CHAPTER 2

LITERATURE REVIEW AND THEORETICAL CONSIDERATION

In this chapter, literature reviews and theoretical consideration are presented. Firstly, the literature reviews are shown. It is described Data Warehouse definitions and its implementation in numerous organizations and the concerned studies of Data Warehouse. Secondly, the theoretical consideration is presented. The concepts of Data Warehouse and Data Mart, Information Technology planning, and the evaluation of implementation effectiveness in Information System are shown.

2.1 Literature Reviews

Data warehousing has become very popular among organizations seeking competitive advantage by getting strategic information fast and easy (Adhikari, 1996). Data warehousing is one of the fastest growing client/server applications. Babcock (1995) described that it is informational and analysis and decision support oriented, not operational or transaction processing oriented. William Inmon, who coined the term "data warehouse" in 1990, defined a data warehouse as a managed database in which the data is:

> **Subject oriented**: There is a shift from application-oriented data (i.e., data designed to support application processing) to decision-support data (i.e., data designed to aid in decision making). If designed well, subject-oriented data provides a stable image of business processes, independent of legacy systems. In other words, it captures the basic nature of the business environment.

Integrated: The database consolidates application data from different legacy systems (usually means old-style mainframe databases), which use different encoding, measurement units, and so on, and eliminates inconsistencies in the data.

Time-variant: Informational data has a time dimension: each data point is associated with a point in time, and data points can be compared along that time axis unlike operational data which is valid only at the moment of access capturing a moment in time.

Nonvolatile: New data is always appended rather than replaced. The database continually absorbs new data, integrating it with the previous data.

As well known, a data warehouse is very expensive and complex to develop (Adhikari, 1996). However, as above the characteristics suggest, a data warehouse has many advantages. One of the major purposes of data warehousing is to build a database (data warehouse) separately from transactional databases because analytic data and transactional data are different in terms of requirements and user communities. The transactional databases are not suitable for analytic purposes because:

Transactional databases contain only raw data, and thus, the processing speed will be considerably slower.

Transactional databases are not designed for queries, reports and analyses uses; therefore, the performance is poor on those tasks. Also, they do not store the historic data that is necessary for data analyses.

Transactional databases are inconsistent in the way that they represent information. For example, different databases may use different units of measurement for the same attributes (Barquin, 1995).

In addition, Laudon (2002) explains that a data warehouse is a database that stores current and historical data of potential interest to managers throughout the company. The data originate in many core operational systems and external sources each with different data models. They may include legacy systems, relational or object-oriented Database Management System applications. The data from these diverse systems are copied into the data warehouse database as often as needed-hourly, daily, weekly, or monthly. The data are standardised into a common data model and consolidated so that they can be used across the enterprise for management analysis and decision-making. As more and more corporate data comes from changing external information sources, the data are available for anyone to access as needed but cannot be altered. He also comments that the data warehouse must be carefully designed by both business and technical specialists to make sure it can provide the right information for critical business decisions.

According to a survey by the Meta Group in 1995, 95 percents of the 250 companies contacted planned to introduce or continue to use data warehouse in the next year. Compared to the previous year's figure of 15 percent, this is a dramatic change (Bull, 1995). Another survey by Forrest Research Inc., found that 96 percents of the senior IS manager at the Fortune 1000 firms surveyed planed to implement data warehouse. Of these, 60 percent expected data warehouses to improve overall access to corporate data, while 31 percents saw them as part of a broader cooperate strategy to improve business process, offer better customer support, and identify new opportunity (Adhikari, 1996).

A study by the Meta Group speculates that data warehousing will grow continuously (Barney, 1995). In addition, many vendors, having noticed this trend, have begun to manufacture various kinds of hardware, software, and tools to help data warehouse function more effectively, thus targeting this profitable market.

There are several literatures that present information involving the data warehouse implementation such as Mcgee (1997) study of the bottlenecks of

implementing a successful data warehouse. This thesis studies the bottlenecks experienced in implementing a successful data warehouse. It covers lessons learned from real life projects, advise from professionals, experiences of the writer, and the views of end users. This thesis provides in depth knowledge of data warehousing and its components. The fundamentals of the data warehouse are presented, as well as findings from research surveys in corporate environment, which validate, through observation, the bottlenecks of implementing a successful data warehouse.

Vigayatipat (1999) presented the development of an implementation plan of a management information system, MIS, at the Wang Noi Power Plant. The development follows the Business Planning, BSP, methodology developed by IBM. It begins with the identification of the MIS objective and strategies. Next, the system requirements are analysed with the Wetherbe and Davis methodology. This results in the definitions and evaluation of information requirements for all organisational subsystems. Then, the system design is considered, including the applications, software selection, hardware and communication network designs. Finally, the implementation plan is developed. It includes the implementation strategies, the master plan and the details of the first twelve-month plan. The organisation for the implementation is proposed, cost and benefits of the system and mechanism for successful implementation are also identified.

In the same year, Jianhui (1999) studied on an implementation of marketing data analysis system. This thesis studies the implementation of a data warehousing initiative for the purpose of marketing data analysis. Implementation of this thesis was divided into two phases. The objective of phase one is to produce a concept-proof prototype. Phase two is to generate an actual production system. Major tasks in phase two covered many aspects of the data warehousing life cycle: revised and fine-tuned the conceptual, logical and physical data model; performed database redesign and database sizing; built and rebuilt the database to improve performance; improved data extraction, transformation and loading process; performed database and SQL

performance tuning; planed and implemented information presentation with off the shell data access tools.

Sujitparapitaya (2000) studied of the effects of organisational structure on the implementation of data warehouse topologies. This thesis studies to explain whether or not the outcome differences in Data Warehouse topology could be explained by differences in an organisation's choice of structures. This leads to two primary objectives: (a) to determine whether a potential relationship exists between organizational structure and the choice of data warehouse topology, and (b) to utilise the research findings to develop appropriate organisational variables that can differentiate data warehouse topologies.

This study focuses on a multiple case study with a research survey to provide a comprehensive understanding of the relationship between organizational structures likely to differ with respect to the degree of centralisation in their Data Warehouse implementation approach? These three aspects of organisational structure are formalization, decentralization, and level of IT decision-making authority. The results of data analyses indicate that formalization and level of IT decision-making authority was found to significantly affect the differences in out come of Data Warehouse topology. In addition, a higher degree of formalization and a highly centralised IT decision authority reflect a dominating enterprise-wide DWG implementation approach.

In the same year, Ullman (2000) study of selection and maintenance of views in a data warehouse which studies two design issues; selection of views to materialize and incremental maintenance of materialized view and it is presented comprehensive solutions to both problems. Selection of views to materialize, It is developed a theoretical framework for the general problem of selection of views in a data warehouse. Given a set of queries to be supported, the view selection problem is to select a set of views to materialize minimizing the query response time given some resource constraint. For different resource constraints and settings, it has been

designed approximation algorithms that provably return a set of views having a query benefit within a constant factor of the optimal.

Incremental maintenance of general view expressions, Traditional maintenance algorithms maintain view expressions in response to changes at the base relations by computing and propagating insertions and deletions through intermediate sub expressions. In this thesis, it have been developed a change-table technique, that computes and propagates " change- tables" through sub expressions, for incremental maintenance of general view expressions involving aggregate and outer join operators. It is shown that the presented change-table technique outperforms the previously proposed techniques by orders of magnitude.

2.2 Theoretical Consideration

Theoretical consideration presents the concepts of Data Warehouse and Data Mart. It describes Data Warehouse components, the Data Mart as the subset of Data Warehouse, the data model of Data Mart. Then Information Technology planning and the evaluation of implementation effectiveness in Information System are shown.

2.2.1 The Concepts of Data Warehouse and Data Mart

2.2.1.1 Data Warehouse Components

Data warehouse architecture exhibits various layer of data in which data from one layer are derived from data of the lower layer. Data sources, also called operational databases, form the lowest layer. They may consist of structured data stored in open database systems and legacy systems, or unstructured or semi-structured data stored in files. The data source can be either part of the operational environment of a company or an organisation, or external, produce by a third party (Laudon, 2000). The components of a data warehouse are shown in Figure 2.1.

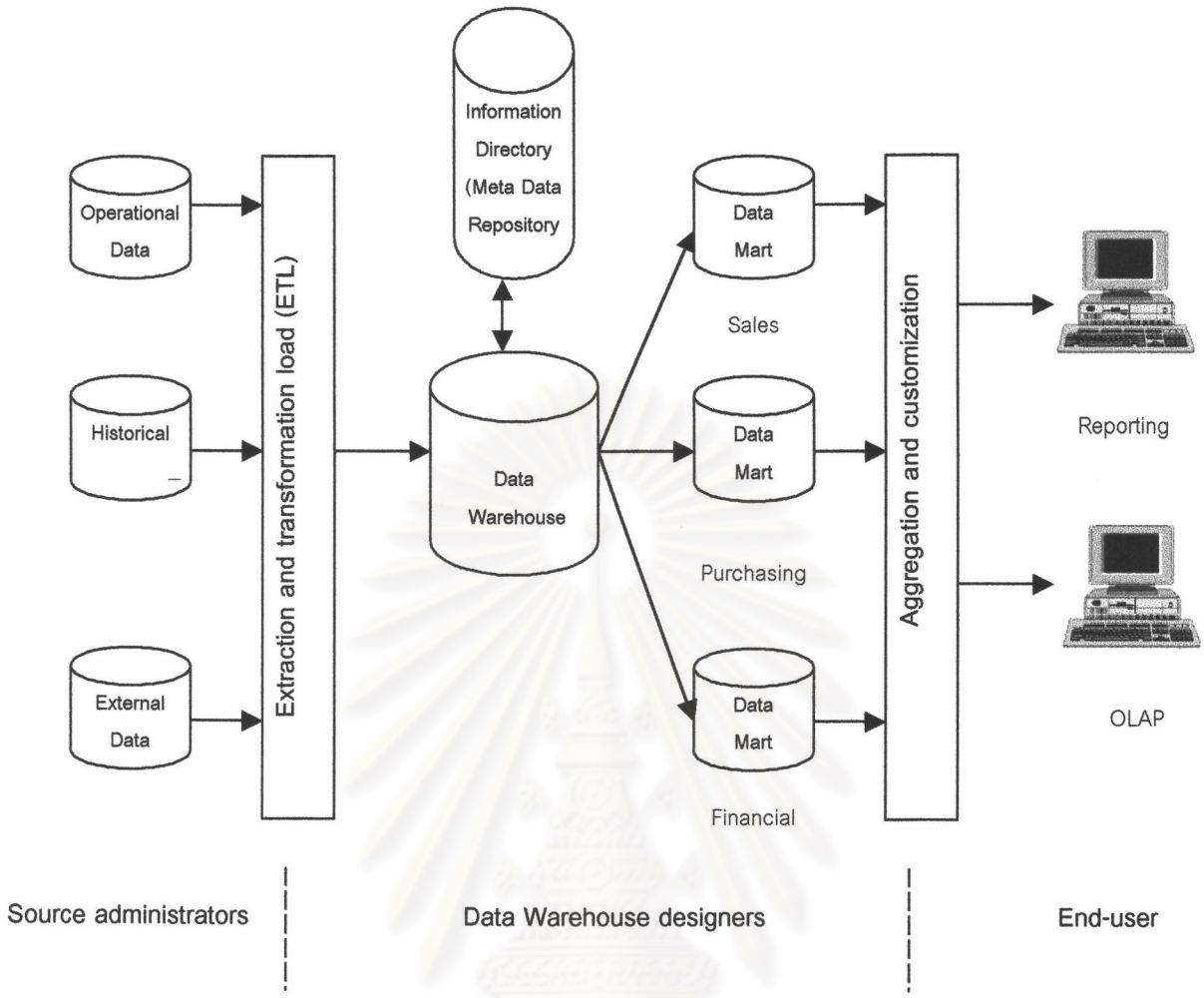


Figure 2.1: Components of a data warehouse (Adapted from Laudon, 2000)

The central layer of the architecture is the "global" warehouse, sometimes called primary or corporate data warehouse. It is a collection of integrated, nonvolatile, subject-oriented databases designed to support the Decision Support System (DSS) function, where each unit of data is relevant to some moment in time, and it contains atomic data and lightly summarized data. He also stated that "The global data warehouse keeps a historical record of data. Each time it is changed is placed in line with the previous snapshots. Typically, the data warehouse may contain data that can be many years old."

The next layer of views are the "local" warehouses, which contain highly aggregated data derived from the global warehouse, directly intended to support

activities such as informational processing, management decisions, long-term decision, historical analysis, trend analysis, or integrated analysis.

There are various kinds of local warehouses, such as the data marts or the Online Analytical Process (OLAP) databases. A data mart enables faster response to queries because the volume of the managed data is much smaller than in the data warehouse and the queries can be distributed between different machines. Data marts may use relational database systems or specific multidimensional data structures. For example, a data mart for the marketing department should include only customer, sales and product information where as the enterprise-wide data warehouse could also contain information on employees, departments, etc. (Laudon, 2000)

In some case, an intermediate layer, called an Operational Data Store (ODS), is introduced between the operational data sources and the global data warehouse. An ODS contains subject-oriented, collectively integrated, volatile, current valued, and detailed data. The ODS usually contains records that result from the transformation, integration, and aggregation of detailed data found in the data sources, just as for a global data warehouse. Therefore, it can be considered that the ODS consists of a set of materialized relational views.

Metadata play an important role in data mart. Before a data mart can be accessed efficiently, it is necessary to understand what data is available in the data mart and where is the data located. In addition to location the data that the end-users require, the Metadata may contain:

- Data dictionary: contains definitions of the database being maintained and the relationships between data elements
- Data flow: direction and frequency of data feed
- Data transformation: transformations required when data is moved
- Version control: changes to Metadata are used
- Data usage statistics: a profile of data in the warehouse
- Alias information: alias names for a field

2.2.1.2 The Data Mart as The Subset of Data Warehouse

In general, Data Mart is a data warehouse, however; for a smaller subset of data elements. Unlike data warehouses, which contain large quantities of data from key operational systems in an enterprise, a data mart typically contains only a subset of the data that would have been stored in an enterprise data warehouse. Data Mart data are selected to meet the specific needs of a subset of the organisation. It is not unusual to find a Data Mart developed and implemented for a department, a division, or a geographical location.

Data Mart are often preferred by enterprises as a first step to building a Data Warehouse, since these can be used as a "proof of concept." Initial success with the Data Mart can be used to convince skeptics in the enterprise and loosen the enterprise's purse strings. (Humphries et al.,1999)

There are many support broad ranges of information sources for Getting Heterogeneous Data into the Data Mart;

- Database systems (relational, object-oriented, network, hierarchical, etc.)
- External information sources (information gathered from other companies, results of surveys)
- Files of standard applications (e.g., Excel, COBOL applications)

Wrappers, loaders and mediators are programs that load data of the information sources into the data mart. Wrappers and loaders are responsible for loading, transforming, cleaning and updating the data from the sources to the Data Mart. Mediators integrate the data into the Data Mart by resolving inconsistencies and conflicts between different information sources. Furthermore, an extraction program can examine the source data to find reasons for conspicuous items, which may contain incorrect information. These tools try to automate or support tasks such as

- Extraction (accessing different source databases),
- Cleaning (finding and resolving inconsistencies in the source data),

- Transformation (between different data formats, languages, etc.),
- Loading (loading the data into the data mart),
- Analysing (e.g., detecting invalid/unexpected values),
- High speed data transfer (important for very large data mart)

Online analytical processing (OLAP) is the technology that enables this exploitation of the information stored in the data mart. Due to the complexity of the relationships between the involved entities, OLAP queries would cross several relations and would require multiple join and aggregation operations over normalized data structures; thus overloading the normalized relational database.

Typical operations performed by OLAP clients include

- Roll-up (increasing the level of aggregation),
- Drill-down (decreasing the level of aggregation),
- Slice and dice (selection and projection), and
- Pivot (reorienting the multidimensional view).

The OLAP applications provide the user with a multidimensional view of the data, which is somewhat different from the typical relational approach; thus their operations need special, customized support. This support is given by multi-dimensional database systems and relational OLAP servers.

2.2.1.3 The Data Model of Data Mart

In order to better understand implementation of Data Mart, it is necessary to know the meaning of Dimensions and Fact, the Data Model of business, and the Data Cube as follows (Louis, 2000)

1. The Dimension

The one fundamental question names basic business drivers-customers, products, services, suppliers, locations, channels, periods of time within which events occur, and additional other entities significant to the business. When these business

drivers are abstracted and represented in a relational database, they are called *Dimensions.* Dimensions are what give meaning to facts and make them unique. They are the basic states of affairs-persons, places, things-of which the real world is composed, that is, the real world of business being represented in the database.

The data models certainly appear to be different. The one looks a bit like a snowflake, elegant and complex. The other looks more like a star, a simple central body surrounded by multiple structures. One of the most famous data model is star schema shown in Figure 2.2.

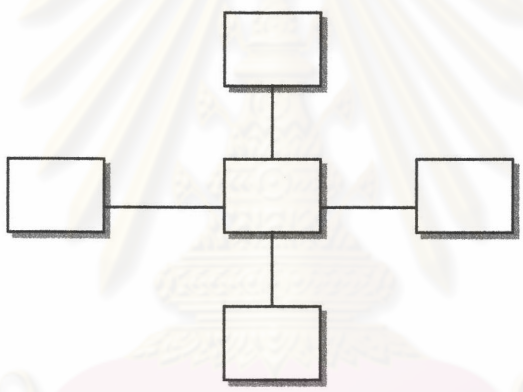
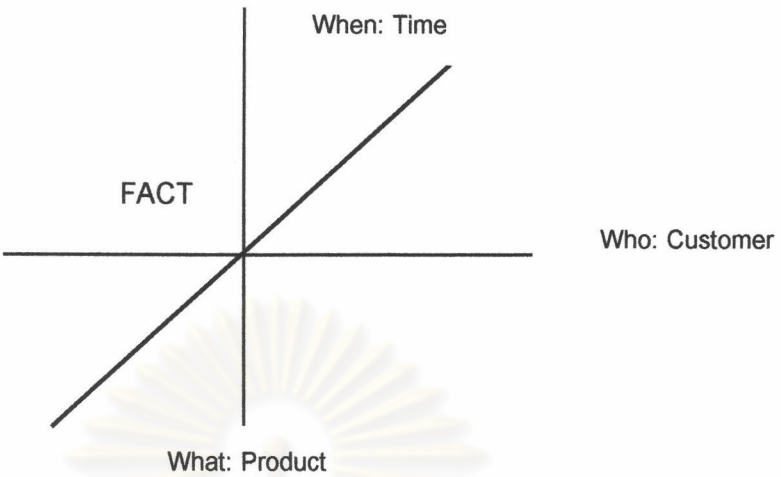


Figure 2.2: The Star Schema (Louis, 2000)

2. The Fact

A Fact is a measurement captured from an event in the marketplace. It is the moment of value when the customer intersects with the product at a particular space and time. It is the raw material for knowledge-observations. This is a significant result. The meaning of Data Mart Fact is shown in Figure 2.3.



FACT: For Performance: Numeric, Continuous, Additive; and an Intersection of Dimension

Figure 2.3: The Data Mart Fact (Louis, 2000)

A customer buys a product at a certain location at a certain time. When the intersection of these four dimensions occurs, a sale is made. The point at which these dimensions intersect, providing an answer to the fundamental question, is a basis business event-a transaction. That sale is describable as amount of dollars received, number of items sold, weight of goods to be shipped, etc. A Data Mart Fact is defined as intersection of the dimensions constituting the basis entities of the business transaction. At this juncture, the number of dimensions that can be drawn through the point of intersection is easily and usefully multiplied-store (location), vendor, promotion, ship-to location, sales personnel, and department.

3. The Data Model of Business

The data model resulting from building a central fact structure with the smaller, supporting dimensional structures placed around the periphery resembles a star. The intersection of different dimensions to form a structure off of which, in effect, a fact table is "hung" actually looks like a star. The fact table in the center and the various dimensions are the many points of the star. Hence, the name given to this form of joining together the various dimensions is the "star schema". When a customer id, a

product id, and a time period are used to determine which rows are selected from the fact table, this way of collecting the data is called the star schema join as shown in Figure 2.4: the star schema join.

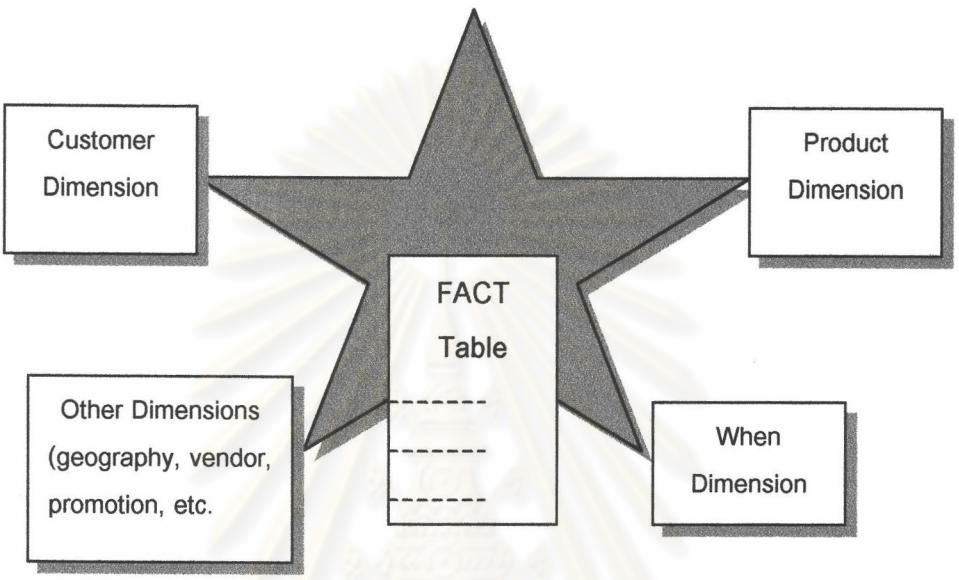


Figure 2.4: The Star Schema join (Louis, 2000)

4. The Data Cube

The cube is defined as the available aggregation by basic business drivers, depicted as completed data structures. The cube is the intersection of dimensions to provide a structure of facts of interest to the business. The classic cube is customer by product by time or place as shown in Figure 2.5. If a customer, Lou, buys a tasty brand granola bar on April 2, 1999 for one dollar, that transaction is given meaning as the intersection of customer, product (item), and date. The most important quantities associated with the transaction are the sale price (one dollar) and item sold. These quantities form the granularity of the cube. The granularity of the cube is a function of the intersecting of the dimensions.

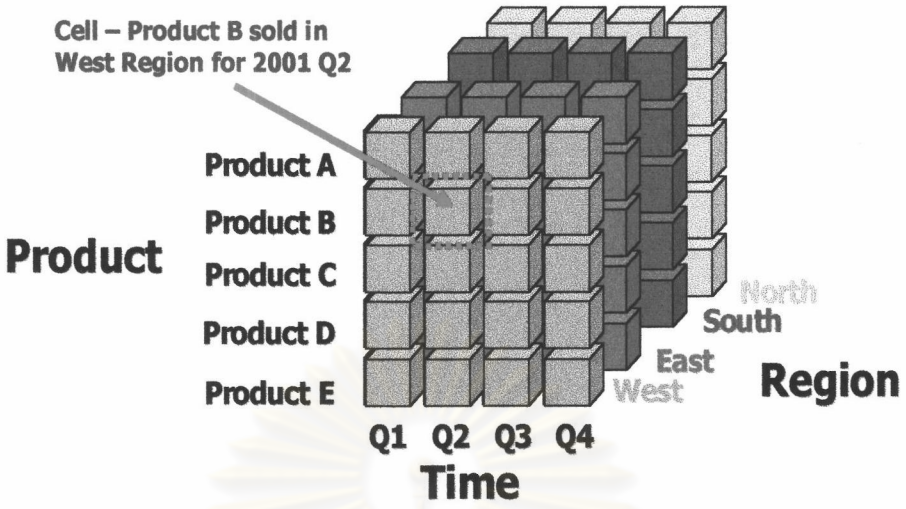


Figure 2.5: The Data Cube

2.2.2 Information Technology Planning

Information Technology (IT) planning is the organized planning of IT infrastructure and application portfolios done at various levels of the organization.

Basic information systems planning address the following four general issues:

1. Aligning the IT plan with the organizational business plan
2. Designing an IT architecture for the organization in such a way that users application, and databases can be integrated and networked together.
3. Efficiently allocating information systems development and operational resources among competing application.
4. Planning information systems projects so that they are completed on time and within budget and include the specified functionalities.

(Turban et al., 2002)

2.2.2.1 IT Planning Methodologies

There are several methodologies that can be used to carry on IT planning. Most of these methodologies start with some strategy and competitiveness, and relates them to technology (Turban et al., 2002).

The one of the most famous of IT planning methodologies is Wetherbe's A Four-Stage Model of IT planning. The model consists of four major activities-strategic planning, requirements analysis, resource allocation, and project planning-and it is valid today. The stages involve the following activities:

Figure 2.6: Basic four-stage model of IT planning

(Turban, et al., 2002)

- Strategic IT planning: Establishes the relationship between the overall organizational plan and the IT plan.
- Information requirements analysis: Identifies broad, organizational information requirements to establish a strategic information architecture that can be used to direct specific application development.
- Resource allocates: Allocates both IT application development resources and operational resources.
- Project planning: Develops a plan that outlines schedules and resource requirements for specific information systems projects.

Most organization engage in all four stages, but their involvement in the specific stages tends to be sporadic and problems as they occur, instead of reflecting a systematic, stage-by-stage process.

2.2.2.2 The Systems Development Life Cycle

Most of the implementation plan of Information System follows Information System Development Life cycle (SDLC). It comprises of 4 phases; Strategic planning,

system analysis, system design, and system implementation. The SDLC model is shown in Figure 2.7.

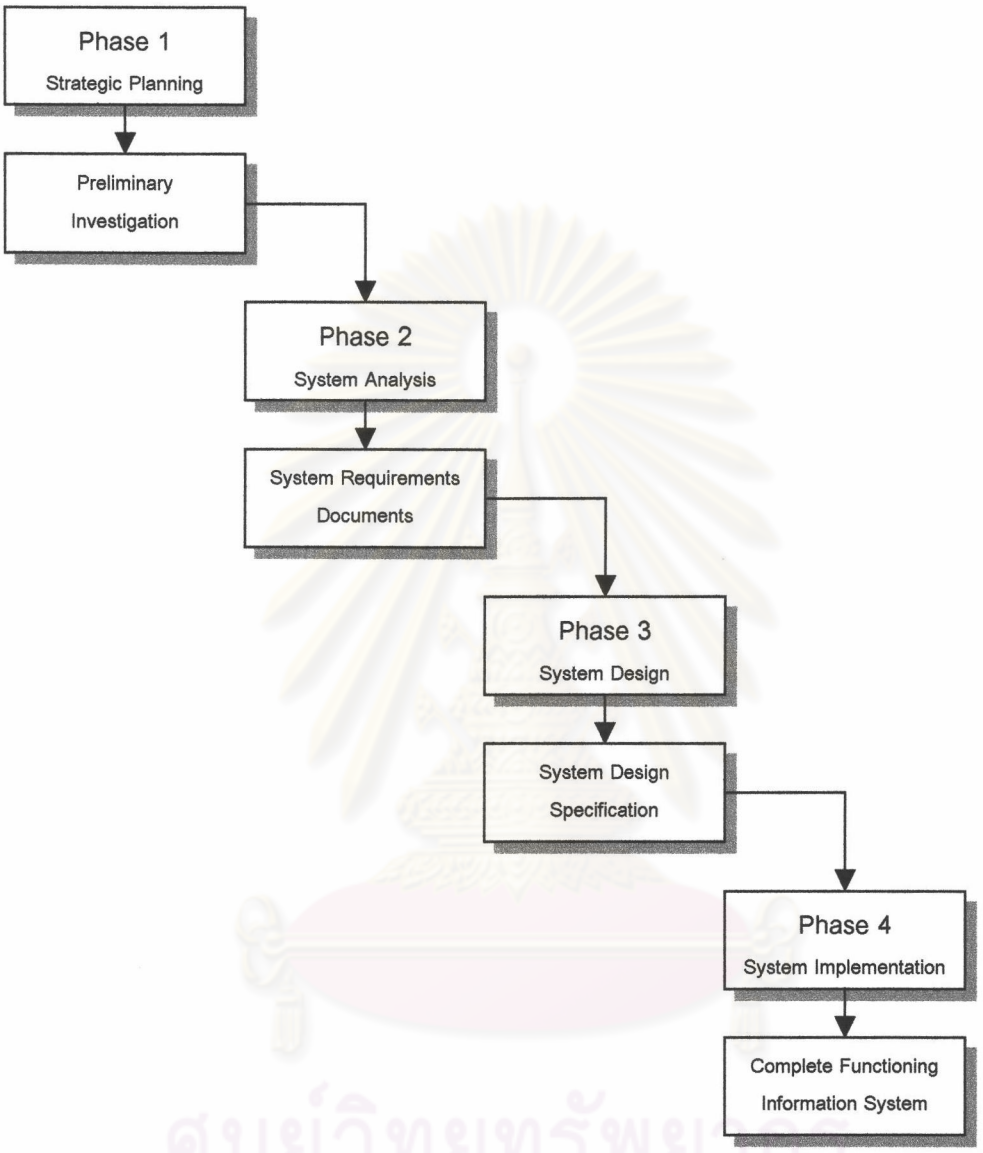


Figure 2.7: The phases of the systems development life cycle (SDLC)
(Adapted from Shelly et al., 2001)

1 Data Mart Strategic Planning

The basic concept of Data Mart strategic planning is that the plan shall be entirely based on the organisation's strategic objective called organisational strategy set. In the other word, the Data Mart strategy plan is devise to support the organisation's objective and consequent organisation's strategy.

2 Systems Analysis

The purpose of the systems analysis phase is to understand business requirements and build a logical model of the new system. The first step of system analysis is the system requirement determination. Once management has granted permission to pursue development of a new system and a project is initiated and planned, it begin determining what the new system should do. During requirement determination, and other analysts gather information on what the system should do from as many sources as possible.

In general, the key task in systems analysis is the collection of information. There are many methods for determining analysis; interview and listening, directly observing users, analysing procedures and other documents. This thesis will use the interviewing and analysing the existing document as follow.

- **Interviewing and Listening**

Interviewing is one of the primary ways analysts gather information about an Information Systems project. Early in a project, an analyst may spend a large amount of time interviewing people about their work, the information they use to do it, and types of information document. Some guidelines the interviewer should keep in mind when they interview. In addition, the guidelines for effective interviewing are shown below;

- Plan the interview
- Prepare interviewee; Appointment, priming questions
- Prepare checklist, agenda, and questions
- Listen carefully and take notes
- Review notes within 48 hours of interview
- Be neutral
- Seek diverse views

(Hoffer et al., 2002)

The interviewer should prepare thoroughly before the interview. Set up an appointment at a time and for duration convenient for the interviewee. The general nature of the interview should be explained to the interview in advance. They should ask the interviewee to think about specific questions or issues or to review certain documentation to prepare for the interview and should spend some time thinking about what it need to find out and write down the questions. In addition, the interviewer should prepare an interview guide or checklist before interview. (Hoffer et al., 2002)

- **Analysis of Existing Documents**

Analysis of existing document is a method to know what is used existing document or report. This is effective ways to gather information about details of existing report or document so that it can use for designing the system.

In addition, in the method for determining requirement, it must collect information about the information systems that are currently being used and how users would like to improve the current systems and organisational operations with new or replacement information systems.

3 System Design

The purpose of system design is to create a blueprint for the new system that will satisfy all documented requirements, whether the system is being developed in-house or purchased as a package. During systems design, it identifies all necessary outputs, inputs, interfaces, and processes.

The design is documented in the systems design specification and presented to management and users for their review and approval. Management and user involvement is critical to avoid any misunderstandings about what the new system will do, how it will do it, and what it will cost.

4 System Implementation

During systems implementation, the new system is constructed, programs are written, tested, and documented, and the system is installed. If the system was purchased as a package, systems analysts perform any necessary modifications and configurations. The objective of the implementation phase is to deliver a completely functioning and documented, and the system is installed.

At the conclusion of this phase, the system is ready for use. Final preparations include converting data to the new system's files, training users, and performing the actual transition to the new system.

In order to conduct user training, the IT department should ask product vendors or consultants to assist in the preparation of the first Data Mart classes. Doing so will enable the Data Mart team to conduct future-training courses independently.

In addition, to conduct training for all intended users of this rollout of the Data Mart, prepare training materials if required. The training should cover the following topics:

- What is a Data Mart?

  Different people have different expectations of what a Data Mart is. Start the training with a Data Mart definition.
- Scope of Data Mart

  All users must know the contents of the Data Mart. The training should therefore clearly state what is not supported by the current Data Mart rollout. Trainers might need to know what functionality had been deferred to later phases, and why.
- Use of front-end tools

  The users should learn how to use the front-end tools. Highly usable front-ends should require fairly little training. Distribute all relevant user documentation to training participants.

- Load timing and publication.

  User should be informed of the schedule for Data Mart loads. (e.g., the Data Mart is loaded with sales data on a weekly basis). Users should also know how the Data Mart team intends to publish the results of each loading.

- Data Mart support structure

  Users should know how to get additional help from the Data Mart team. Distribute help desk phone numbers, etc.

In addition, training should be conducted for all intended end users of the data mart. Some senior managers, particularly those who do not use computer every day, may ask their assistants or secretaries to attend the training the their place. In this scenario, the senior manager should be requested to attend at least the portion of the training that deals with the warehouse scope. (Humphries et al., 1999)

The last design task concerns the development of job descriptions for the users or operating the application. During the design stage, the specific skills and proficiency levels for all users need to be determined. This information is used to establish their training requirements and to modify their job descriptions. The design components may be developed by asking for an outline of procedures, review a draft of the user job descriptions and plan for personnel training. This activity may be developed by the vendor.

Besides, set up the project team is necessarily considered for getting successful implementation. The team shall depend largely on the person selected by the top management to lead the implementation of data mart project that is the project manager. The project manager should have knowledge in business matters and have a broad perspective of the business. He can save the project team valuable time with his first-hand knowledge of how the various departments of the business interactions, and

where detailed information about the operation of the business can be obtained. He should be a functional vice president or equivalent.

2.2.3 The Evaluation of Implementation Effectiveness in Information System

Remenyi et al. (1995) describes that so years ago the evaluation of the IT function was relatively straight-forward. Traditional cost benefit and work study methods for calculating the effectiveness of the IT function were adequate. The techniques used to perform cost benefit analysis included cut off period, payback period, discounted cash flow (DCF) and return on investment (ROI).

Since then, new technology, particularly the advent of the microcomputer, has resulted in information technologies having progressed from the basis cost reduction and control type applications to provision of decision support at strategic level. The influence of new technologies is, therefore, increasingly being felt at top management level.

These upward penetrations of new information technologies raise issues, which previously did not exist. In evaluating IS effectiveness we have to consider both the Management Information System (MIS) and the environment within which it operates. Thus, broader organisation-wide issues have to be considered, and this includes behavioral aspects. A consequence is that there is a certain invisibility associated with the contributions of the information systems to the effectiveness as a whole. This invisibility is usually expressed by reference to intangible benefits. The traditional cost regarded as inadequate.

More recent approaches account for the intangible benefits, which tend to be overlooked by traditional cost benefit analysis. These approaches incorporate user perceptions on a number of criteria relating to IS into an overall measure of satisfaction with the IS. These include perceptions on numerous variables related to such things as input procedures, output procedures, computer processing capabilities, speed of

response, quality of service, IS staff quality, availability of training, quality of documentation, and organisational factors such as top management involvement and user participation.

2.2.3.1 Goal Centred & Systems' Resources

According to Remenyi et al. (1995), there are basically two general views with respect to measuring IT effectiveness. These are the goal centred view and the systems' resource view. In the goal centred view, it is focused on the outcomes of the IT function. The team determines the task objectives of the system and then establishes the criteria for measuring whether these objectives have been achieved. In the systems' resource view, it is focused on the process or functional aspects of the system. In this case effectiveness is measured against such things as user job satisfaction, communication between IT staff and users, and quality of service.

In the context of IS effectiveness, it is generally believed that if users declare themselves to be satisfied with the system then the system may be said to be effective.

In this thesis the evaluation of implementation effectiveness is based on systems' resource view. User Information Satisfaction (UIS) is recognised as an important indicator (surrogate) of implementation effectiveness. This involves incorporating user feelings, beliefs, opinions and attitudes towards IT into the evaluation procedure.

2.2.3.2 User Information Satisfaction (UIS) of IS

User satisfaction is generally considered to result from a comparison of user expectations of the IS with the perceived performance of the IS on a number of different facets of the IS. More specifically, overall attitude to the IS function can be considered to be influenced by the size and direction of the discrepancies (or gap) between expectation and performance. A positive (negative) gap results when perceived performance exceeds (is below) expectation. A large "positive" gap can be interpreted

as indicating that IS resources are being wasted, whereas a large "negative" gap indicates a need for improved performance. (Remenyi et al.,1995)

Of the many published paper on UIS, the Miller and Doyle Approach and A Multiple Gap Approach are two of the most famous conceptual models.

2.2.3.2.1 The Miller-Doyle Approach

The Miller-Doyle Approach is an instrument for measuring, through perception, user satisfaction with information System. It is designed to measure the effectiveness of implementation by comparing user expectations with the perceived performance of the overall IS by using a questionnaire. The questionnaire comprises of 38 questions with different facets based on seven dimension of user satisfaction as below.

1. Functioning of existing transaction/reporting system
2. Linkage to Strategic processes of the firm
3. Amount and quality of user involvement
4. Responsiveness to new systems needs
5. Ability to respond to end-user computing needs
6. IS staff quality
7. Reliability of services

(Remenyi et al.,1995)

2.2.2.3.2 A Multiple Gap Approach

IS researchers at UK's Henley Management College measured UIS by questionnaire. The research is designed to find ways of offering assistance to how systems are viewed of their production, implementation, and use, and how this has an impact on UIS. The questions in the questionnaire based on "sixteen different benefit types" as below.

1. Reduce overall costs
2. Displace costs

3. Avoid costs
4. Provide opportunity for revenue growth
5. Provide improved management information
6. Provide improved staff productivity
7. Provide capacity for increased volume
8. Reduce error
9. Provide a competitive advantage
10. Catch up with competition
11. Provide improved management control
12. Provide improved management productivity
13. Provide improved staff morale
14. Provide an improved corporate image
15. Provide improved customer service
16. Provide improved client/Seller relationships

In this thesis, the evaluation of Data Mart 's implementation effectiveness is based on the Miller-Doyle Approach that a questionnaire is used as a tool to measure the effectiveness of implementation by comparing user expectations with the perceived performance. The questionnaire comprises of 32 questions that are adapted from both the Miller-Doyle Approach and a Multiple Gap Approach. They were selected by considering to cover all attributes of Data Mart system in AAA Company. The questions are divided into 4 groups; system performance, the ability of the system to develop the organisation, the quality of the project team, and others which those are not included in first three groups. The questions are shown below.

- **System Performance**

1. Up-to-datedness of software
2. The ability of the system to change the format of the report
3. The quickness of the system to change the format of the report

4. The simplicity of the system to access
5. The completeness of the data generated by the system
6. The precision of the data generated by the system
7. The low level of the system's downtime
8. The ability of the system to secure and correct the data effectively
9. The sufficiency of the hardware and software to access to the system
10. The ability of the system to generate the report according to the targets and user requirements
11. The ability of the system to extend the scope and support the upcoming system in the future.

- **The Ability of the System to Develop The Organisation**

12. The ability of the system to response to the organisation's needs and coincide with the organisational strategies
13. The ability of the system to increase the employees' productivity
14. The ability of the system to provide the important information for business decision-making
15. The ability of the system to reduce the working period
16. The ability of the system to explore more opportunities to generate more organisational profit
17. The ability of the system to collect and maintain the organisational knowledge
18. The ability of the system to reduce the overall organisational cost
19. The ability of the system to support CRM (Customer Relationship Management)

- **The Quality of the Project Team**

20. The staffs' effort to develop the system
21. The good attitude of the project staffs toward the users
22. The technical capabilities of the IT staffs in the projects

23. The ability of the staffs to coordinate and communicate with you
24. The appropriateness of the project implementation steps
25. The project can be finished on time

- **Others**

26. User's involvement to share and present the ideas towards the project implementation
27. The training before using the system
28. The completeness of the working manual
29. User's confidence toward the systems
30. User's understanding toward the usefulness of the system
31. User's understanding toward the way to use the system
32. User's desire to use the system