product using Computer Aided Design (CAD) has made possible to develop variety of products at faster rate. The new technological development in manufacturing using Computer Aided Manufacturing (CAM) can produce variety of products at much faster rate with all types of flexibility in the manufacturing as compared to conventional methods. Materials management department has to act according to use of such variety of materials to produce variety of parts and ensure the supply of such materials. It should also be decided how to purchase and produce such variety of products with flexibility and at cheaper economic cost.

MAKE AND BUY DECISIONS

These types of decisions are the policy matter of the management. The capacity of the organization and the various facility developed by the organization to manufacture various items is the main objective of every organization. This is the important planning activity of every undertaking. But when a company grows fast, its sales increases at rapid rate then it becomes an important matter to decide whether the company should buy the parts and components or increase and establish its facilities to cope up with the increased demand and sales. This will be great concern to materials management department. It will help in selecting the suppliers to buy the items at reduced cost. The material evaluation, its availability, alternative materials selection, procurement and inventory control are the functions influence all managerial decision whether to buy or stop. The make and buy decisions are largely based on cost economics and cost benefit analysis made by the organization using the existing production capacity of labour, skill and machines available with the factory and how best they can be utilized.
CODING AND CLASSIFICATION OF MATERIALS

This is an important function of the materials management to help the production and purchasing department of every organization. It uses its own methods of classification of materials used to manufacture the product or a company selling various goods. ABC analysis is one of the simple and standard method used by most of the firms for classification and storing their variety of materials. The materials are recognized to purchase and stored as an inventory by its codes and nomenclatures. The various methods of coding are used by every organization to control the variety of materials and its quantity and price rates.

FORECASTING AND PLANNING

Materials requirements planning are based on correct forecasting of sales and demand of the products in the market. The market fluctuations are to be observed to control production of the organization. The various methods of forecasting are available and the materials management department can choose the one which gives the best results to the company. Forecast of future demand of sales initiate the planning of materials supply. Analytical methods are adopted for systematic forecasting and planning to procure the various materials required for production. In the case of fluctuating demands, there can be uncertainties in supply as well. This can be overcome by maintaining the proper quantity in the inventory of short supply materials at proper time. The different techniques available are used by materials manager to plan the procurement, purchase, supply, managing the outside and inside transport and storing of the materials to maintain the supply chain lines at every production facility to meet the changes in production quantity and schedule of production to meet the fluctuating demand of sales of products manufactured by the organization.
To fulfill the objectives and functions of materials management and control the activities of this department, they are thoroughly studied and analyzed. The topics for this study and analysis are given as follows:

- Materials management organization
- Materials requirements planning
- Forecasting
- Purchasing
- Inventory control
- Storing, warehouse planning and control
- Value analysis
- Materials handling
- Just In Time

The main functions of materials management are summarized as follows:

- Materials planning as per production requirements for quantity and time
- Purchasing the required materials
- Make or Buy decisions
- Receipts and inspections of materials
- Storage, warehousing securities and preservation
- Distribution of materials
- Transportation should be expedited and must be economically done
- Inventory control
- Disposal of over stock, surplus, scrap and salvage of materials
- Developing new sources of supply at competitive way
- Ancillaries industrial development
- Indigenous source of supply for foreign materials
• Material cost control and cost reduction
• Co-ordination and co-operation with the other departments
• Research and developments in materials management and their use

1.7 MATERIAL MANAGEMENT ORGANIZATION

The major resources in any organization to manage are the materials out of seven main resources required to run any organization. They are management, materials, money, man power, machines, methods and matrix or facilities which include systems, plants, location and buildings etc. The purpose of materials management organization in any industry is to plan the materials requirements for the production of goods and services. The structure of the organization must be such as to have the efficient management of materials controlling its flow, conservation and utilization. Materials management include inventory management, purchase management, value analysis, store keeping, maintenance and upkeep of the inventories in hand and in process.

The organization of material management functions in such a way that it should ensure a integration among various departments in the same wing for maintaining stability in the production. Though proper information system and maintaining harmonious relation among various wings in the same department, finally led the organization to achieve its desired goals.

The organization of materials management must be such as to efficiently integrate the activities concerned with materials and regulate its use as per requirements in the production so as to have stability. The structural development and authority within the hierarchy of the system must be harmonious and integrative for proper decision making and achieving goals of the organization through proper information supply system.
1.7.1 PURPOSE OF MATERIALS MANAGEMENT

- To gain economy in purchasing.
- To satisfy the demand during period of replenishment.
- To carry reserve stock to avoid stock out.
- To stabilize fluctuations in consumption.
- To provide reasonable level of client services.

1.7.2 NEEDS OF MATERIALS MANAGEMENT

- To have adequate materials on hand when needed
- To pay the lowest possible prices, consistent with quality and value requirement for purchases materials
- To minimize the inventory investment
- To operate efficiently.

The Objective of this project is effective management & supervision. It depends on managerial functions of Planning, Organizing, Staffing, Directing, Controlling, Reporting, Budgeting, Sound purchasing methods, Skillful & hard poised negotiations and Effective purchase system.

1.8 BUSINESS INTELLIGENCE IN MATERIALS MANAGEMENT

BUSINESS INTELLIGENCE (BI)

BI applications encompass many activities such as decision support systems, query and reporting, online analytical processing, statistical analysis, forecasting and determining, which altogether support the organisation to realize its set goals.
WHAT IS BI USED FOR?

Organizations use Business Intelligence to gain data-driven insights into anything related to business performance. It is used to understand and improve performance and to cut costs and identify new business opportunities, this can include, among many other things given below:

- Analyzing customer behaviors, buying patterns and sales trends.
- Measuring, tracking and predicting sales and financial performance
- Budgeting and financial planning and forecasting
- Tracking the performance of marketing campaigns
- Optimizing processes and operational performance
- Improving delivery and supply chain effectiveness
- Web and e-commerce analysis
- Customer relationship management
- Risk analysis
- Strategic value driver analysis

Softcode BI solution provides enterprise-wide reporting, budgeting and also integrates all the remote offices and disparate departments and provides information for fine collaboration derived during a single source. It allows you to quickly capture and integrate information into meaningful reports and securely distribute them across your entire enterprise on demand. Softcode Business intelligence solution provides the following features:

- Supports role based access e.g., employees, customers, and partners
- Provides a web-based portals
- Quickly create reports using predefined functions for simple reporting.
• Online analytical processing (OLAP) cubes for deeper analysis provides executives dashboard.

Implementing an inventory improvement solution driven by business intelligence (BI) can help retailers to improve their business in five key areas:

• Assortments,
• Replenishment,
• Vendors,
• Supply chain
• Markdown Optimization

TARGETED ASSORTMENTS

Many retailers have begun to implement assortment planning tools which help them to create the most profitable mix of merchandise to carry within their stores. While assortment planning tools can help retailers create multiple iterations of their plans, integrating business intelligence is critical to provide insight as to what assumptions should be made to guide those plans. BI enables retailers to:

• **Analyze large amounts of detailed historical data:** This analysis allows retailers to identify buying patterns for group of products with similar attributes across groups of similar stores based on factors such as geography, demographics, size or volume ranking.

• **Refine their assortments:** Business intelligence facilitates pre-season analysis to determine purchase quantities by size, allocate quantities by store for fashion items, and initial model stocks by size for new basic replenishment items as well as analysis of data from past seasons to determine the optimal mixture of sizes and styles for the product assortment.
- **Receive more accurate information on product profitability:** Business intelligence provides the means by which retailers can assign and analyze financial costs by product and combine that information with sales to get a true picture of product profitability, allowing them to make more informed decisions on the items to be included or excluded from their assortments.

  Business intelligence allows retailers to utilize metrics that may not be available in assortment planning tools to provide even greater insight into the assortment planning process.

**IMPROVED REPLACEMENT**

Many retailers carry an assortment of products that are replenished from a central distribution center based on pre-assigned target on-hand quantities. Best-in-class retailers are controlling and optimizing replenishment throughout their operations by applying BI to:

- **Improve the accuracy of operational forecasts:** Business intelligence can bring model and safety stock data together with inventory and sales information to identify potential out-of-stock situations, highlighting where target stocks and/or safety stocks need to be increased to prevent lost sales. BI tools can be used to proactively generate alerts in these situations so that the problem can be addressed appropriately.

- **Determine over-stock situations:** By combining sales data, forecast data and replenishment data, retailers can compute measurements such as target stock weeks of supply. Target and safety stocks that are too high relative to current
sales trends can be reduced and the inventory repositioned in the supply chain as and when needed without risking stock-outs.

- **Identify slow-turning locations and products:** Retailers can use BI to identify products with sluggish turnover ratios or products with stock on hand at the store but without sales, potentially indicating a failure to replenish shelves with available product; insufficient demand for the product at the location in question; noncompetitive pricing; ineffective marketing; or poor planogram layout.

- **Ensure the accuracy of inventory data in replenishment ordering systems:** Retailers can use BI to automatically generate schedules for inventory verification via physical inventory counts. By focusing on small samples of products selected based on specific product attributes, historical sales trends, replenishment status, and prior count discrepancies, they can reduce the labor requirements, service delays, and significant process disruptions of an exhaustive inspection.

  Business intelligence gives retailers the ability to closely monitor and analyze inventory levels within their enterprise, enabling them to more effectively stock merchandise based on the buying behavior of their customers.

**VENDOR COLLABORATION**

Inefficiencies in the supply chain affect not only the retailer, but also the vendors that supply the goods to consumers. Inaccurate or inaccessible data in the inventory management system can lead to retailers ordering unnecessary products because they
don't know they have supply on hand or hinder a retailer from placing necessary orders when supplies are low.

- **Reduce or eliminate the "bullwhip effect"**: The bullwhip effect is the distortion of product demand signals generated by order batching, shortage planning and reactions to price variations across the supply chain. Although retailers may open access for vendors to monitor aggregated sales data on their products, vendors typically lack of visibility in fine-grained transaction-level demand at retail stores. Providing vendors with insight into true demand reduces the necessary volume of safety stock kept on hand.

- **Leverage economies of scale.** Demand for product keep pace with constant variability such as fashion items is inherently difficult to predict. By combining business intelligence-based sales analysis with postponement (also known as delayed differentiation), the vendor can stock undifferentiated product in bulk and delay specific labour to convert it into its final form until a dependable demand forecast is available.

- **Make vendors responsible for managing inventory.** Web-based BI applications can allow selected external suppliers to access timely detailed demand information for their products across all locations and channels, allowing vendors to predict more accurately customer demand. Additionally, by providing aggregated information pertaining to their competitors' performance, retailers can foster competition between suppliers to proactively maintain shelf stock, virtually eliminating wasteful out-of-stock and overstock situations.
BI-based Vendor Managed Inventory systems (VMI) coax vendors in taking responsibility for properly managing inventory levels at distribution centers and stores, resulting in exponential value for both the retailer and vendors alike.

**SUPPLY CHAIN EFFICIENCY**

Business intelligence gives retailers the ability to gain access to enterprise-wide information on the company's supply chain operations. This insight can help to improve the accuracy of demand forecasts and increase the efficiency of the supply chain, reducing lead times, carrying costs, and operating costs across the enterprise. Retailers can use BI to gain visibility within their supply chain by:

- **Scrutinizing detailed waypoint logs.** Long order picking times may indicate equipment maintenance problems or suboptimal routing. High error rates in orders picked by a given operator can be symptomatic of insufficient training, excessive distraction or defective identification mechanisms. Lessening the amount of time spent locating specific items to fill orders can help to reduce operating costs, increase productivity and optimize service levels.

- **Analyzing vendor and distribution center lead time and lead time variability.** Retailers can reduce the need for safety stock if they can identify bottlenecks in their delivery system and reduce lead times for movement to the sales floor.

- **Measuring forecast accuracy.** Retailers who more quickly predicts the fluxation in the field demand, can avert the situation where we are supposed to opt for either over-stock or out of stock.
The aggregated effect of using business intelligence for supply chain optimization is a reduced need for safety stock to avoid service interruptions, increased asset liquidity, and easier access to available working capital.

**MARKDOWN OPTIMIZATION**

Business intelligence can be instrumental in both quickly identifying products that should be discontinued or marked down and determining the most profitable way to sell through poor performing merchandise. Combining item level plans with sales data allows retailers to quickly identify items to be promoted, marked down, or sent to outlet stores. The ability to react promptly to issues at item level enables retailers to avoid build-ups of non-productive merchandise.

In addition, business intelligence can be used to determine the most efficient ways to sell-through slow selling inventory. Retailers can use BI to identify the levels of discounts that have worked in the past to liquidate similar merchandise. Alternatively, BI can also be used to identify which locations have sold the product better or which sell mark down merchandise better so that broken assortments can be consolidated to the locations where these materials have the possibility of sold out quickly and at the same time at a higher price.

Detailed data related to physical and calculated inventories, inventory receipts and adjustments, supplier shipments and intra-enterprise item movements, sales, plans and forecasts, replenishment targets and safety stocks gathered in a centralized data repository serve as the foundation for the solution.

The importance of inventory management and how best-in-class retailers are utilizing business intelligence to analyze information and internal operations to improve the efficiency of inventory throughout the enterprise in order to:
• Conduct detailed, in-depth analysis of historical sales transactions, better anticipate demand, and relate their stocking positions to both short and long term trends.

• Accurately track inventory throughout the entire supply chain from order through distribution centers to stores and to the sales floor.

• Develop and leverage fact-based analytical models of customer behavior to understand the factors that influence sales.

1.8.1 THE BENEFITS OF BUSINESS INTELLIGENCE FOR INVENTORY IMPROVEMENT

World-class business intelligence environments allow retailers to increase their visibility into inventory management without hampering daily operations. By extracting information from disparate source systems and put into a centralized repository such as an enterprise data warehouse, retailers are concurrently reporting on metrics related to their supply chain, sales, production and internal operations to make better, fact-based business decisions. By utilizing a data warehouse that supports trending on both historical and future operational metrics such as weeks of supply, sell-through, inventory turnover, gross margin return on inventory and shrinkage, retailers can improve data quality and accuracy, manage inventory levels to avoid lost sales or oversupply, provide external vendors with increased visibility into product performance, and allow managers and executives to make more timely decisions using a common set of data trusted across the entire user community.
1.8.2 SUPPLY CHAIN INTELLIGENCE

Today’s demands in doing business are increasing every day, regardless of what kind of business a company is involved in. Companies are under compulsion to reduce its operational and service cost, in addition to prepare itself to face stiff competition doing other competitors. To sustain its growth in the competitive atmosphere, it is left with option of taking right decision at right time, guided by its own collection historic data. Taking right decision at right time is distorted by many facts such as changing customer need and market condition and the non-availability of hidden information (documents, e-mails, know-how, voice records, external sources etc.). ERP systems have also been designed to capture all these data, but their grater limitation lays in the fact that ERP do not support ad hoc querying and reporting, and simulations on data. Therefore, we need integrate our core business information system with a set of intelligent tools, intelligent information systems and modern analytical and artificial intelligence tools to discover relevant knowledge from all of these sources, to manage uncertainty, and to create and adopt our business intelligence as our main competitive advantage.

It is very important that users are able to explore and analyze data, and make different reports, but it is also important they can predict the behavior of customers, products and processes. Business intelligence tools are the one that can help users to reach all these goals – via querying, reporting, analyzing, visualization, uncovering patterns and correlations and relationships hidden in data. But, the real future of the business intelligence is in the right use of these tools. They have to be guided and used by users who understand the business, the data, and the general nature of the analytical methods involved and are familiar with the software environments.
One of the most significant factors influencing the realization of these goals and way of doing business and collaborating with trading partners effectively is information and communication technology, which enables fast and reliable internal and external communication, permanent storing of business data and activities needed for current business and planning future business activities. In an uncertain environments, where data from external sources are needed for strategic planning, it is even more important that we know how to explore all these data, process them in the way to produce knowledge and find hidden patterns, relationships and correlations that help us in strategic decision making, forecasting trends and possibilities.

These capabilities, related technologies and tools are seen as promising future technologies prerequisites to survive or beat out the recession (Pincher, 2009). Business intelligence, data content, and data knowledge are emerging technologies that are expected to have innovative potential in the next years.

1.8.3 DATA MINING

Data mining (sometimes called data or knowledge discovery) is the process of analyzing data from different perspectives and summarizing it into useful information - information that can be used to increase revenue, cuts costs, or both. Data mining software is one of the number of analytical tools for analyzing data. It allows users to analyze data from many different dimensions or angles, categorize it, and summarize the relationships identified. Technically, data mining is the process of finding correlations or patterns among dozens of fields in large relational databases.

Data mining is primarily used today by companies with a strong consumer focus retail, financial, communication, and marketing organizations. It enables these companies to determine relationships among "internal" factors such as price, product positioning, or staff skills, and "external" factors such as economic indicators,
competition, and customer demographics. And, it enables them to determine the impact on sales, customer satisfaction, and corporate profits. Finally, it enables them to "drill down" into summary information to view detail transactional data.

With data mining, a retailer could use point-of-sale records of customer purchases to send targeted promotions based on an individual's purchase history. By mining demographic data from comment or warranty cards, the retailer could develop products that make to appeal to specific customer segments.

1.8.4 DECISION SUPPORT SYSTEM (DSS)

A decision support system (DSS) is a computer-based information system that supports business or organizational decision-making activities. DSSs serve the management in its operations, and in its planning and help to make decisions, which may be rapidly changing and not easily specified in advance.

DSSs include knowledge-based systems. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from a combination of raw data, documents, personal knowledge, or business models to identify and solve problems and make decisions. Typical information that a decision support application might gather and present are:

- inventories of information assets (including legacy and relational data sources, cubes, data warehouses, and data marts)
- comparative sales figures between one period and the next,
- projected revenue figures based on product sales assumptions.
THE DECISION-MAKING PROCESS

The model includes three phases such as termed intelligence, design and choice. The extended version of the original scheme, which results from the inclusion of two additional phases, namely implementation and control.

INTELLIGENCE

In the intelligence phase the task of the decision maker is to identify, circumscribe and explicitly define the problem that emerges in the system under study. The analysis of the context and all the available information may allow decision makers to quickly grasp the signals and symptoms pointing at a corrective action to improve the system performance. For example, during the execution of a project the intelligence phase may consist of a comparison between the current progress of the activities and the original development plan. In general, it is important not to confuse the problem with the symptoms.

For example, suppose that an e-commerce bookseller receives a complaint concerning late delivery of a book order placed on-line. Such inconvenience may be interpreted as the problem and be tackled by arranging a second delivery at the shortest interval of time through shipping. Responding in such a way, we can win the heart of the customer.

DESIGN

In the design phase actions aimed at solving the identified problem should be developed and planned. At this level, the experience and creativity of the decision makers play a crucial role, as they are asked to devise viable solutions that ultimately allow the intended purpose to be achieved. Where the number of available actions is small, decision makers can make an explicit enumeration of the alternatives to identify
the best solution. If, on the other hand, the number of alternatives is very large, or even unlimited, their identification occurs in an implicit way, usually through a description of the rules that only feasible actions should satisfy.

CHOICE

Once the alternative actions have been identified, it is necessary to evaluate them on the basis of the performance criteria deemed significant. Mathematical models and the corresponding solution methods usually play a valuable role during the choice phase. For example, optimization models and methods allow the best solution to be found in very complex situations involving countless or even infinite feasible solutions. On the other hand, decision trees can be used to handle decision-making processes influenced by stochastic events.

IMPLEMENTATION

When the best alternative has been selected by the decision maker, it is transformed into actions by means of an implementation of this plan. This involves assigning responsibilities and roles to all those who involve in the action plan.

CONTROL

Once the action has been implemented, it is finally necessary to verify and check that the original expectations have been satisfied and the effects of the action match the original intentions. In particular, the differences between the values of the performance indicators identified in the choice phase and the values actually observed at the end of the implementation plan should be measured. In an adequately planned DSS, the results of these evaluations one translated into experience and information, which are then transferred into the data warehouse to be used during subsequent decision-making processes.
The most relevant aspects characterizing a decision-making process can be briefly summarized as follows.

- Decisions are often devised by a group of individuals instead of a single decision maker.
- The number of alternative actions may be very high, and sometimes unlimited.
- The effects of a given decision usually appear later, not immediately.
- The decisions made within a public or private enterprise or organization are often interconnected and determine broad effects. Each decision has consequences for many individuals and several parts of the organization.
- During the decision-making process knowledge workers are asked to access data and information, and work on them based on a conceptual and analytical framework.
- Feedback plays an important role in providing information and knowledge for future decision-making processes within a given organization.
- In most instances, the decision-making process has multiple goals, with different performance indicators, that might also be in conflict with one another.
- Many decisions are made in a fuzzy context and entail risk factors. The level of propensity or aversion to risk varies significantly among different individuals.
- Experiments carried out in a real-world system, according to a trial-and-error scheme, are too costly and risky as far as practical use are concerned for decision making.
- The dynamics in which an enterprise operates, strongly affected by the pressure of a competitive environment, imply that knowledge workers need to address situations and make decisions quickly and in a timely fashion.
FIVE STEP OF DECISION MAKING MANAGEMENT

As a business owner, you have to make decisions on a regular basis. Whether they are big decisions or small ones, everyone has an impact on your business. It’s not uncommon to feel a bit overwhelmed.

There is an excellent way to fine-tune your decision making process, one that is guaranteed to keep you from becoming overwhelmed by all the information and facts and figures that you need to consider before making a decision.

Break each decision down into five manageable steps. This will help you to distinguish each part of the process, to put all the information into a logical order that will help you to make the best possible choice.

DEFINE THE ISSUE

When you have to make a decision, it is usually because something has come up and it requires your attention; whatever it is, you need to identify it so that you are absolutely clear on what is happening. Defining the issue, the situation will clarify your thoughts. It will remove any extraneous ideas and keep you focused on the specific issue that you must resolve.

EVALUATE THE OPTIONS

Once you have defined the issue, you will find that there is more than one potential solution. You have to evaluate each option to determine which will bring you
closer to your business vision. Your decision may only bring you one step closer, but that is fine. You will reach your business goal one step at a time.

MAKE THE DECISION

When you know which option is the best choice, you are ready to make your decision. You know what is good for your business, what will bring you closer to your goals and vision. At this step, it’s natural to want to take some time to reflect on your choice. That’s fine, but don’t spend too much time in a reflective state. Once you are confident that you have chosen the best option fix the decision strongly in your mind and take steps toward it with full confidence.

Figure 1.8 Five step of decision making management
IMPLEMENT THE DECISION

Once you have decided on the course you will take, implement whatever you need to do to realize the decision in its true sense. If you have decided to offer a workshop, start planning it now. If you are going to invest in yourself, commit and organise investment. If you are going to write a new sales letter, start drafting it today. Don’t delay. Your decision won’t help you if you don’t actually make it happen.

MONITOR THE SOLUTION

The only way to make sure that your decision is moving you and your business forward is to monitor the solution that you chose. If you wrote a new sales letter, keep track of how many clients it brings to you. If you’re using a new accounting software, pay attention to how much time you can save in the event of using this software. Most importantly, it isn’t the end of the world if you find that the decision is not bringing you closer to your goals. Now that you know the steps to follow, you can use what you have learned to begin again. Following these five steps is always the right decision.

BI SUPPORT FOR DECISION-MAKING

BI systems are believed to offer when we face the challenge or converting of data into information and knowledge. Beside they provide some environment for effective decision making, strategic assessment, and taking steps in organisations. Importance of BI for organization is mainly articulated in the fact that BI systems cast some light on information that may serve as the base for accomplishing radical changes in a specific enterprise, i.e. creating new cooperation, attracting new clients, developing new markets, offering products. Executive decision making actions can be supported by the utilization of these components [17, 95]. Actions are explained as

• Acquire (e.g. supported by the data warehousing)
- Gather (e.g. supported by the ETL)
- Analyze (e.g., supported by the use of OLAP)
- Report (e.g., supported by the data-mining) data that come from various and discrete sources

Table 1.3 BI component employed for decision-making

<table>
<thead>
<tr>
<th>BI SYSTEM COMPONENT</th>
<th>HOW USED IN DECISION-MAKING</th>
</tr>
</thead>
</table>
| ETL Tools           | Used to extract, transform and load data from both operational databases and scattered data sources, permitting the task of gathering of volumes of data [95], which allows for:  
  - Access to information in real-time  
  - Standardized and consistent data type in which to analyze |
| Data Warehouse      | Used as warehouse for all data applicable to an organization to facilitate the decision making [81] by:  
  - gathering related and context sensitive data  
  - offering multiple dimensions to data |
| OLAP Techniques     | employed to analyze and report data from vast data sources [95] by:  
  - giving user access to data warehouse  
  - building data models |
| Data Mining         | Utilized to identify structure, associations, and patterns within a data warehouse and generates comprehensive reports [46]. It facilitates:  
  - predictions based on past data  
  - graphing and computing to produce formulas to analyze data |
**STRATEGIC LEVEL**

BI makes potential to set goals accurately and to pursue realization of the goals. BI facilitate carrying out a variety of comparative reports, such as on chronological results, profitability of a certain offers, effectiveness of distribution channels together with doing modeling of development or anticipating future trend on the basis of some hypothesizes [94, 59]. Strategic decisions are made or modified rarely, but the scope of decisions is extensive and has influence on other decisions [59].

**OPERATIONAL LEVEL**

BI Systems are utilized to carry out ad hoc analyses and respond matters linked to departments’ current operations, the latest financial status, collaboration with contractors and clients, sales etc. Operational decisions represent a policy hub, as the policies are applied to different decision points where actions are taken [94, 59].

**TACTICAL LEVEL**

BI Systems can facilitate decision making in sales, marketing, capital management, etc. BI is capable of optimizing future achievements and changing organizational, financial or technological aspect of business performance properly to support organizations in achieving strategic goals successfully. Decisions in this level can happen in high volume and are repeated regularly. Such decisions can also be made automatically such as, approval of loans and assignment of credit lines. These decisions are made by extremely programmed algorithmic decision support processes [94, 59].

**1.8.5 DATA CAPTURING**

Data input can happen in several ways. One way is the result of data entry. In data entry, data is placed in chosen fields of a database by a human agent using a device such as a mouse, keypad, keyboard, touch screen, or stylus, or alternatively, with speech
recognition software. Data capture is a kind of data input in which there is no data entry. Instead, data is collected in conjunction with a separate activity.

1.8.6 DATA PROCESSING

Computer data processing is any process that a computer program does to enter data and summarize, analyze or otherwise convert data into usable information. The process may be automated and run on a computer. It involves recording, analyzing, sorting, summarizing, calculating, disseminating and storing data. Because data is most useful when well-presented and actually informative, data-processing systems are often referred to as information systems. Nevertheless, the terms are roughly synonymous, performing similar conversions; data-processing systems typically manipulate raw data into information, and likewise information systems typically take raw data as input to produce information as output.

Data processing may or may not be distinguished from data conversion, when the process is merely to convert data to another format, and does not involve any data manipulation.

BUSINESS INTELLIGENCE AND DATA MANAGEMENT

Here, you'll find links to the information and resources you need to make an informed BI and Data Management software selection.

The terms business intelligence (BI) and business performance management (BPM) are heard time and again, but what do they really mean for businesses?. Getting back to basics, both terms refer to the concept of using technology to

- Identify sales trends to develop sales strategies and to manage future sale
- Manage employee performance
- Identify quality issues on the shop floor
- Optimize business processes through the use of technology
- Forecast, budget, and plan within a process-centric environment
- Allow C-level executives the ability to monitor the organization's performance regularly and centrally throughout the day

The common theme within these technologies is that organizations use them to optimize their performance and stay competitive within the market. Business performance management should not be confused with business process management, also known as BPM.

**BI FOR PROCUREMENT: SPEND ANALYSIS**

Business intelligence help companies in a better way in the area of cost controlling. BI can provide the visibility and insight needed to improve procurement performance. Some specific questions BI can help answer include; not only that, BI provide better knowledge to companies, particularly in some areas where material purchase and service should be limited and thus save money is a profitable manner.

**MATERIAL ANALYSIS**

- What materials has the procurement organization purchased this period? In what volumes and for what prices? How has that changed over time?
- How is the total landed cost of a material distributed across unit cost, and other carry costs? Has this changed?
- How many items do we carry on our material list? Has this increased over time? Can we consolidate or substitute items to maximize buying power?
- What types of requests (MRO, Manufacturing Job Orders, MRP) by volume have been processed? Do patterns reveal opportunities for streamlining?
- Are different demand channels ordering similar commodities? Can we synchronize needs across channels or substitute materials for consolidated buying?

**VENDOR ANALYSIS**

- How many vendors have we got this year? On average how much is spent per vendor in a specific period?
- How do vendors be ranked by volume and revenue spent? How has that changed over time?
- How many vendors do we have for a specific material or material group? What percentage of the volume is sourced from a single supplier?
- How do prices be compared across vendors for a specific material? Has this changed?
- How do vendors be compared across payment and delivery terms, quality of materials received, on time delivery, order and invoice accuracy?

**PROCESS ANALYSIS**

- How many transactions are performed for various stages in the procurement cycle?
- How long does it take to move from one stage to the next in the procurement cycle?
- How do processing times relate to specific materials, vendors and buyers?
• What percentages of requisitions are declined? What are the reasons for rejection?
• How does this compare across commodities, and demand channels?
• Where are there opportunities for reducing non value added activities?

PEOPLE ANALYSIS

• How many requisitions, contracts, and purchase orders are processed across the organization by buyer? What is the average value of each transaction?
• How is each buyer’s activity distributed across vendors, materials and demand channels? Should buyer responsibilities be redistributed?
• Is there an opportunity to consolidate transactions with a vendor through one buyer?
• Are there opportunities for consolidating the purchase of certain materials with certain buyers?

1.9 SCOPE OF MATERIALS MANAGEMENT

Referring to the various functions of material management stated above the materials management co-ordinates various departments of manufacturing concern. Since the cost involved in manufacturing has maximum investment in the materials. It is about 55% to 65% of the sales value has been investigated by the Directorate of Industrial Statistics during 1954-57 in India. As soon as materials are purchased and brought by the organization, its value goes on increasing as the other costs that we tend to bear in the following task of carrying, storing and subject the material to various processes before we get a final product. So original cost of material is multiplied. In order to economize all the costs of materials management company has to adopt definite method of deciding the quantity of materials to be ordered, quantity to be stored as inventory and work in process inventory. In order to reduce the material cost and all
other costs stated above, there has to be some efficient and effective materials management techniques, which must be dynamic to adjust with changing demand and production.

1.9.1 INTEGRATED MATERIALS MANAGEMENT CONCEPT

Materials management concept is to manage resources in an integrative way for national economic development. This is possible with the development Management Information System (MIS), technological innovations and selection of economic and newly-developed materials for manufacture. It is the management’s responsibility to develop the materials management system, which will find the ways and means for most efficient and most effective use of its resources, using new technological processes, methods and ideas. The various resources to be fully utilized are men, money and materials and therefore there is importance of materials management. This will be further cleared by studying the examples given below in the table about the expenditure incurred in the materials resource.

Materials worth Rupees 30,000 crores flow in various production channel annually in India, out of which about Rupees 15,000 crores are held up in the stock and out of which Rupees 1200 crores worth of materials are in cold storage without any use. Some become absolute in course of time.

AVERAGE EXPENDITURE ON THE MATERIALS BY VARIOUS INDUSTRIES

Various industries one spending their money on materials to get a final product after undergoing various processes. The table given below give some insight in to the concept of average expenditure on materials.
Table 1.4 Average Expenditure on the Materials by Various Industries

<table>
<thead>
<tr>
<th>S.NO</th>
<th>INDUSTRIES</th>
<th>AVERAGE EXPENDITURE ON MATERIALS IN PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Electrodes, rubber goods, cotton and silk yarns, electric motors, sugar, jute, motor vehicles etc.</td>
<td>65% to 70%</td>
</tr>
<tr>
<td>2.</td>
<td>Cotton, textiles, cables, wires and utensils.</td>
<td>60% to 65%</td>
</tr>
<tr>
<td>3.</td>
<td>Engineering goods and non-ferrous metals.</td>
<td>55% to 60%</td>
</tr>
<tr>
<td>4.</td>
<td>Ship building, cement, chemicals and electricity</td>
<td>50% to 55%</td>
</tr>
<tr>
<td>5.</td>
<td>Pharmaceuticals and medicines</td>
<td>45% to 50%</td>
</tr>
<tr>
<td>6.</td>
<td>Aircraft, fertilizer and steel</td>
<td>40% to 45%</td>
</tr>
<tr>
<td>7.</td>
<td>Other industries</td>
<td>40%</td>
</tr>
</tbody>
</table>

Industries-wise expenditure on materials is given in the above table to show its importance. The integration of materials management functions is necessary in the following ways:

- Materials management will take decisions for purchase of materials.
- The centralization of authority is necessary.
- It will co-ordinate all the functions.
- Speedy and accurate decisions are needed.
- Data analysis through Electronic Data Processing (EDP) and use of computers is necessary.
- Opportunity for growth must be emphasized.
1.9.2 TYPES OF MATERIALS

The various types of materials to be managed are:

PURCHASED MATERIALS

They are raw materials, components, spare parts, oils, grease, cotton waste, consumables and tools.

WORK IN PROCESS (WIP) MATERIALS

These are semi-finished and finished parts and components lying on the shop floor.

FINISHED GOODS

These are the final products either waiting to be assembled in the assembly lines or in stores which are stocked for final delivery. The various costs involved in these materials are basic price, purchasing costs, inventory carrying cost, transportation cost, materials handling cost, office cost, packing cost, marketing cost, obsolescence and wastages.

1.10 FRAMEWORK OF THE THESIS

In this thesis business intelligence, the proposed Soft code and Soft Computing algorithms such as Genetic Algorithm, Ant Colony Optimization, Particle Swarm Optimization, Fuzzy logic and Neural Network are used for both Static and Dynamic Business Intelligence (BI) optimization problems and Enterprise Resource Planning (ERP) solutions. The thesis is organized into eight chapters.

Chapter 1: Introduction
The first chapter is introductory in nature and the subsequent chapters discuss the proposed technique in detail. The gist of each chapter is provided below.

Chapter 2: Literature Review

Systematic overviews of the existing techniques for implementing business intelligence are analyzed in this chapter.

Chapter 3: Soft Computing Approach and Development of Algorithms

The soft computing algorithms are proposed to implement the business intelligence. The soft computing algorithms like GA, ACO, PSO, Fuzzy Logic and Neural networks are used. And also discusses about the solution algorithm should be identified and a software tool that incorporates the solution method should be developed or acquired.

Chapter 4: BI Model Formulation

This chapter analyzes about an appropriate mathematical BI model to represent the system.

Chapter 5: Implementation & Test

This chapter discusses about the BI model developed, then implemented, tested and utilized in the application domain.
Chapter 6: Experiment & Results

This chapter analyzes about the experiments and results carried out to generate a Soft Computing report for business intelligent system.

Chapter 7: Performance and Analysis

This chapter discusses the Performance Evaluation in generating report for business intelligence is discussed and also calculates the Error Rate for all optimization algorithms.

Chapter 8: Conclusion and Future work

In this concluding chapter, result obtained through this research work and contributions made are presented. Scope for future research is also obtained.