

**The Critical Success Factors of Data Warehousing  
Applications**

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<b>Title of Thesis:</b> CRITICAL SUCCESS FACTORS OF DATA WAREHOUSING APPLICATIONS: THE CASE OF FINNISH COMPANIES.	
<b>Abstract:</b> <p>The purpose of this thesis has been to investigate the Critical Success Factors (CSFs), under the organizational, environmental and project-related dimensions, which influence the adoption of data warehouse technologies in the Finnish market.</p> <p>In the theoretical portion ERP and Data warehouse implementation and success factors literature have been reviewed and discussed within the context of Critical Success Factors of data warehousing.</p> <p>The subject of the empirical research has been to explore the impact of the selected factors, under organizational, project-related and environmental dimensions, on data warehouse applications in Finnish companies. A focused survey was conducted among mid to large-sized Finnish companies crossing many industrial classifications.</p> <p>A total of 220 questionnaires were e-mailed to targeted people at selected companies. Eighteen responses to the questionnaire were received after a period of more than two months. The results revealed that all organizational and project-related factors, in addition to one factor under the environmental (Selection of vendors) dimension would affect the adoption of data warehouses in Finnish companies.</p>	
<b>Keywords:</b> Critical Success Factors (CSF), Data warehouse technology, Organizational dimension, Project-related dimension, Environmental dimension, mid- and large-sized companies, Selection of vendors.	

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# 1. Introduction:

## 1.1 Background to the thesis:

It is a critical aspect for organizations in today's highly globalized market, to manage transaction- and non-transaction- oriented information for making timely decisions and respond to changing business circumstances. With the receding economy, enterprises have changed their business focus towards customer orientation to remain competitive. Accordingly, maintaining relationships with clients and managing their data have appeared as top issues to be considered by global companies. Many researchers have reported that the amount of data in a given organization doubles every five years. ([www.ciol.com](http://www.ciol.com))

The most fundamental aspect in a particular organization is the critical decision making capacity of the management, which influence the successful running of business operations.

For such decisions, the information must be reliable, accurate, real-time and easy-to-access. For such information, all the enterprise-related data should be appropriately analyzed from a multi-dimensional point of view and presented at one place. The solution is a data warehouse!

A data warehouse is one of the fundamentals of the decision support systems that are used to support the decision making initiatives, of many IS technologies.

Since the introduction of the term "data warehousing" in early 1990s, companies have investigated the ways they can capture, store and manipulate data for analysis and decision support (Smith, TDAN.com).

As indicated by market surveys of data warehouse technology, the worldwide need of data warehousing solutions has grown greatly in the last 5 years.

The US market share alone accounted for \$72.7 billion worth of data warehousing solution sales by 2003. The US market is growing by 41% annually.(www.ciol.com)

A data warehouse is not only a software package. The adoption of data warehouse technology requires massive capital expenditure and a certain deal of implementation time. Furthermore it has a high likelihood of failure.

It is crucial to have a thorough understanding of critical success factors to assure the successful embracing of data warehouse technology.

Former research papers have focused on technical, data related, operational and educational matters of data warehouse implementation.

There is an obvious lack of theoretical and empirical studies which discuss organizational, project-related and environmental dimensions regarding adoption of data warehouse technology in general and in Finnish companies in particular. This study will address important concerns and attract attention of data warehouse researchers, because it empirically investigates critical factors under organizational, environmental and project dimensions in Finnish companies.

## **1.2 Thesis objectives:**

Data warehouse technology is a very costly, time-consuming and risky project compared with other Information technology initiatives, as cited by prior researchers (Wixom and Watson, 2001), (Hwang et al, 2004), (Mukherjee and D'Souza, 2003), (Solomon, 2005), and (Watson et al. 2002).

Therefore it is important to have a deeper understanding about the factors which affect the adoption of data warehouse technologies.

The research problem of this thesis can be portrayed as “what are the Critical Success Factors under organizational, environmental, and project-related dimensions that influence the process of adopting data warehouse technology in Finnish companies”.

### **1.3 Structure of the thesis:**

The structure of this thesis follows the standardized pattern of scientific research papers. I start by presenting an executive summary of the overall thesis. The first chapter of the thesis is Introduction, where I present the thesis background, then define the goals and the objectives of the thesis.

A brief tour will be held through the second chapter regarding data warehouse definition, old applications that were used before the introduction of the data warehouse, and the concepts and common characteristics of data warehouses.

These aspects are introduced in order to reveal the complexity of data warehouse technology and the importance of having a thorough knowledge and awareness of all aspects regarding data warehouse. This will lead to the increased possibility of having a successful data warehouse implementation.

The third chapter opens a discussion about Critical Success Factors influencing the adoption of ERP systems. During the last decade, ERP has attracted the attention of practitioners and academics due to its impact on managing facets of business and integrating enterprise functions.

This chapter was included in the thesis for the following reasons:

- A lot of researches have targeted different aspects of ERP systems, particularly the CSFs aspect.
- The lack of sufficient theoretical and empirical research on CSFs in data warehouse implementation.

This chapter served the study more from the background information point of view. It defines the critical issues and explores their influence on data warehouse technology.

The first three chapters represent the entrance to the fourth chapter. Chapter four begins to discuss the main objective of the thesis by providing the reader with comprehensive insights about critical success factors which influence the adoption of data warehouse technology, based on the findings of prior research papers.

Chapter five talks about the empirical side of the thesis and encompasses development of hypotheses, methodology used in this study (the ways of collecting and gathering the data) and description of the sample. In this chapter the proposed hypotheses are tested, then the data gathered from the methodology is analyzed and discussed.

The conclusions and the suggestions for further research are introduced in chapter six.

Appendix and References are presented at the end of the thesis.

## **2. Data warehouse**

### **2.1 Objective and structure**

In this chapter, Data warehouse technology is introduced to the reader to assemble a preliminary knowledge pertaining to its definition, its characteristics and its contribution to maximizing the performance of adopters.

Section 2.2 defines the data warehouse from the point of view of the so-called data warehouse leaders and argues their definitions. In section 2.3, the historical techniques of data analysis, reporting and querying before the emergence of data warehousing are presented. The key reasons that led to the invention of data warehousing are then cited. Data warehouse concepts and common characteristics are discussed in section 2.4.

This chapter is built based on reviewing the following reference material: (Kimball, 1996), (Hwang et al. 2004), (Inmon, 1996), (Gupta, 1997), (Han and Kamber, 2000), (Todman, 2001) (Hashmi, 2000), and (A. Smith, TDAN.com).

### **2.2 Data warehouse definition**

Early constructors of data warehousing technologies considered their products to be the key components of future IT strategy and architecture since the introduction of the term "data warehousing" in late eighties and early nineties. At that time companies explored the ways to capture, store and manipulate data for analysis, reporting and decision making initiatives. Data warehousing has quickly evolved into a distinctive and popular business application class. Numerous examples of highly successful implantation of data warehousing applications can be cited from different fields and sizes of business.

Nowadays this simple concept becomes a multibillion-dollar industry, and both practitioners and academicians believe that data warehousing applications are up-to-the-minute weapons for decision-making initiatives. (Hashmi, 2000)

Ralph Kimball defined in his book “**The Data Warehouse Toolkit**” a data warehouse:

A copy of transaction data specifically structured for query and analysis (Kimball, 1996).

I have two slight criticisms of his definition:

1. You can sometimes find non-transactional data stored in a data warehouse.
2. Data warehouses are used heavily for querying and reporting initiatives rather than for querying and analysis activities. Querying and analysis are two faces to the same coin.

(Hwang et al. 2004) in their article “**critical factors influencing the adoption of data warehouse technology**” introduced a thorough definition of a data warehouse:

An application collects daily transaction-oriented enterprise data both internally and externally and then accumulates, categorizes, and stores huge historical data for further analysis, prediction and discovery of data pattern (Hwang et al, 2004). They added:

Those data are more related to statistics, non-modified and stored in warehouse in a long-term manner, also they are time-oriented, integrated and can be used effectively for analyzing and decision-making (Hwang et al, 2004).

The authors defined a data warehouse as a transaction-oriented data repository (as Kimball stated in his definition). In reality, data warehouse can store transactional and non-transactional data.

This study adapts the definition of William's H. Inmon, who is known as the father of data warehousing, from his famous, book "**Building the data warehouse**":

A subject-oriented, integrated, non-volatile and time-variant collection of data in support of management decisions (Inmon, 1996).

A closer look will be taken at each of the above-mentioned key features in Inmon's definition in the data warehousing concepts and characteristics section.

## **2.3 Before data warehousing applications**

In this section a brief tour will be held through the historical ways and techniques of data analysis, reporting and querying before the invention of the data warehouse. After that the key factors that have led to the evolution of data warehousing technologies will be mentioned.

In the past, a crucial stress had been given to operational systems and the data derived from these systems. It is impractical in any way to keep data forever in the operational systems. One good reason is that the strategic data supplied by an analysis system is needed for decision making initiatives, which support the core competence of the organization.

The fundamental prerequisites for the operational systems and analysis systems are absolutely different: The operational systems need performance, whereas the analysis systems need flexibility and broad scope (Gupta, 1997).

This section is divided into four parts to build a comprehensive review concerning the historical methods and techniques used before introducing the data warehouse.

### **2.3.1 Data from legacy systems**

In the 1970's until the late 1980's business applications were run in a mainframe-based environment using different software platforms (Cobol, IMS, DB2) (AS/400 and VAX/VMS) (Gupta, 1997).

Although the introduction of the client-server was in the late eighties, the heavy weight of business data still resided in the mainframe environment. This was due to the ability of these systems to catch and process business knowledge and rules that were too difficult to be managed effectively by a new application or platform at that time.

These systems were called legacy systems, which were considered the main source for data analysis.

### **2.3.2 Desktop-based applications**

During the past decade, the world has experienced a radical increase in demand for desktop-based applications due to the wide popularity of personal computers. Desktop tools and programs increasingly targeted toward the end users. These tools and programs have introduced new techniques for business analysis and blurred the gap between programmers and end users.

Desktop tools and programs generate data geared toward very specific needs and desires. In other words the user can get what he or she wants, and the extracted data can not address the requirements of multiple users and uses.

Desktop tools and programs are too expensive and time-consuming because they are user-specific tools.

### **2.3.3 Decision support and executive information systems**

Decision support systems provide aggregated information for lower or mid-level managers. Executive information systems provide a lower level of aggregated information with multi-dimensional capabilities, which are targeted toward high level executives due to their need to slice and dice the data for strategic decision making (Gupta, 1997).

Decision support and executive information systems are designed to be used by non-technical users; this could be the key reason behind the development of these systems.

#### **2.3.4 Key factors for data warehouse emergence**

As mentioned by Gupta in his study (**An introduction to data warehousing**), two aspects have led to the appearance of data warehousing, technical matters and business matters (Gupta, 1997).

The discussion below is a short précis of his outlook regarding the reasons of data warehouse appearance.

##### **2.3.4.1 Technical matters**

1. The sharply increasing power of hardware coupled with its falling price has led to the introduction of more powerful data analysis tools in business.

2. Increasing the power of desktop software and hardware: Personal computers, in the past, were used for minor tasks such as word processing. After the introduction of powerful desktop software and hardware, the personal computer has become the main tool for powerful multi-dimensional analysis and has allowed the maturation of client-server environment.

3. Evolution of server software:

Server operating systems and software have become feature-rich with multi-tasking and multi-processing capabilities. This software is available in an inexpensive manner.

4. Emergence of intranets and web-based applications:

Internet and web-based tools are heavily used in data warehousing applications. These technologies enable the data warehouse to work 24 hours a day in inexpensive fashion, in addition to providing a multi-tier basis where all the heavy-duty analysis takes place before the data is presented to end users.

5. Data access-tools crisis:

Every day an organization generates billions of bytes of data about various aspects of operation such as customers, products, operations and people. Small portions of data are caught, processed and stored for executives and decision makers. The remainders are locked up in the information system; this phenomenon is called “data in jail”.

#### **2.3.4.2 Business matters**

##### 1. Economic factors:

In recent years economic factors have changed the way in which the organizations incorporate and pushed them to re-evaluate their business practices.

##### 2. Globalization:

The common trend for companies, to be a global corporation, forces companies to incorporate efficiently and effectively. This is tied with possessing powerful analysis tools.

##### 3. End users become more knowledgeable in technical aspects:

Day by day, the users become more proficient in technical matters. Technology-savvy end users have played an integral role in the development of the data warehouse and other powerful data processing technologies, since they are the main users of such kinds of technologies.

### **2.4 Data warehousing concepts and characteristics**

This section explores data warehousing concepts and characteristics. These concepts and characteristics are grouped into two Sub-sections.

#### **2.4.1 key features of the data warehouse**

W. H. Inmon, a chief architect in data warehouse construction, defines a data warehouse as: a subject-oriented, integrated, non-volatile and time-variant collection of data in support of management decision making (Inmon, 1996).

Let's take a closer look at the four keywords in Inmon's definition, based on reviewing the relevant books and research (Inmon, 1996), (Han and Kamber, 2000), (Todman, 2001) and (Hashmi, 2000):

- **Subject-oriented:** A Data warehouse is organized around key subjects such as customer, supplier, and sales, this enables the data warehouse to provide a concise view of these subjects.
- **Integrated:** A data warehouse is constructed by integrating data from varied, heterogeneous databases and information systems such as relational databases and flat files.
- **Time-variant:** A data warehouse stores historical data and covers a much longer time horizon than any other data repository (several years to decades); the time element is included implicitly or explicitly in every key structure in a data warehouse.
- **Non-volatile:** A data warehouse contains read-only data, which are updated in planned periodic cycles not frequently, so once the data is stored in a data warehouse it is not easily changed.

#### 2.4.2 Difference between operational systems and data warehouses

There are two fundamentally different types of information systems in all organizations, as cited by many researchers (Gupta, 1997), (Han and Kamber, 2000), (Todman, 2001) and (A. Smith, TDAN.com):

- **Operational systems:** Systems that support day-to-day operations, such as order entry, inventory, accounting and payroll systems. Organizations cannot operate without their operational systems and the data that these systems maintain.

- **Informational systems:** These systems are used for planning, forecasting and managing the organization, such as marketing planning and financial analysis, which support data analysis and decision-making.

Online operational systems, which are called online transaction processing (OLTP), perform online transaction querying and processing. On the other hand data warehouses, which are considered one of the informational systems, is based on online analytical processing (OLAP). OLAP technologies serve the knowledge-workers in the role of data analysis and decision making.

A Data warehouse is constructed separately from operational systems. The main reason for such a separation is the potential degradation of the operational systems, which can result from the analysis process, and to promote the high performance of both systems, as mentioned by (Han and Kamber, 2000).

They added the following other reasons for the separation between a data warehouse and operational systems:

Firstly, an operational system is designed from known tasks and workloads, such as indexing and hashing using primary keys, searching for particular records and optimizing canned queries. On the other hand, data warehouse queries are often complex. They involve the computation of large groups of data at the summarized level and may require the use of special data organization, access, and implementation methods based on a multidimensional view.

Secondly, an operational database supports the concurrent processing of multiple transactions. Concurrency control and recovery mechanisms such as locking and logging are required to ensure the consistency and robustness of transactions. OLAP query often needs read-only access of data records for summarization and aggregation.

So applying any one of them to do the other's mission may degrade the performance of the system.

Thirdly, there are major distinction characteristics between operational system (OLTP) and data warehouse (OLAP). The table below indicates the differences in characteristics between the both systems, as shown and discussed by (Han and Kamber, 2000)

Feature	OLTP	OLAP
Characteristic	Operational processing	Informational processing
Orientation	Transaction	Analysis
User	Clerk, DBA, database professional	Knowledge worker
Function	Day-to-day operations	Long-term informational requirements, decision support
DB design	ER based, application oriented	Star/snowflake, subject oriented
Data	Current; guaranteed up-to-date	Historical; accuracy maintained over time
Summarization	Primitive, highly detailed	Summarized, consolidated
View	Detailed, flat relational	Summarized, multidimensional
Unit of work	Short, simple transaction	Complex query
Access	Read/write	Mostly read
Focus	Data in	Information out
Operations	Index/hash on primary key	Lots of scans
Number of records accessed	Tens	Millions
Number of users	Thousands	Hundred

DB size	100 MB to GB	100 GB to TB
Priority	High performance, high availability	High flexibility, end-user autonomy
Metric	Transaction throughput	Query throughput, response time

**Table 2.1**

## **2.5 Summary of the chapter**

Data warehouses have become one of the most talked about information technologies for today's business. Although the term of data warehousing was coined in the early nineties, the global trend is headed for accommodating this technology due to myriad benefits acquired by the adopters.

Many reasons have contributed to emergence of data warehousing (as cited previously) in the business field. The lack of convenient awareness, in regard of data warehousing in general and critical success factors in particular, has raised a barrier in front of the adopters.

Data warehouses are different from operational systems (see the table in section 2.4.2). Therefore, the separation between data warehouse and operational systems is a must to promote the high performance of both systems.

This chapter provides the reader with a preliminary insight about data warehouses in order to progress toward the investigation of the critical issues impacting data warehouse applications.

### **3. Critical success factors of ERP implementation**

#### **3.1 Objective and structure**

This chapter proposes to exhibit the critical success issues influencing ERP implementation processes and discusses them from point of view of practitioners and academics. The reason for including this chapter in the thesis is to define the critical success issues in ERP, which were discussed largely in the literature and empirical research, and explore their impact on data warehouse implementation projects, which suffer from the lack of related literature and empirical studies that discuss the CSFs in data warehousing.

The ERP system is defined and the common characteristics of this system are listed in section 3.2. Finally, in section 3.3 the prior relevant research papers in the field of CSFs of ERP projects are cited and further discussed.

The content of this chapter is based on the following books and research papers: (O’Leary, 2000), (Mabert et al. 2001), (Nah et al. 2001), (Bingi et al. 1999), (Akkermans and Helden, 2002), (Umble et al. 2003), and (Parr and Shanks, 2000).

#### **3.2 ERP definition & characteristics**

Global enterprises around the world have invested heavily in information technology to take advantage of tackling and altering the myriad challenges and changes experienced in today's highly competitive market. Many firms have accommodated company-wide systems called Enterprise Resource Planning (ERP) systems. ERP systems are designed to integrate different factional parts of the organization in a unified fashion and optimize coherent business processes.

By the late 1990s, companies were spending over \$23 billion a year on enterprise software of which a major portion was ERP software (Mabert et al. 2001).

What does the term “ERP system” mean?

In his book “**Enterprise resource planning systems**”, Daniel O’Leary defined ERP systems as computer-based systems designed to process an organization’s transactions and facilitate integrated and real-time planning, production and customer response (O’Leary, 2000).

He listed the following characteristics that an ERP system is assumed to have (O’Leary, 2000):

- An ERP system is packaged software designed for the client server environment, i.e. client (user’s computer) and server (other computing source that provides computing resources such as software and data) are linked so that the computing and storage can be distributed between the client and server.
- ERP integrates the majority of a business’s processes.
- ERP processes large majority of an organization’s transactions.
- ERP uses an enterprise-wide database that stores each piece of data once (but it has limited capabilities compared with those of the data warehouse in terms of storing historic data, multidimensional view and analysis of data, data integration from multiple data source and storage size of data)
- ERP allows access to the data in real time.
- Support for multiple currencies and languages
- Support for specific industries, i.e. Different ERP applications for each field of industry (gas, oil, health care, chemicals and banking).

In 1999, the top five vendors (J.D. Edwards, Baan, Oracle, PeopleSoft, and SAP) in the ERP market accounted for 59 percent of the industry's revenue. AMR Research expects the top five vendors in 2005 (SAP, Oracle, Sage

Group, Microsoft, and SSA Global) to account for 72 percent of ERP vendors' total revenue.

The term Enterprise Resource Planning was invented by Gartner Group in the early 1990s to describe the extended version of MRP II (manufacturing resource planning). ERP software includes integrated modules for accounting, finance, sales and distribution, Human resource management, material management, supply chain management and other business functions (Mabert et al. 2001).

### **3.3 Prior relevant studies and research papers**

ERP systems may well count as the most important development in the corporate use of information technology in the 1990s'.

ERP projects are usually expensive, complex and risky projects that may take several years and cost millions of dollars to make the system alive. In addition to engaging large groups of people and other resources working together under substantial time stress and facing many sudden and unforeseen developments, as indicated by prior research (Mabert et al. 2001), (Nah et al. 2001), (Bingi et al. 1999), (Akkermans and Helden, 2002), (Umble et al. 2003), and (Parr and Shanks, 2000).

The aforementioned challenges have created pressure on the academicians' shoulders to gear their research effort toward investigating the critical success factors that influence the ERP implementation project.

The table below summarizes from the earlier research papers all the important factors for enterprises to consider in the process of adopting ERP applications with a short synopsis about each research paper.

Authors	Factors	About the Paper
Mabert et al.	Senior management support, cross-functional team, defining the objective and project details, clear guidelines for implementations, consultants, and training users.	An empirical study, which investigated the importance of an ERP system, process and procedures of ERP installation, key success factors, the improved area after the implementation and accumulated benefits from ERP installation. They interviewed key business managers and IT professionals in 15 different ERP implementations (ranging from small to large firms) and the senior ERP consultants from 6 different consulting firms.
Nah et al.	Teamwork and composition, top management support, business plan and vision, effective communication, project management, project champion, appropriate business and legacy systems, change management program and culture, business process reengineering and minimum customization, and software development, monitoring and evaluation of performance.	A theoretical research presented 11 factors (from previous relevant research studies) emerged as critical to successful implementation of ERP systems. These factors were classified into the appropriate phases in Markus's and Tanis's ERP life cycle.

Bingi et al.	Top management commitment, reengineering, integration, ERP consultants, Implementation time, implementation costs, ERP vendors, selecting right employees, training employees and employee morale.	A theoretical study probed for the critical issues affecting the ERP implementations based on the previous researches in this field.
Akkermans and Helden	Top management support, project team competence, interdepartmental co-operation, clear objectives and goals, project management, interdepartmental communication, management of expectations, project champion, vendor support and careful package selection.	The authors deployed a list of 10 critical success factors, which influence the ERP implementation and taken from (Toni Somers and Klara Nelson, 2001), in a specific company case that adapt ERP system. The authors aimed, by including a company case into their studied, to build a rich framework and test the explanatory power of the CSF.
Umble et al.	Clear understanding of goals, top management commitment, excellent project management, organizational change management, great implementation team, data accuracy, extensive education and training, focused performance measures, and multi-site issues.	An empirical study presented the CSFs, software selection steps, and critical implementation procedures for successful implementation. A case study of successful ERP implementation was launched and discussed in terms of the above-mentioned aspects.
Parr and	Management support, release	The authors defined 3 phases of ERP

Shanks	full-time relevant business experts, empowered decision makers, set realistic milestones and end date, champion, minimum customization, smaller scope, definition of goals and scopes, balanced team, and commitment to change.	implementation project. After that they introduced the CSFs of ERP system in each phase of the ERP project.  Two case studies were presented at the same company. The first one is an unsuccessful implementation of ERP project and the second one is a later successful implementation.
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**Table 3.1**

The argument below provides a quick trip for the reader through the prior relevant research papers.

**3.3.1 (Mabert et al, 2001)**

They presented in their paper an objective and comprehensive insight of ERP systems as a management tool for coordinating the activities of a firm.

They started with defining ERP clearly and highlighting its advantages and disadvantages, then moved to the process of selecting and installing the ERP system. After that they introduced the key prerequisites for an ERP implementation project (required resources). Later on they underscored the accumulated benefits gained from the ERP implementation project by the adaptor. Finally the key success factors for ERP system were counted and explained.

Their methodology was based on conducting interviews in 15 different ERP implementations with key business managers and IT professionals. Although the sample was limited, it included varied firms (small to large) with diverse industrial and consumer products. They also interviewed the senior ERP consultants from 6 different consulting firms. The data from these interviews

were used to answer the questions that were presented in the research, using professional insights in the area of ERP systems.

### **3.3.2 (Nah et al, 2001)**

They introduced 11 factors that were found to be critical to ERP implementation success. They have a distinctive way of introducing these factors in their research, by classifying these factors into respective phases (chartering, project, shakedown, onward and upward). These phases were derived from Markus and Tanis' ERP life cycle model. The importance of each factor and its contribution in each phase were discussed.

Through an intensive review of the literature, they found ten articles that provide the answer to the following question: What are the key critical factors for ERP implementation success?

These articles were defined through a computer search of databases of published works and conferences in information systems area in general and ERP systems in particular.

The following is their list of key factors that affect ERP implementation success:

1. ERP teamwork and composition.
2. Change management program and culture.
3. Top management support.
4. Business plan and vision.
5. Business process reengineering with minimum customization.
6. Project management.
7. Monitoring and evaluation of performance.
8. Effective communication.
9. Software development, testing and troubleshooting.
10. Project champion.
11. Appropriate business and IT legacy systems.

### **3.3.3 (Bingi et al. 1999)**

Bingi et al. promoted the critical implementation concerns that must be understood by ERP adopters for ongoing ERP implementation success.

They started the research with giving an adequate overview of ERP solutions (their definitions, their importance and contribution, and their advantages and disadvantages). Then they identified and discussed the critical issues in ERP implementation.

Top management, Reengineering, Integration, ERP consultants, Implementation time, Implementation costs, ERP vendors, Selecting the right employees, Training employees, and Employee morale are critical issues that must be realized by the organizations when ERP system is seriously undertaken, according to researchers' points of view.

Based on reviewing previous related-literature and relevant field-experience, the researchers built their research model and discussed the issues that are critical for successful ERP implementation projects.

### **3.3.4 (Akkermans and Helden, 2002)**

Akkermans and Helden listed out a group of critical factors for successful implementation of ERP systems. This list was used to analyze and explain the project performance in one ERP implementation project at a company in the aviation industry.

In the case study, poor project performance lead to a serious project crisis, but the situation was turned around into a success. The list of critical success factors employed was found to be helpful in explaining both the initial failure and eventual success of the implementation.

The list of critical success factors contains the top 10 of critical success factors articulated by Toni Somers and Klara Nelson. The explanatory power of this list was tested in the case.

The list includes the following factors:

1. Top management support.
2. Project management competence.
3. Interdepartmental co-operation.
4. Clear goals and objectives.
5. Project management.
6. Interdepartmental communication.
7. Management of expectations.
8. Project champion.
9. Vendor support.
10. Careful package selection.

The results in this study revealed that:

- The list of critical success factors, as observed by Nelson and Somer (top ten of their list), can explain adequately the key issues, which affect the successful running of ERP project.
- The critical success factors are related to each other in the way that they affect each other in the same direction. i.e. changes in any one of them may influence most of the others as well.
- The interdepartmental communication was found to be the most critical factor for project progress.
- Top management, project management, project champion and selection of vendor represent the root of the most critical factor (interdepartmental communication).

### **3.3.5 (Umble et al. 2003)**

They identified critical success factors, software selection, and critical implementation procedures for successful implementation of ERP systems. The authors started with giving a proper background of ERP systems, and then they discussed the reasons behind the evolution towards ERP systems. Afterwards the promises and pitfalls of ERP were sufficiently explained. Finally, a list of critical success factors for successful ERP implementation was launched.

Based on reviewing the previous research material in the field of CSFs for ERP systems, the authors identified the following critical success factors for ERP implementation:

1. Clear understanding of strategic goals.
2. Commitment by top management.
3. Excellent project management.
4. Organizational change management.
5. A great implementation team.
6. Data accuracy.
7. Extensive education and training.
8. Focused performance measures.
9. Multi-site issues.

In this research, the authors include a case study of an international incorporation (Huck international Inc.), which successfully implemented an ERP system. The contribution of the key factors to the successful implementation of ERP system was discussed and presented in this case study.

### **3.3.6 (Parr and Shanks, 2000)**

Parr and Shanks presented a project phase model (PPM) of ERP implementation projects. PPM has three major phases (planning, project and enhancement).

Two case studies of ERP implementation within the same organization, the first unsuccessful and the second successful, were introduced and analyzed to identify the necessary critical success factors within each phase of the PPM.

The critical success factors were selected from the former related research paper. The PPM model was used to understand the ERP implementation project and to figure out the difference between the two cases.

The PPM with the related CSFs represent guidance for the practitioners before planning the ERP project by providing a template, which suggests important CSFs to consider during particular project phases.

The results revealed that the practitioners must pay careful attention to the planning phase and to the CSFs across the phases of the implementation project.

### **3.4 Definition of factors influence the ERP implementation**

In this section, the factors, which were heavily discussed and included in earlier related-research papers, are presented and defined.

#### **1. Top management sponsorship:**

The ERP project is not the theme of changing the software systems. It is a matter of restructuring the company and converting the business practices in addition to its significant contribution to the company's competitive advantage. As known, ERP is a resource and time-consuming project (as a data warehouse project). Therefore it needs to be approved from the top management to allocate valuable resources (needed people, adequate amount of time and enough finance) to get the job done.

This factor has been discussed by most of the prior research studies (Nah et al. 2001), (Mabert et al. 2001), (Bingi et al. 1999), (Akkermans and Helden, 2002), (Umble et al, 2003), and (Parr and Shanks, 2000).

Top management sponsorship has attracted the attention of practitioners in the field of data warehouse success factors. As is known, any sizable project (such as the data warehouse project) needs to be accepted by the top management to secure the required resources.

## **2. Presence of Champion:**

The success of an ERP project is linked to the existence of a champion who plays integral roles in leadership, facilitation and marketing the benefits of the new system to the employees. Usually, this person is supposed to be at senior management level, so he has the power to make substantial organizational changes.

This factor was included in many previous studies (Parr and Shanks, 2000), (Akkermans and Helden, 2002) and (Nah et al. 2001).

The literature about data warehousing has discussed largely the significant contribution of the existence of champion factor as a critical component affecting the successful proceeding of data warehouse project.

## **3. Employee morale:**

Employees working on an ERP installation project may face stress and tension due to long daily shifts and work seven days a week. This may decrease the employees' moral rapidly. Top management and project management should work together to adopt preventive procedures and boost the morale of team participants. Taking the employees on field trips and arranging parties after certain achievement of the project, for example after finishing 40% of the project, are some strategies to boost the employee morale. This factor was discussed by (Bingi et al. 1999).

A data warehouse is a huge and critical project, which lasts for several months to two years. The employees may face stress and tension during the

implementation phase. Therefore, the high-level management must think carefully about this challenge and try to reduce it to guarantee a successful execution of data warehouse initiatives.

#### **4. Interdepartmental cooperation and communication:**

An ERP system is actually about tightly integrating different business functions, so the close co-operation and communication across disparate business functions would be a natural prerequisite in an ERP implementation project. Some authors have described the co-ordination and communication between departments as the oil that keeps everything working properly in these contexts. (Akkermans and Helden, 2002) and (Nah et al. 2001).

The cooperation between the departments in an organization has a large effect on the smooth flow of the required information and expertise among the departments, which strongly influences the successful adoption of data warehouse technology.

#### **5. Vendor selection:**

An ERP project is a mass undertaking which needs sufficient planning and preparation to complete. Companies do not have enough technical and transformational skills in-house to manage this project. So it is extremely important to select a suitable vendor based on some metrics, such as the vendor's market focus (small-, mid-, or large-sized enterprises), global rollout of ERP systems (ability to work in different countries), and substantial presence of the vendor in many countries. This discussion was highlighted by (Akkermans and Helden, 2002), and (Bingi et al. 1999).

In the case of data warehouses, the expensive and the risky nature of data warehouses have forced the potential adopters to pay extra attention in selecting appropriate vendors to increase the possibility of having successful data warehouse initiatives.

## **6. Great and authorized implementation team:**

This is one of the most important factors, which effect the ERP implementation. Building a cross-functional and great team is a critical prerequisite based on selecting people for their skills, past accomplishments, reputation and flexibility, as indicated by (Nah et al, 2001), (Umblel et al, 2003), (Parr and Shanks, 2000), (Bingi et al, 1999), (Akkermans and Helden, 2002), and (Mabert et al. 2001).

The team should have a mix of external consultants and internal staff, and they should to be assigned to the project in full-time work basis. Compensations and incentives should be provided to the team for successfully implementing the system on time and within the allocated budget.

The members must be empowered to make critical and rapid decisions.

Data warehouse professionals heavily stress having a good cross-functional team when the subject of possessing a successful data warehouse appears on the surface of the discussion table.

## **7. Accurate definition of project's objectives and goals:**

It is crucial to start the IT project with a clear definition of goals and the way to accomplish them. (Mabert et al, 2001), (Parr and Shanks, 2000), (Umble et al, 2003), (Akkermans and Helden, 2002), and (Nah et al. 2001).

It is important, as well, to define the expectations and the deliverables from this project. In the case of an ERP project, the organization must know the following: why the ERP system is being selected and implemented? What critical business needs the system will address? and finally, how to achieve these goals in the most efficient and effective manner?

In the case of a data warehouse project, it is crucial to define apparently, from the very early stages of the project, the objectives and what is expected from the data warehouse technology, then try to match the expectations with the

real achievements to start the project in the right direction before the new system comes to life, taking into consideration that the apparent definition of objectives assists to build relevant guidelines for project implementation.

#### **8. Existence of consultants:**

Because the ERP market has grown so fast, there has been a lack of competent consultants. It is important and challenging to find the right consultants and keep them throughout and after the implementation phase. The enterprise must establish a knowledge transfer process from outside consultant to in-house staff for both system configuration information and long-run maintenance. One technique could be by involving the in-house staff in all the implementation phases of the ERP system together with the external consultants and building training courses.

(Parr and Shanks, 2000), (Mabert et al, 2001), and (Bingi et al. 1999) have investigated this factor in their research works.

Building a successful data warehouse demands qualified consultants to provide the adopter with necessary insights into constructing the system, in addition to educating the users to interact effectively and efficiently with the new system.

#### **9. Implementation time:**

It is necessary for an ERP project to set milestones and an end date, as stated by (Parr and Shanks, 2000), and (Bingi et al. 1999). Since ERP systems are modular-based systems it is possible for companies to phase-in one module at a time. The length of the implementation is effected by the number of modules to be installed, the scope of implementation (number of units in the organization), the degree of customization (customize the ERP system based on the specific requirements of the enterprise), and the number of interfaces with other applications.

To make sure that the data warehouse project is not behind the predetermined schedule, it is necessary to design a fixed schedule and define the end date for each phase in the implementation process.

#### **10. Focused performance measures:**

Performance measures must be constructed to measure the achievements against project goals and to encourage the desired behavior by all functions and individuals. Such measures can encompass on-time deliveries, gross profit margin, customer order-to-ship time, inventory turns, and vendor performance.

Project performance measures must be included from the beginning of the project. Additionally, if system implementation is not tied to compensation, the project will not be successful. For example, if the team members will get their bonuses next year even if the system is not yet implemented, the successful implementation is less likely.

This factor was argued by (Umble et al, 2003), (Nah et al. 2001), (Akkermans and Helden, 2002), and (Mabert et al. 2001).

In data the warehouse case, measuring the achievements from the project against the goals, throughout the running of the project, is critical for success. The reason for that is to make sure that the company is on the right track and to correct the unnecessary activities.

#### **11. Business process reengineering (BPR) and minimum customization:**

Installing an ERP system includes reengineering the existing business processes to the best business process standard followed in the industry. All the business processes must agree to the ERP model. Organizations should be willing to change the business to fit the software with minimal customization. Modifications should be avoided or reduced to reduce errors and to take advantage of newer versions of the ERP systems. It is not easy to get every one to agree to the same process. Sometimes business processes are so unique

and valuable that the company wants to preserve them. In this case the company has two options; Change its business processes to conform to the ERP package or customize the ERP package to suit the company's needs. The 2<sup>nd</sup> option is costly because the costs of customization, future maintenance and upgrade will greatly increase.

(Parr and Shanks, 2000), (Bingi et al. 1999), and (Nah et al. 2001) discussed this factor in the context of ERP implementation.

BPR seems to be an ERP-specific factor since an ERP system adopts the so-called business best practices known in the industry. This stimulates and encourages the adopters to change their way of doing business and adopt the ERP system way. In the case of a data warehouse project, there is no need to change the existing business process. Data warehouse technology comes up with a new way of analyzing and processing the business transactions which mostly did not exist before the installation of data warehouse applications, such as a multidimensional view of analysis.

## **12. Integration:**

Many companies feel that having a single application from a single vendor seems to serve the customer more efficiently and makes it easier to maintain and upgrade the system. Unfortunately no single application can meet all the company's requirements and needs. Some companies may use other specialized software to meet their needs and requirements. An ERP system needs to be integrated with all of that software. The ERP system will serve as a backbone of the company's IS. Other software is bolted on to the ERP system. In other words ERP systems are installed on the top of the disparate legacy applications to integrate them and make them work together in a unified manner. There is third party software called middleware which can be used to integrate different specialized software with the ERP system. Unfortunately middleware is not available for all software that is available on

the market. Middleware vendors concentrate only on the most popular software package in the market.

This factor was researched by (Bingi et al. 1999), and (Nah et al. 2001).

This factor is important to secure the smooth running of data warehouse applications. The data warehouse system works as a big data store collecting the data from different transaction systems and putting them all in one place. Therefore the data warehouse must be integrated with those application systems.

### **13. Careful selection of packaged-software.**

Selecting an adequate software package is an important step in the ERP implementation process, as shown by (Nah et al. 2001), and (Akkermans and Helden, 2002).

Some packages are more suited for larger firms and others are more suited for smaller ones. Some packages have become a de facto industry and others have stronger presence in certain places in the world. Once the selection of the package has been done, the next step would be the decision of what versions or modules would be the best to fit the organization's needs. These decisions have to be made in the very early stage of the ERP implementation project. If the wrong choices are made then the company faces a big problem that can only be solved by doing time consuming, costly and high risk modifications on the selected software package.

Selecting adequate packaged-software contributes largely to the success of data warehouse technology. The software selection is done based on certain criteria, which are identified after defining and analyzing the companies' situation and requirements, such as type of industry, size of company and others.

### **14. Data accuracy:**

ERP systems require data accuracy. Because of the integrated nature of the ERP system, if someone enters the wrong data, the mistake can affect all the functional areas in the enterprise. Educating the users about the importance of the data accuracy should be a top priority of the ERP implementation process. Data accuracy was discussed by (Umble et al. 2003).

As cited earlier, data warehouse technology serves as a huge data repository, which collects the data from different data sources. This data store is used by many end-users in the company for different purposes. Therefore, a careful consideration must be paid on the quality of the raw data stored in a data warehouse. The main reason is that it will affect massively the strategic position of the company by influencing the decision making initiatives.

### **15. Extensive education and Training**

Training and updating the employees' knowledge of ERP is a major challenge. ERP implementation requires a huge mass of knowledge to enable people to use, cope and solve problems within the framework of the system. Training employees to use ERP is not as simple as training them in any other packaged-software such as a Microsoft package. An ERP system is extremely complex and demands intensive training; it is difficult for the trainers to pass the knowledge to the users within a short period of time. Top management should understand this aspect and should be willing to spend adequate money on educating and training the end users.

This factor was explored by the (Bingi et al. 1999), (Umble et al. 2003), and (Mabert et al. 2001).

Training and education of the employees are required in a successful data warehouse project. A data warehouse is not a simple project or an easy-to-learn system. It demands time to educate and transfer the knowledge to users by setting up training courses and distributing related-material.

### **3.5 Summary of the chapter**

ERP stands for Enterprise Resource Planning and is a computer-based system that integrates all components of the business, including planning, manufacturing, sales, and marketing. This chapter introduced the reader to the ERP from different aspects starting with the definition, going through the common characteristics and features and ending with the critical success issues for ERP implementation.

ERP has been intensively discussed in the literature and empirical studies, particularly the CSFs aspect. On the other hand, there is an obvious lack of discussion concerning the CSFs in data warehouse literature and empirical studies. Therefore I found that it is relevant to define these factors and measure their influence on data warehouse technology, since both systems are expensive, complex and risky undertakings. The follower can find many similar critical factors have been discussed by the professionals in both areas of expertise.

## **4. Critical success factors of data warehouse implementation**

### **4.1 Objective and Structure**

Chapter 4 is considered the main theoretical chapter in the thesis. It serves the study more from the background information point of view regarding the CSFs influencing the adoption of data warehouse technology.

Section 4.2 presents the previous relevant research papers, empirical and theoretical, which investigated the CSFs in the data warehouse adoption project. Then section 4.3 defines and categorizes these factors into respective dimensions. In section 4.4 the phases of data warehouse project are defined and discussed, and then the critical factors are classified and assigned into these phases. Finally, section 4.5 identifies the scope of this study, by defining the factors that will be investigated throughout the remaining parts of the thesis.

This chapter was structured and designed based on reviewing the following research papers: (Joshi and Curtis, 1999), (Wixom and Watson, 2001), (Hwang et al. 2004), (Mukherjee and D'Souza, 2003), (Solomon, 2005), (Hurley and Harris, 1997), and (Watson et al. 2002).

### **4.2 Prior relevant studies and research papers**

The difficulty and failure implementation of data warehouse technology were discussed in the literature. But the research (empirical and theoretical) on critical success factors influencing data warehouse implementation is infrequent and fragmented.

Unfortunately the majority of the available research focused largely on technological and educational aspects, which represent the operational level in the organization.

Earlier studies in data warehousing discussed partly and slightly organizational, environmental and project-related dimensions, by investigating a single or a couple of factors under one or more dimensions. This obviously has led to lack of exploring the impact of these dimensions, which represent the managerial and strategic levels in the organization.

This study is timely and important because it sheds light on organizational, environmental, and project-related dimensions, together as a package, which influence the adoption of data warehouse technology in general, and in Finnish companies in particular.

For master thesis purposes, the most relevant and important factors under the umbrella of the selected dimensions will be investigated. The selection of factors was done based on reviewing the relevant prior research papers in the field of data warehousing and ERP systems.

The table below aims to provide a list of preceding related-studies in the field of data warehousing, and then presents the factors, discussed in each study, and a short overview of each study.

<b>Authors</b>	<b>Factors</b>	<b>About the Paper</b>
Joshi and Curtis	Technical issues (data warehouse architecture and access tools), training factors, data related factors and clear identification of objectives and organizational needs.	It is a theoretical study in which the Authors stated some recommendations for successful implementation of data warehouse.
Wixom and Watson	Organizational factors (management support and Champion), Project factors (User participation, resources and team skills) and Technical factors	An empirical study which investigates the model of data warehousing success through cross-sectional mail survey to data warehousing managers and data

	(source systems and development tools)	suppliers from 111 organizations in U.S.
Hwang et al.	Organizational dimension (organization's size, champion, Top management support and internal needs), Environmental dimension (Business competition and selection of vendors) and Project-planning dimension (project team's skills, Coordination of organizational resources, consultants support and end user support)	An empirical study conducted to investigate the factors influencing the adoption of data warehouse technology in the banking industry in Taiwan. The data was gathered based on the prior-related research and a mailed questionnaire to CIOs in 50 domestic banks in Taiwan.
Mukherjee and D'Souza	Technical issues (data, technology and expertise), Management issues (executive sponsorship and operating sponsorship), Goals and Objectives issues ( business need and clear link to business objectives), Users issues (user involvement, user support and user expectation), Organizational issues (organizational resistance and organizational politics) and System issues (evolution and growth)	A theoretical study presents a framework to understand the critical success factors of the data warehouse in each phase of the data warehouse implementation process.

Solomon	Identifying the project's scope, source system identification, data quality planning, Technical matters (Data model design, ETL tools, Relational database software selection, data transport and conversion tools), and end-user support	The Author in this theoretical study provided useful guidelines to avoid expected obstacles in enterprise-sized data warehouse projects and increase the likelihood of success based on the prior-related research and his experience in this field.
Hurley and Harris	Team skills, Technical infrastructure, Project management, Good vendor, Business imperative, Clear objectives, and data quality.	An empirical study discussed a survey conducted among the pacific countries (Australia, New Zealand and Singapore) across the industrial companies to have a thorough understanding of the data warehouse issues through investigating different aspects such as Management issues, technical matters, reasons for data warehouse approach, reasons for data warehouse success and reasons for data warehouse failure.
Watson et al.	Business need, Champion, Top management support, user involvement, training matters, Technical issues (adequate tools) Accurate definition of the project's objectives, growth and	An empirical study geared to answer the following question: why some organizations are receiving more significant returns than others after the data warehouse implementation?  Three case studies of data warehouse

	upgradeability, Organizational politics, skilful team.	initiatives from diverse industries were introduced to answer the above-mentioned question.
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**Table 4.1**

**4.2.1 (Joshi and Curtis, 1999)**

Joshi and Curtis explored some key issues that any organization should think about before planning to adapt data warehouse technology.

Based on reviewing the related research papers, they developed important issues that the organization must consider to have a successful planning of a data warehouse project. The following list is a summary of their work:

1. Data warehouse development issues
  - Alignment of data warehouse project to business needs
  - Define clearly the Scope of the data warehouse project
2. Data warehouse architecture issues
  - Defining the appropriate database architecture and adequate development and analytical tools such as selection of DBMS, Online analytical processing, and data warehouse development options.
3. Data issues
  - Careful consideration of the span and extend of the data
  - Defining adequate metadata and appropriate tools to maintain it
  - Identification of useful external and qualitative data sources
  - Careful consideration of the data loading tools
  - Managing and increase the quality of the data integrity
4. User Access issues
  - Provide the broadest range of possible user access, interface and analysis tools
  - Adequate training courses to prepare the users for the tools.

**4.2.2 (Wixom and Watson, 2001)**

They held an empirical investigation of the factors influencing data warehouse success among the American organizations.

A cross-sectional survey was used in this study to build up a model of data warehousing success. This questionnaire was distributed among data warehouse managers and data suppliers from 111 organizations, to gain relevant data about implementation and success factors of data warehouse.

They cited, in their studies, seven factors considered to be crucial in the adoption of data warehouse based on reviewing the prior related research materials (Management support, Champion, Resources, User participation, Team skills, Source Systems, and Development technology).

The results revealed that the following factors have a big and positive influence on the successful adoption of data warehouse project; Management support, Resources, User participation, Team skills, Quality source systems, and Better development technology.

#### **4.2.3 (Hwang et al. 2004)**

The researchers intended to explore the critical factors affecting the adoption of data warehouse technology in the banking industry in Taiwan.

There focus scope was on the following packaged-dimensions (Organizational, Environmental, and Project dimensions). A questionnaire survey was designed and used to achieve the study's objective. A total of 50 questionnaires were mailed to CIOs in local banks. After an intensive review of prior relevant studies, a total of ten factors influencing the success of data warehouse project were developed (Size of bank, Champion, Top management support, Internal needs, Degree of business competition, Selection of vendors, Skills of project team, organization resources, User participation, and Assistance of information consultants).

After collecting the results from the questionnaire, they found that top management support, size of the bank, effect of champion, internal needs and

competitive pressure would affect the adoption of data warehouse technology in banking industry in Taiwan.

#### **4.2.4 (Mukherjee and D'Souza, 2003)**

Mukherjee and D'Souza presented a framework which might help the data warehouse people to visualize how critical success factors can be included in each phase of data warehouse implementation process.

They found that the data warehouse implementation process follows the three-phased pattern of evolution (Pre-implementation, Implementation and Post-Implementation phases).

After reviewing previous related-studies, a list of 13 critical implementation factors was developed; Data, Technology, Expertise, Executive sponsorship, Operating sponsorship, Having a business need, Clear link to business objectives, User involvement, User support, User expectation, organizational resistance, organizational politics, and Evolution and growth.

They have discussed each factor and the contribution of each factor in every phase of data warehouse implementation process.

#### **4.2.5 (Solomon, 2005)**

Solomon provided guidelines to help managers avoid common pitfalls and obstacles in enterprise-level data warehouse projects based on reviewing previous related-studies and extensive field experience.

The following are the guidelines that must be considered, by the organizations, to increase the chances for success

- Service level agreements and data refresh requirements.
- Source system identification
- Data quality planning
- Data model design
- Extract, transform, and load tool selection

- Relational database software and platform selection
- Data transport
- Reconciliation process
- Purge and archive planning
- End-user support

#### **4.2.6 (Hurley and Harris, 1997)**

Hurley and Harris described a survey conducted by KPMG management consulting and the Nolan Norton institute. This survey was distributed among the Pacific's senior information managers in mid- and large-sized companies. The survey aimed to achieve a coherent understanding regarding data warehousing initiatives.

The findings from the survey revealed that data warehouse technology heavily increases financial and business returns in the adopters. They found also the following factors for successful data warehousing initiatives: project team skills, Technical infrastructure, Project team, Technical architecture, Good vendor capability, Business imperative, clear objectives, Data quality, and IS alignment.

#### **4.2.7 (Watson et al. 2002)**

The researchers presented an explanation of why some organizations realize more exceptional benefits than others after data warehouse installation.

The authors started by giving a basic background about a data warehouse. Then they went through the obtainable benefits gained from data warehouse installation in general by the adopters.

Three case studies of data warehousing initiatives, a large manufacturing company, an internal revenue service and a financial services company, were discussed within the context of the suggested framework.

The results from the case studies highlighted the benefits achieved by the three organizations. The researchers noticed that some of them considered more significant payoffs than the other adopters.

The researchers built an argument about the main issues behind the success in the three cases. The argument led to the following critical success factors: Business need, Champion, Top management support, user involvement, training matters, Technical issues (adequate tools), Accurate definition of the project's objectives, growth and upgradeability, Organizational politics, skilful team.

### **4.3 Definition of factors influencing the data warehouse implementation**

The findings from earlier related-materials (either theoretical or empirical ones) have flagged the following critical success dimensions that have to be taken into account by global managers:

- 1. Organizational factors.**
- 2. Environmental factors.**
- 3. Project factors.**
- 4. Technical factors.**
- 5. Educational factors.**

The first four dimensions were derived directly from earlier related- studies. I came up with the last dimension to include the factors that mainly discuss the educational and learning matters.

#### **4.3.1 Organizational factors:**

The organizational dimension is an important aspect in the adoption of data warehouse applications.

By taking into consideration the organizational factors, many of the obstacles and barriers faced will be altered.

The following factors are included under the organizational dimension:

### **1. Size of the organization:**

Size of the organization greatly affects the adoption of data warehouse technology. The larger organization has more resources and capital to be assigned for a data warehouse project. Large organizations mostly have enough resources and power to overcome obstacles, such as huge set-up costs and labor expenses, in data warehouse project. This factor has been investigated by (Hwang et al. 2004).

### **2. Existence of champions:**

Champions are the people from inside the organization, who appreciate and support the adoption of new technology.

Existence of champions has a critical impact on the embracing of data warehouse technology. They play an integral role in providing necessary information, required resources, needed assistance, political support and stimulate the staffs to adapt and cope with the new technology, as discussed (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002).

### **3. Top management sponsorship (executive and operating):**

The commitment of top management support is very important to pass over sudden barriers and complexities in a data warehouse project, as highlighted by (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002), and (Mukherjee and D'Souza, 2003). With the top management support the organization can secure required capital, human support, and availability and coordination of other related internal resources in adoption and development process.

### **4. Business Internal needs:**

The alignment of the data warehouse to business needs is a crucial step in a data warehouse adoption project, as cited by (Hwang et al. 2004), (Mukherjee and D'Souza, 2003), (Joshi and Curtis, 1999), and (Watson et al. 2002). Before commencing such a gigantic effort, it is important to elucidate the

strategic business objectives and needs that a data warehouse would be expected to meet. A data warehouse is expected mainly to meet the need of having a unified data repository, which encompasses integrated information to support the initiatives of different business units.

#### **5. Organizational resistance:**

Employee resistance is the emotional factor exhibited as a result of organizational change. This resistance basically is driven by the fear of loosing their jobs, by replacing labor-intensive production with automated production or replacing technology-incompetent employees with technology-savvy ones after implementing the new technology. Consequently, it is important to understand the employee resistance and try to reduce it. The resistance must be addressed appropriately by encouraging the staff to accept and adapt the new technology through training courses and lectures. Mukherjee and D'Souza (2003) pointed out the significance of this factor to secure a comprehensive adoption of data warehouse technology among the users.

#### **6. Organizational politics:**

Organizational legislation and regulations are developed to govern and control processes and activities in the enterprise and achieve the long-term goals and objectives. The organizational policy provides specific policy (detailed) information of how the legislation serves to achieve the long-term objectives in the organization. The policy is usually accompanied by procedural information, explaining the specific steps involved in executing the process in question.

In the matter of data warehouses, it is important to secure the alignment of data warehouse technology to the legislation in order to achieve the long-run objectives. The policies provide detailed information about how the alignment

(between data warehouse and legislation) can be established to achieve the long-term objectives.

(Mukherjee and D'Souza, 2003), and (Watson et al. 2002) introduced this factor as a key issue in a successful data warehouse.

#### **4.3.2 Environmental factors:**

The enterprise incorporates in a dynamic environment with high possibilities of sudden and uncontrolled changes. The enterprise must measure and reduce the uncertainties in the surrounding environment and create competitive advantages by adopting newer information technology. Below is the list of factors under the environmental dimension.

##### **1. Business competition:**

Enterprises often try to boost their competitive advantage by adopting new information technology. Previous researchers, such as (Hwang et al. 2004), have shown that business competition is directly allied with the adoption of new information technology. The organization is no longer to maintain the piloting edge in its industry without the adoption of a data warehouse if the competitors are adopting or have adopted this technology.

##### **2. Selection of vendors:**

Selection of vendors largely affects the decision of data warehouse adoption, as shown by (Hwang et al. 2004), and (Hurley and Harris, 1997). Today's organizations intend to outsource their business applications. In this regard companies must be aware while selecting the vendors. Data warehouse technology itself is not only a software package. It is a time-consuming and very expensive project, and the plans suggested by vendors may not be completely convenient for an enterprise itself. Therefore, the enterprise cannot leave all execution plans and operating details in the vendor's hands.

### **3. Compatibility with industry standards and governmental regulations:**

There are regulations and industry standards, which regulate and govern the transactions, communications and processes, in the business field. These regulations and standards are established by authorized parties such as government or business standard setters. Companies must understand and adapt these standards and regulations by getting their systems aligned with them. Example, if the regulation allows a partner, in Supply chain, to view certain types of information, then the data warehouse should restrict the partner's authority to view this type of information.

### **4. Compatibility with partners:**

A company is no longer to be a star performer in its industry without having tight relationships with direct, upstream and downstream, partners. This tight relationship is driven by the compatibility with direct partner's systems. When enterprises intend to install a new system (like data warehouse), they must understand the systems adopted by direct partners and try to figure out a suitable new system. This procedure is considered a plus point to maintain the relationships with partners and heighten the overall performance of the supply chain.

A data warehouse is a data source which stores a huge amount of relevant data and can be used by direct partners to collect needed, accurate and real-time, data for supply chain matters. As a result, the compatibility with direct partners' systems is important to facilitate successful interaction between the systems of direct partners and the focal company when exchanging the data.

#### **4.3.3 Project-related factors:**

The project-related dimension is one of the most important dimensions in adoption of data warehouse technology. Project-related factors are related to project plan, analysis, development and control.

The following factors were discussed in the context of the project-related dimension.

**1. Skills of project team:**

The skills of project team factor has an endless impact on the success of a data warehouse project. The members must be proficient in data warehousing matters. Possessing strong background and knowledge of new technology adoption, coupled with better communication capability positively influences data warehouse implementation. It is necessary to select the members from different departments, to add diverse values to data warehouse project, as well as educate them in different aspects, as shown by (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002), and (Hurley and Harris, 1997).

**2. Emergence and Coordination of organizational resources:**

Resources comprise money, people, and time, which are necessary to successfully finish the project. Resources are so important in data warehouse projects, because data warehouses are high-priced, time-consuming and recourse-intensive initiatives. Coordination and correct allocation of resources can help project teams to meet their project milestones and overcome organizational obstacles. Coordination of resources can be accomplished by affording enough capital, sufficient time and required labor, as indicated by (Wixom and Watson, 2001), and (Hwang et al. 2004).

**3. End-user involvement:**

End-user involvement has a direct influence on successful implementation of information technology, as mentioned by (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002), (Mukherjee and D'Souza, 2003) and (Solomon, 2005). Better user participation increases the probability of managing user's expectations and satisfying user requirements. Selection and inclusion of fitting users in the project team is an important mission. Adequate training can help users to explore the desirable information positively and in a

much more effective mode. Sufficient user involvement reduces the resistance from end users to use newer information technology.

#### **4. Support from outside consultants and expertise:**

As known, data warehouse technology is a time-consuming and expensive project with high risk possibilities. Consultants who possess much experience positively influence the success and smooth adoption of new technology. The consultants can be employed to provide ideas and lend a hand to organizations that lack the experience to adopt, install and maintain new information technology, as cited by (Hwang et al. 2004), and (Mukherjee and D'Souza, 2003).

#### **5. Accurate definition of project's priorities, scope and goals:**

Building a data warehouse symbolizes a massive investment of resources and effort. So it is necessary to define clearly the scope, goals and priorities of the overall project before any step to be undertaken. Inaccurate definition of the project's priority may cause bottlenecks and shortage in project resources resulting in delays in the project's schedule and processes, as indicated by (Watson et al. 2002), (Hurley and Harris, 1997), (Solomon, 2005), and (Mukherjee and D'Souza, 2003).

#### **4.3.4 Technical factors:**

The technical dimension was measured by discovering technical problems that appeared and technical limitations that occurred during the implementation of data warehouse technology.

The discussion below is regarding the sub-factors under the technical dimension.

##### **1. User interface:**

Extra-care must be taken to select suitable tools that will be interfaced with the end-user, as stated by (Solomon, 2005), and (Joshi and Curtis, 1999). The

project team should work hard on weighing up the friendliness and easiness of the user interface. The user interface must guarantee to provide the users with the greatest flexibility in the choice of access methods and strategies. Friendliness, easiness and flexibility of user interface tools lead to reduce the resistance from end users to new information technology and increase the adaptability.

## **2. Technical resources availability :**

Technical resources are hardware, software, methods and programs used in carrying out a project. A good visualization of technical resources allows managers to conceptualize future states and recognize benefits more realistically, as shown by (Joshi and Curtis, 1999), (Wixom and Watson, 2001), (Solomon, 2005), (Hurley and Harris, 1997), and (Watson et al. 2002). These resources influence effectiveness and efficiency of the development team to actualize the needs and requirements of the organization. This factor is the most talked about factor among critical success factors of data warehouse technology in the prior related studies.

## **3. Quality of data sources:**

Data sources and their governance policies should be identified clearly, especially in large data warehouse initiatives, where the data is extracted from many data sources. The quality of organization's present data is another important aspect, which affects the systems initiatives. Data in a data warehouse often comes from diverse and heterogeneous sources. So the need for data standards can result in easier data handling, fewer problems and eventually a more successful system, as thrashed out by (Wixom and Watson, 2001), (Solomon, 2005), and (Hurley and Harris, 1997).

### **4.3.5 Educational factors:**

This dimension answers the following question:

How dose the organization assure a comfortable interaction between users and new technology, which concretely leads to reduce users resistance and widen users acceptance of new technology?

The following is the answer of the above question.

### **1. Training courses:**

The end users must be continuously informed and aware of the latest developments regarding data warehouse technologies. Increasing users' knowledge can be done by setting-up training courses and distributing related-materials, such as books and research papers. Adequate training assists the users in understanding the newer technology and reduces their resistance, as pointed out by (Joshi and Curtis, 1999), (Solomon, 2005), and (Watson et al. 2002).

### **2. Certified trainers :**

The trainers contribute positively to increasing the success of new technology and reducing the users resistance (Joshi and Curtis, 1999), (Solomon, 2005), and (Watson et al. 2002). Certified trainers are employed to blur the lines between non-technology-knowledge users and technology-knowledge users. One technique could be involving the in-house users in all implementation phases of the data warehouse system together with the trainers to transfer the knowledge to users, in addition to setting training lectures and distributing related-materials.

### **3. Availability of best practices adaptors:**

The availability of good examples, regarding successful implementation of data warehouses, supports the decision of adapting the data warehouse and facilitating the implementation process. Best practices adopters represent the source, where an organization can have feedback to successfully implement new information technology and overcome obstacles faced by best practices adopters.

#### **4.4 Classifying the CSF based on the phased logic of the data warehouse implementation**

Prior research papers in the field of ERP systems identified different phases in the ERP life cycle. (Nah et al. 2001) classified the key factors of ERP systems into respective phases according to Markus and Tanis's ERP life cycle model, which includes four phases (Chartering, Project, Onward, and Upward). (Parr and Shanks, 2000) introduced three major phases in ERP implementation projects, which are (Planning, Project and enhancement).

In case of data warehouses, a few earlier research papers have identified a sorting of data warehouse project life cycle.

After an intensive review of former research papers, the three-phased pattern of data warehouse evolution, proposed by (Mukherjee and D'Souza, 2003), was found and adapted. This sorting includes three phases; Pre-implementation, Implementation and Post-implementation.

The first phase encompasses a bunch of activities and tasks carried out before the actual deployment of data warehouse technology.

The second phase includes a group of activities and tasks that arise during the actual installation of data warehouse technology.

The third phase includes a group of activities and tasks that happen after the actual installation of the data warehouse technology.

The scope of the following part is to answer this question: what are the factors influencing data warehouse technology in each phase of above-mentioned ones?

##### **4.4.1 Pre-implementation phase**

There are many tasks and activities occurring in this phase, such as needs analysis, capability assessment, problem exploration and identification, and development of goals.

In this phase, the critical factors support the project by ways of securing needed resources, problem identifications, goals clarification, understanding informational needs and securing smooth progression of data warehouse project.

The following factors are believed to support the adoption of a data warehouse in this phase:

**Organizational factors:**

1. Size of the organization
2. The existence of champions
3. Top management sponsorship (executive and operating)
4. Business Internal needs
5. Organizational politics
6. Organizational resistance

**Environmental factors:**

1. Business competition
2. Selection of vendors
3. Compatibility with industry standards and governmental regulations
4. Compatibility with partners

**Project factors:**

1. Emergence and Coordination of organizational resources
2. Accurate definition of project's priorities, scope and goals
3. End-user involvement

**Technical factors:**

1. Technical resources availability

**Educational factors:**

1. Availability of Best practices adaptors

#### 4.4.2 **Implementation phase**

In this phase, analysis, design and development of the technical backbone of the data warehouse technology are undertaken. Also an implementation plan is developed, resources are assembled, and the installation processes of data warehouse technology are undertaken and addressed in place.

This phase is often the most time-consuming and resource-spending phase in data warehouse development.

The critical factors in this phase assure flexible and successful ongoing of the data warehouse project.

The following factors are supposed to influence the adoption of the data warehouse in this phase:

##### **Organizational factors:**

1. Size of the organization
2. The existence of champions
3. Top management sponsorship (executive and operating)
4. Organizational politics
5. Organizational resistance

##### **Environmental factors:**

1. Business competition
2. Selection of vendors
3. Compatibility with industry standards and governmental regulations
4. Compatibility with partners

##### **Project factors:**

1. Emergence and Coordination of organizational resources
2. Skills of project team
3. End-user involvement
4. Support from information consultants and expertise
5. Accurate definition of project's priorities, scope and goals

##### **Technical factors:**

1. Technical resources availability

2. User interface
3. Quality of data sources

**Educational factors:**

1. Availability of Best practices adaptors
2. Training courses

#### **4.5.1 Post-implementation phase Factors**

In this phase, data warehouse technology is assessed to determine whether the project objectives are met or not. Data warehouse implementation may take two or more years. Therefore during that period the organization may experience many changes, which might influence data warehouse adoption badly or well. Accordingly the organization must decide whether to end the implementation phase and accept the data warehouse as it is or to go back some steps and upgrade the system.

The main activities, in this phase, are collecting the feedback about data warehouse technology, upgrading of data warehouse applications and maintaining system stability (smoothing the ongoing of the data warehouse system without any interruption and facilitating the effective interaction between the staff and the system).

The following Factors are believed to affect the successful adoption of data warehousing in this phase:

**Organizational factors:**

5. size of the organization
6. The existence of champions
7. Top management sponsorship (executive and operating)
8. Organizational resistance

**Project factors:**

1. Skills of project team
2. End-user involvement
3. Support from information consultants and expertise

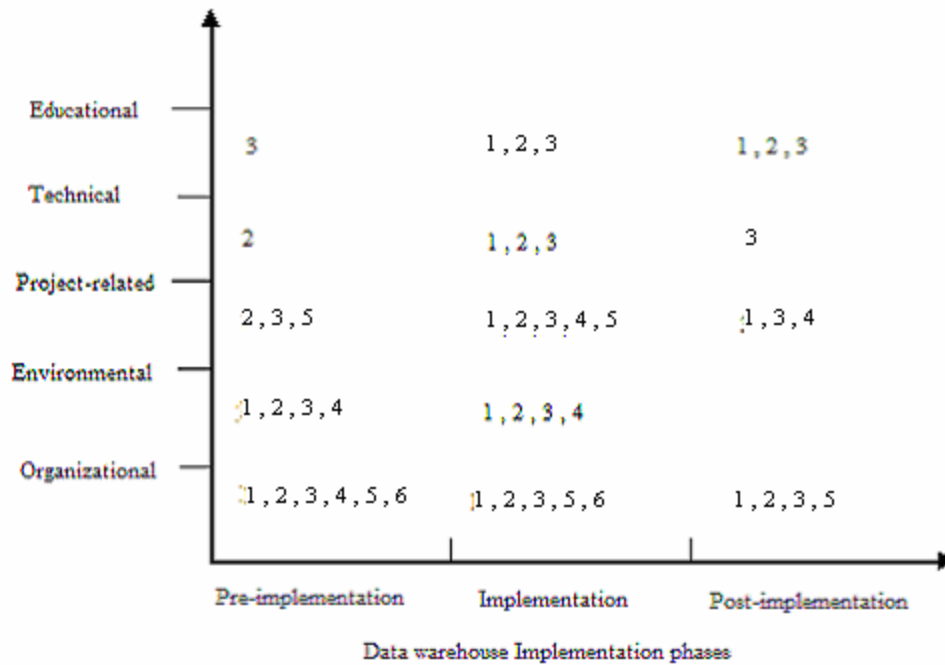
**Technical factors:**

- 1. Quality of data sources

**Educational factors:**

- 1. Availability of Best practices adaptors
- 2. Training courses
- 3. Certified trainers

The diagram below illustrates the phases of data warehouse implementation process and critical success factors occurring in each phase. The key words below the diagram highlight the meaning of the numbers in the diagram.



**Figure 4.1**

**Key words:**

Organizational factors:

- 1. Size of the organization
- 2. The existence of champions
- 3. Top management sponsorship (executive and operating)
- 4. Business Internal needs

5. Organizational resistance
6. Organizational politics

Environmental factors:

1. Business competition
2. Selection of vendors
3. Compatibility with industry standards and governmental regulations
4. Compatibility with partners

Project factors:

1. Skills of project team
2. Emergence and Coordination of organizational resources
3. End-user involvement
4. Support from information consultants and expertise
5. Accurate definition of project's priorities, scope and goals

Technical factors:

1. User interface
2. Technical resources availability
3. Quality of data sources

Educational factors:

1. Training courses
2. Certified trainers
3. Availability of Best practices adaptors

The following table summarizes the long discussion, under the phases of data warehouse project life cycle, by assigning the critical factors into the respective phases.

Factors	Pre-implementation	Implementation	Post-implementation
Size	X	X	X
Champion	X	X	X
Top management	X	X	X
Internal needs	X		
Org. Resistance	X	X	X
Org. Politics	X	X	
Business competition	X	X	

Vendor support	X	X	
Industry standards	X	X	
Partner compatibility	X	X	
Project team		X	X
Org. resources	X	X	X
End-user involvement		X	X
Consultants		X	X
Clear objectives	X	X	
User interface		X	X
Technical resources	X	X	
Data source quality		X	X
Training courses		X	X
Certified trainers		X	X
Best practices	X	X	X

**Table 4.2**

## **4.5 Factors investigated in the thesis**

This study provides additional insights to supplement the findings from foregoing research in the area of critical success factors of Data warehouse implementation.

Although the organizational, environmental and project-related issues in data warehousing are of importance, little attention was paid to these aspects. This study attempts to fill the space and add these aspects to the main subjects, which need to be discussed, regarding the key factors of data warehouses.

Below is the list of selected dimensions and the factors that will be investigated throughout the remaining parts of this study.

### **4.5.1 Organizational factors:**

1. The existence of champions
2. Top management sponsorship (executive and operating)
3. Business Internal needs

**4.5.2 Environmental factors:**

1. Business competition
2. Selection of vendors
3. Compatibility with partners

**4.5.3 Project-related factors:**

1. Skills of project team:
2. Emergence and Coordination of organizational resources:
3. End-user involvement:
4. Support from information consultants and expertise:

These factors are selected based on reviewing former related studies in the field of critical success factors of data warehouse technology and ERP systems, as indicated by the following table:

<b>Main Factor</b>	<b>Sub-factor</b>	<b>Data warehouse research</b>	<b>ERP research</b>
Organizational factor		Wixom and Watson, Hwang et al., Mukherjee and D’Souza, and Watson et al.	Mabert et al., Nah et al., Bingi et al., H Akkermans and Helden, Umble et al, and Parr and Shanks
	The existence of champions	Wixom and Watson, Hwang et al., and Watson et	Nah et al., H Akkermans and Helden, and Parr

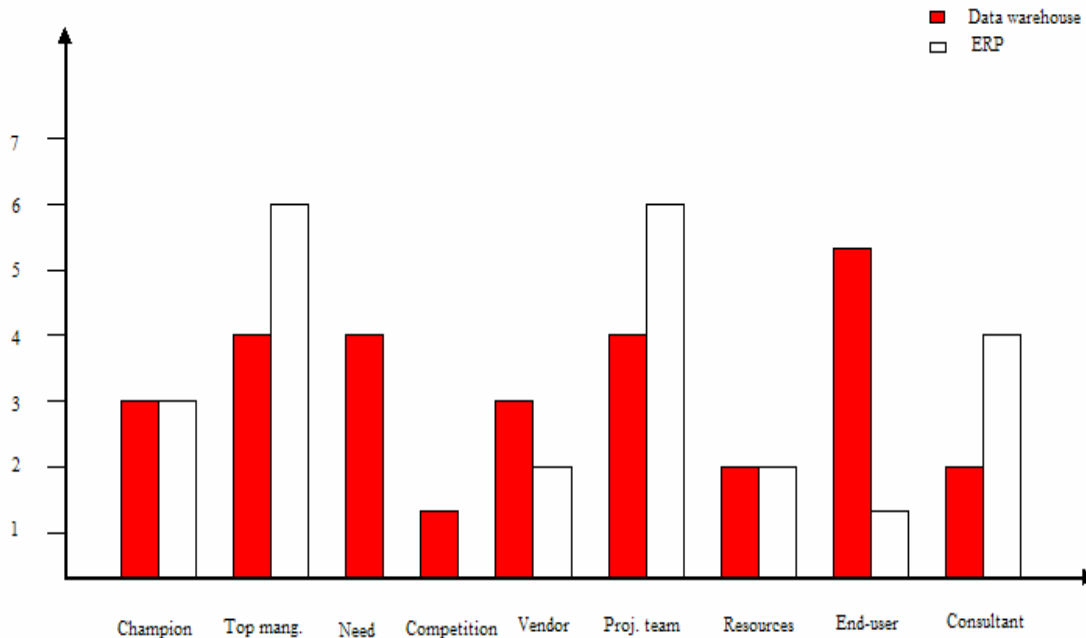
		al.	and Shanks
	Top management sponsorship	Wixom and Watson, Hwang et al., Watson et al., and Mukherjee and D'Souza	Mabert et al., Nah et al., Bingi et al., H Akkermans and Helden, Umble et al, and Parr and Shanks
	Business internal needs	Hwang et al., Mukherjee and D'Souza, Joshi and Curtis, and Watson et al.	-----
Environmental factor		Hwang et al., and Hurley and Harris	Bingi et al., and H Akkermans and Helden
	Business competition	Hwang et al.	-----
	Selection of vendors	Hwang et al., and Hurley and Harris.	Bingi et al., and H Akkermans and Helden
	Compatibility with partners	-----	-----
Project-related factors		Wixom and Watson, Hwang et al., Mukherjee and D'Souza, Solomon, and Hurley and Harris.	Mabert et al., Nah et al., Bingi et al., H Akkermans and Helden, Umble et al, and Parr and Shanks.
	Skills of project	Wixom and	Mabert et al., Nah

	team	Watson, Watson et al., Hwang et al., and Hurley and Harris.	et al., Bingi et al., H Akkermans and Helden, Umble et al., and Parr and Shanks.
	Emergence and coordination of organizational resources	Wixom and Watson, and Hwang et al.	Bingi et al., and H Akkermans and Helden
	End-user involvement	Wixom and Watson, Hwang et al., Watson et al, Mukherjee and D'Souza, and Solomon.	Bingi et al.
	Support from information consultants and expertise	Hwang et al., and Mukherjee and D'Souza.	Mabert et al., Bingi et al., H Akkermans and Helden, and Parr and Shanks

**Table 4.3**

The figure below summarizes the idea in the table above. The x axis represents the selected critical success factors. The y axis represents the number of relevant research papers, which discuss the CSFs of data warehouse and ERP technologies.

The white bar represents the research papers in the field of CSFs of ERP system, which investigated the selected factors. The red bar represents the research papers in the field of CSF of data warehouse technology, which investigated the selected factors.



**Figure 4.2**

As mentioned earlier and based on the above table and figure, many research papers have partly conferred about the organizational, project-related or environmental dimensions (by discussing a factor or a couple under one dimension or more). The main focus of these research projects was on the technological and educational dimensions.

As observed, there were no research papers, or very few, that discussed compatibility with partners and business competition as critical factors influencing the adoption of data warehouse. This study digs deeper into these two factors due to the following reasons:

- They identify key issues important to maintaining a competitive edge of the enterprise in today's highly competitive market.
- They stress the importance of having tight cooperation with direct partners in different aspects of the supply chain.

The factors that will be investigated in the thesis are supposed to influence data warehouse applications in pre-implementation and implementation phases.

It is more important to consider the factors influencing data warehousing in these two phases than it is to focus on the factors which influence the data warehouse in the last phase (Post-implementation). In the first two phases, the technical, organizational, environmental and operational backbones of data warehousing are defined, planned and developed. On the other hand, upgrading and modifying the system are the main activities in the post-implementation phase. Therefore, it is important to identify the critical factors that affect the activities in the first two phases.

#### **4.6 Summary of the chapter**

A data warehouse is not just a software or simple project. It is a huge project, which demands the coordination of a massive quantity of resources and capacities and may last more than two years. Therefore it is crucial to be aware of the critical issues which affect successful data warehousing implementation before starting such a gigantic project.

This chapter clusters the knowledge of CSFs influencing a data warehouse from the points of view of practitioners and academics to build the needed backbone of the empirical research of this study. After that the critical factors are classified into relevant phases of the data warehouse implementation project. Finally, this chapter identifies the factors that will be investigated later in the thesis.

## **5. Empirical research**

### **5.1 Objective and structure**

In this chapter, the empirical investigation is introduced. Research problems, research model, proposed hypotheses, techniques used to extract and analyze the data, and findings from the analysis are explained and discussed.

Section 5.2 indicates the research problem and objectives. In section 5.3, the research models used throughout the study are presented and drawn. The hypotheses of this thesis are developed in section 5.4. Methods and techniques used to collect the data for data analysis and testing hypotheses are highlighted in section 5.5. The data is analyzed and findings from research methods are discussed in section 5.6. Finally, Section 5.7 investigates the benefits gained from data warehouse, introduces the ranked list of CSFs and discusses observations on the current status of data warehouses in the investigated companies.

### **5.2 Research problem and objectives**

The adoption of data warehouse technology is costly and time-consuming with high probability of failure, compared with other information technology initiatives. Therefore, it is important to have a deeper understanding of the factors which affect the adoption of data warehouse technologies.

The research problem of this thesis can be portrayed as “what are the Critical Success Factors, under organizational, environmental and project-related dimensions, which influence the adoption of data warehouse technology in Finnish companies”.

### **5.3 Research model**

To develop the research model, IT and data warehousing implementation and success literature was reviewed to identify factors that affect data warehousing success.

The proposed research model of this thesis groups the investigated critical success factors into three dimensions (Organizational dimension, Environmental dimension, and Project-related dimension). The key success factors are classified under each dimension after studying the findings from earlier research papers and using my educated guess.

Categorizing the relevant critical success factors into appropriate elements facilitates showing the relationship among relevant factors and building the proposed hypotheses for this thesis.

The figure below illustrates the research model of this study.

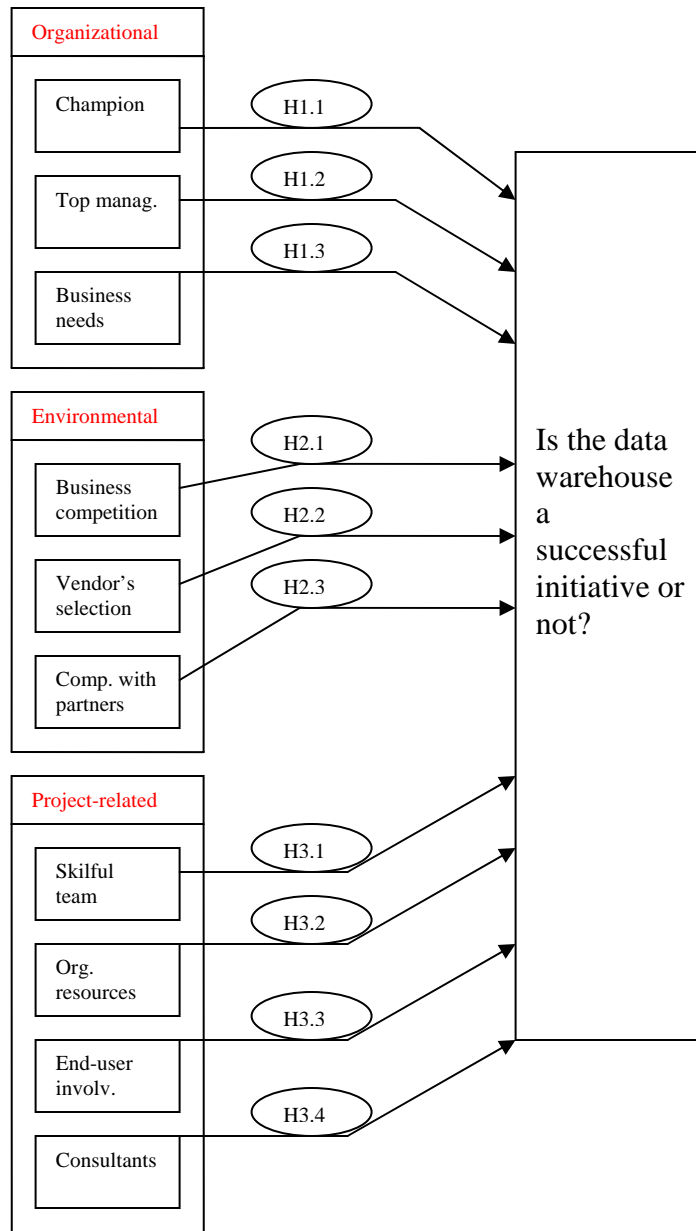


Figure 5.1

## 5.4 Hypotheses and variables

### 5.4.1 Organizational dimension

It is important for organizational factors to be understood by the decision makers in order to overcome and reduce the barriers.

This dimension includes three factors (Existence of champions, Top management sponsorship, and Business internal needs).

### **H1.1. Existence of champion**

Previous research papers have indicated the positive influence of the existence of the champion factor on successful implementation of data warehouse technology.

Champions are the people inside the organization who appreciate and support the adoption of new technology.

Champions play integral roles in providing necessary information, required resources, needed assistance, political support and stimulating their associates and staff to adapt the new technology.

This study believes that the existence of champion factor has a critical and positive impact on the adoption of data warehouse technology.

### **H1.2. Top management sponsorship**

Earlier studies have discussed largely the large positive influence of the Top management sponsorship factor on successful adoption of data warehouse technology.

The commitment of top management support is important to pass over sudden barriers and complexities in data warehouse project. With top management support the organization can secure required capital, human support, cooperation and availability of other resources needed for the development process.

This study builds the second hypothesis by assuming that the Top management support factor has a great and positive influence in the adoption of data warehouse technology.

### **H1.3. Business internal needs**

The alignment of data warehouse to business needs is a crucial step in data warehouse adoption. It is important to clarify the strategic business objectives and needs that a data warehouse would be expected to meet.

This study assumes that business internal needs have constructive and positive influence in the adoption of data warehouse technology.

#### **5.4.2 Environmental dimension**

Environmental elements contribute largely to the success of data warehouse technology. An enterprise is no longer able to maintain a competitive edge without responding to challenges and changes resulting from the surrounding environment. One possible solution, for responding to these challenges and changes could be adapting powerful new technologies.

This dimension includes three factors (Business competition, Selection of vendors, and Compatibility with partners).

##### **H2.1 Extent of business competition**

Enterprises often try to boost their competitive advantage and increase their market share by adopting new information technology, especially if the competitors have adopted this technology.

This study hypothesizes that the business competition factor influences positively the successful adoption of data warehouse technology.

##### **H2.2. Selection of vendors**

Today's organizations aim to outsource their business applications, the data warehouse is one of them. As known, a data warehouse is a time-consuming and very expensive system. Therefore companies must be aware while selecting the vendors (implementation partner) and review carefully the suggested plans. These plans might not be fully convenient for the company to adapt them.

This study is aligned with the earlier studies in their belief that the selection of vendors has a positive effect on the adoption of data warehouse technology.

### **H2.3. Compatibility with partners**

Understanding partners' systems and operations, and then reacting positively could be the key subject to maintain long-term relationships with these partners. A positive reaction could be visualized and actualized by adapting compatible systems.

This study builds the sixth hypothesis by assuming that compatibility with partners' system has a positive impact on the adoption of data warehouse technology.

### **5.4.3 Project-related dimension**

The Project-related dimension is one of the foremost dimensions in the adoption of data warehouse technology. Project-related factors are related to project plan, analysis, development and control.

This dimension includes four factors; skills of project team, emergence and coordination of organizational resources, end-user involvement, and support from information consultants and expertise.

### **H3.1. Skills of project team**

Project team members possessing strong knowledge of new technology and better communication capability positively influence data warehouse implementation, as shown in the previous studies. It is necessary to select the members from different departments to add diverse values to the data warehouse project. Providing relevant training courses to project team members about technical, management and maintenance aspects is a very important subject as well.

This study assumes that the skills of project team factor affects greatly and positively the adoption of data warehouse technology.

### **H3.2. Emergence and coordination of organizational resources**

Data warehouses are high-priced, time-consuming and resource-intensive initiatives. Therefore, having enough resources (people, money, and time) is a prerequisite in the success of data warehouse projects. Coordination and correct allocation of resources help the project team to finish the data warehouse project on the proposed budget and on time.

This study builds the eighth hypothesis based on assuming that emergence and coordination of organizational resources affects the adoption of data warehouse technology positively.

### **H3.3. End-user involvement**

Better user participation increases the probability of managing users' expectations, satisfies their requirements and reduces their resistance to newer technology. Previous investigators have stated that selection and inclusion of fitting users in project teams is an important mission in the adoption of data warehouse applications. Adequate training can help users to explore the desirable information positively and in much more effective mode.

This study hypothesizes that end-user involvement has a positive impact on the adoption of data warehouse technology.

### **H3.4. Support from outside consultants and expertise**

The new appearance of data warehouse in the business field, coupled with rapid growth of data warehouse market has led to the lack of competent and qualified consultants. It is important and challenging to find experienced consultants and keep them involved during and after the data warehouse

project. They provide professional insights and experiments to the adopters for smooth running of the data warehouse project.

This study builds the last hypothesis by assuming that the support from outside consultants factor greatly and positively influences the successful adoption of data warehouse technology.

## **5.5 Data collection**

In this section, methods and techniques used to collect relevant data for study analysis and testing the proposed hypotheses, are discussed and explained.

An emailed-questionnaire was used in this study to collect data from the selected companies.

### **5.5.1 Questionnaire**

#### **5.5.1.1 Design of the questionnaire**

In alignment with the research model, the questionnaire in this study was designed based on reviewing prior related research questionnaires and collecting professional insights.

To secure relevance, validity and reliability of this questionnaire a three-round process of revision was formed.

The questionnaire was checked by my supervisor Mr. Anders Tallberg to review each question and make necessary modifications. Then the questionnaire was sent and further reviewed by a panel of PHD students. Finally, the questionnaire got the approval from Mr. Anders Tallberg after his second review and evaluation.

This questionnaire is composed of two sections:

- The first section is designed to collect basic data on respondents who answer the questionnaire, and general data about their companies.

- The second section is the major part of the questionnaire. In this section, data regarding critical success factors influencing data warehouse technology in Finnish companies is collected. This section gathers, as well, data about the obtainable benefits from adopting data warehouses in Finnish companies.

### **5.5.1.2 Objective of the questionnaire**

The main objective of this study is to define the critical issues influencing the adoption of data warehouse technology in Finnish companies. Therefore the survey aimed to achieve a better understanding of these issues (critical factors) by collecting relevant data for decent analysis and testing the significance of the proposed hypotheses.

### **5.5.1.3 Sample description**

The survey yielded results from Finland with respondents' companies crossing many industrial classifications.

As known, a Data warehouse is an expensive and time-consuming system, which requires resources, expertise and capabilities. These resources and expertise are used to afford huge set-up costs, dips in production (during and after implementation phase), upgradeability and maintenance expenses. Mid- and large- sized companies are the only ones that possess enough capabilities to afford data warehouses. Consequently, the questionnaire was steered toward mid- and large-sized companies.

In order to achieve the thesis objectives, a focused survey was conducted and geared toward certain titles of posts such as Chief Information officers (CIO), Chief Financial Officers (CFO), IT administrators and other similar titles.

The reasons behind selecting such people are as follow:

- These people are mostly involved and assigned as project team leaders in data warehouse projects.
- They interact daily or regularly with data warehouse technology for varied purposes.

- These people have strategic and managerial levels in their organizations with relevant educational background (bachelor's degree and above) and broad decision making capabilities. Therefore, some of these people might be the champions of data warehouse technology projects in their companies.

After a three-round process of checking and reviewing the questionnaire, a total of 220 questionnaires were e-mailed to the targeted delegates at the selected companies. The companies were identified via a computer search of Hanken's financial database (Voitto). This database lists companies and their basic information (their trade name, their website address, annual turnover and so on) based on certain metrics (criteria). The sample was selected based on their annual turnover (the companies which had a turnover of more than 25000000€last-year).

The original e-mailed questionnaire was followed by a three-round process of sending solicitation (reminders) to remind the delegates to fill out the questionnaire.

## **5.6 Data analysis and discussion of research results**

### **5.6.1 Analysis of data gained via questionnaire**

A final of eighteen responses to the questionnaire were received after a period of more than two months. All of the survey responses are valid and utilizable except for some questions within a response, which were answered by N/A (No Answer).

The resulting response rate was 8% after sending the original e-mailed questionnaire and performing a three-round process of mailing solicitation (reminders) to targeted employees.

The response rate was quite low for the following reasons:

- The limited existence of mid- and large-sized companies in the Finnish market. As mentioned earlier, those companies are the most capable ones to afford the adoption of data warehouses.
- The lack of comprehensive understanding and knowledge regarding data warehouse technology due to the recent appearance of this technology in the business field.
- The questionnaires and reminders were e-mailed to the companies during June and July. Those two months are well-known as the season of vacations in Finland. Consequently, I got a lot of auto replies to my e-mails from the delegates, saying they were out of their offices for work or vacation-related reasons

The parts below are the analysis of results obtained from the questionnaires.

#### **5.6.1.1 Analysis of the first section of the questionnaire**

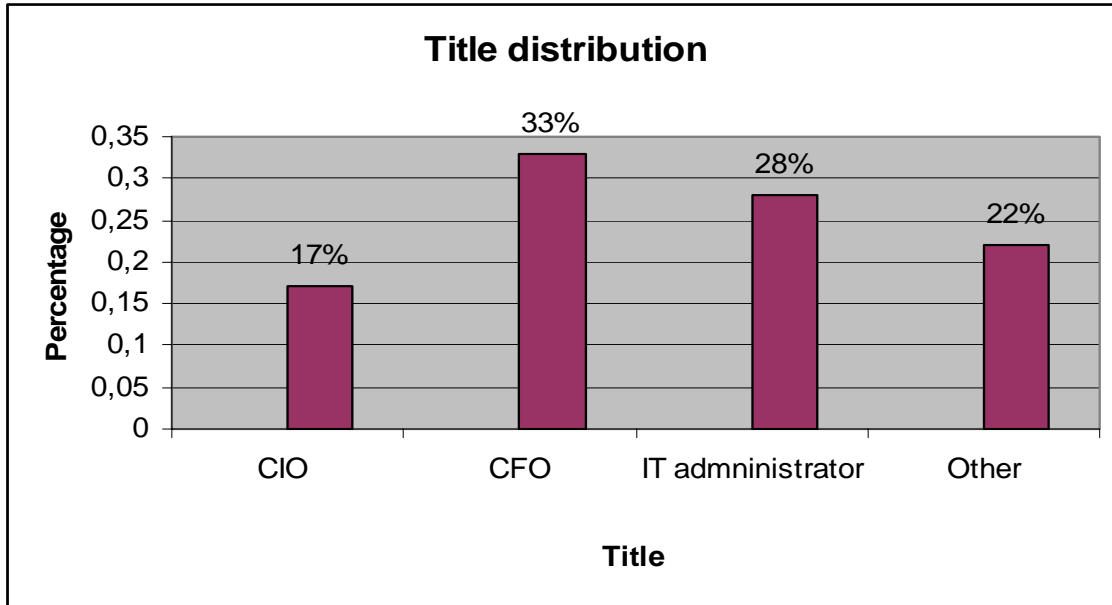
The first section in the questionnaire was designed to collect basic data on the respondents, who answer this questionnaire, and general data about their companies.

This section contains a mix of multiple choice and open-ended questions. The open-ended questions were designed to remove the impression of restricting respondents with predetermined choices.

##### **5.6.1.1.1 Title of post of respondent**

To secure validity, relevance and reliability of data for analysis, it is important to ensure the relevance of respondents' backgrounds (educational and work-related background). The respondent should be an IT- and data warehouse-savvy person and have regular interaction with a data warehouse. Such a person can be in the following positions CIO, CFO and IT administrator.

The figure below shows the distribution of respondent's title. The axis (x) represents the title of the post of the respondent and the axis (y) represents the percentage.



**Figure 5.2**

As noticed from the above figure, 33% of the respondents (6 respondents) were CFOs at their companies. 28% of the respondents (5 respondents) were IT administrators at their companies. 17% of the respondents (3 respondents) were CIOs at their companies. 22% of the respondents (4 respondents) were playing different roles in strategic and managerial levels at their companies, such as production director (1 respondent), logistic director (1 respondent), corporate advisor (1 respondent), and solution owner (1 respondent).

#### **5.6.1.1.2 Last year's turnover**

Data warehouses are mostly adopted by mid- and large-sized companies, because, as mentioned earlier, these companies are the most competent ones to overcome the obstacles presented by data warehouse adoption.

This question is included in the questionnaire to measure the size of the company in terms of annual turnover.

The table below illustrates the sizes of the companies measured by last year's turnover.

Last year's turnover	Percentage
25000000€ – 100000000€	6%
100000000€ – 500000000€	44%
500000000€ – 1000000000€	22%
More than 1000000000€	28%

**Table 5.1**

As noticed, 44% of the responses (8 responses) received from companies reported last year's revenue between 100000000€- 500000000€ 28% of the responses (5 responses) received from companies reported last year's revenue more than 1000000000€ 22% of the responses (4 responses) received from companies reported last year's revenue between 500000000€- 1000000000€ 6% of the responses (1 response) received from companies reported last year's revenue between 25000000€- 100000000€

#### **5.6.1.1.3 Type of industry in which the company incorporates**

This question aims to investigate types of industries, which use data warehouse technology. This question can be applied as well to digging deeper into identifying the industries which use data warehouses extensively (with high percentage) and the ones, which use this technology narrowly (with low percentage).

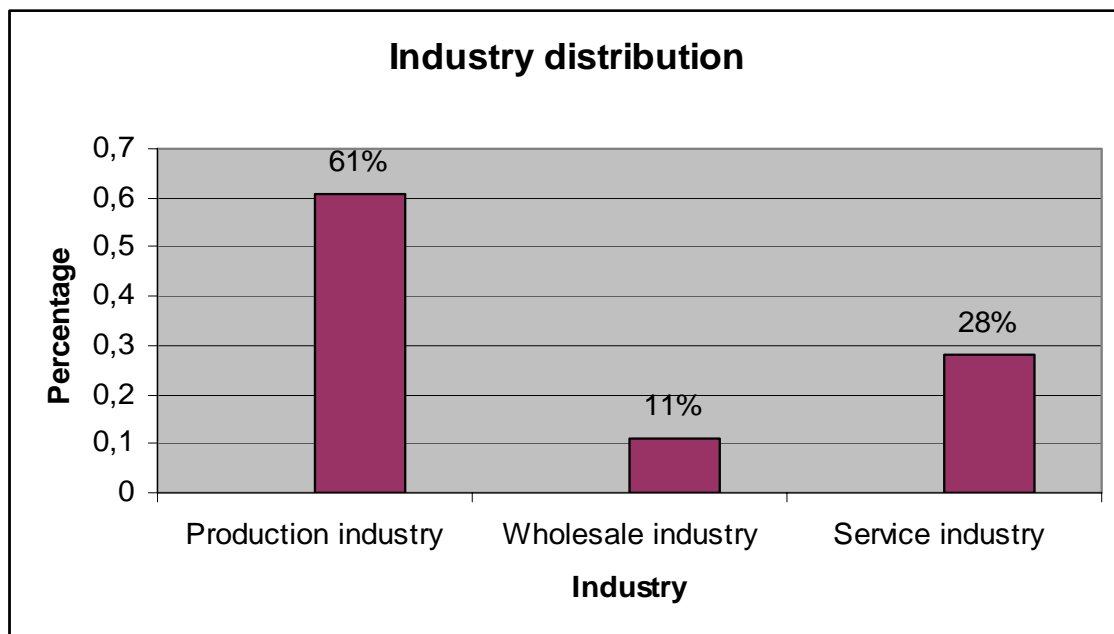
The table below indicates the types of industries cited in the responses and the number of responses for each type of industry.

Type of industry	Number of responses
Graphic Business	1
Steel production	2
Paper and pulp production	3
Mechanics and electronics	1
Service	3
Technical wholesale	1

Beverages	1
Consumer Discretionary	1
Food production	2
Pharmaceutical wholesale	1
Software and network	1
Machinery rental	1

**Table 5.2**

I reclassified the aforementioned industries into bigger categories. This classification was made based on finding common functional characteristics among the smaller ones. Examples, The companies, which produce tangible products, are classified under production industry. The sorting facilitates analyzing the industries and supports the identification of industries which widely or narrowly adopt data warehouse, as shown in the figure below.



**Figure 5.3**

As observed, 61% of the responses (11 responses) were received from companies producing and manufacturing tangible products to customers. 28% of the responses (5 responses) were received from companies producing intangible products (services) to clients. 11% of the responses (2 responses) were received from wholesalers in the Finnish market.

#### 5.6.1.1.4 Year of data warehouse installation

It is relevant to this study to know the year when data warehouse technology was installed in the companies investigated. This question intends to explore the maturity level of data warehousing in companies, i.e. young or mature data warehouse.

The table below illustrates the year of data warehouse installation and the number of responses for each year.

Year of installation	Number of responses
1991	1
1999	3
2000	2
2001	4
2002	2
2003	1
2004	3
2005	1
Continuous development process	1

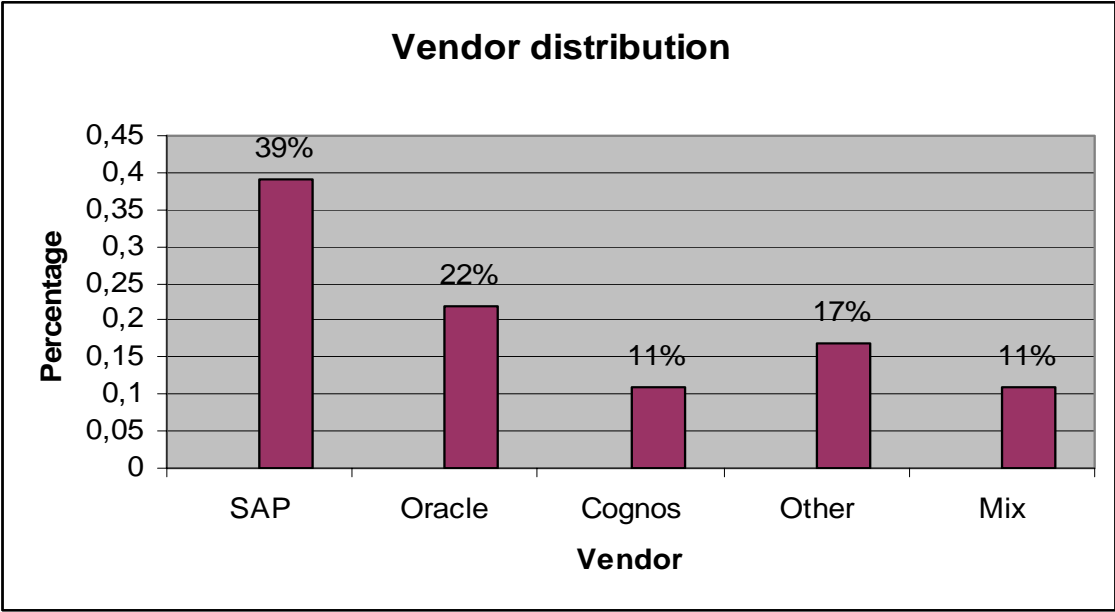
**Table 5.3**

As shown by the above table, most of the companies installed their data warehouses during the last 5 years. The short-term deployment of data warehouse technology leads to the following conclusion: The investigated companies, in particular and Finnish companies in general, do not have enough experience in data warehousing initiatives.

#### 5.6.1.1.5 Name of supplier (vendor) of current data warehouse technology

This question investigates the name of the supplier of the current data warehouse, used at the respondents' companies.

The figure below shows the vendor distribution, where you can find the vendor's name and the percentage.



**Figure 5.4**

As noticed, SAP is the dominant brand name, as a data warehouse solution provider, in the Finnish market with 39% of the responses (7 responses). Oracle has the second largest market share, as a data warehouse technology provider, with 22% of the responses (4 responses). 11% of the responses (2 responses) received from companies use Cognos's data warehouse solution. 11% of the responses (2 responses) received from companies use data warehouse solutions from different suppliers (more than one DW provider). 17% of the respondents' companies (3 responses) use data warehouses supplied from other suppliers, such as Datium (1 response), and e-big (1 response), and use self-made data warehouse (1 response).

**5.6.1.1.6 Previous data warehouse installed and used**

This question is answered only by the companies, which have renewed their data warehouse technology recently. The reasons behind the replacement might be related to efficiency matters, or upgradeability to newer versions or overcoming problems experienced in the previous system.

Based on the responses, 78% of the respondents (14 responses) answered this question “NO”, i.e. their companies didn’t change their data warehouse technologies. 22% of the respondents’ companies (4 responses) have changed their data warehouse technology due to different reasons. The following are the reasons behind changing the previous data warehouse, as stated by the respondents:

- Moving from one vendor to another for more flexibility, efficiency and automation of data storage, analysis and reporting
- Moving from department-level to enterprise-level data warehouses
- Upgradeability to newer versions.

#### 5.6.1.1.7 The data warehouse type

This question aims to explore the types of data warehouse technology in the respondents’ companies.

The figure below highlights the data warehouse type distribution. The x axis represents the data warehouse types and the y axis represents the percentage.

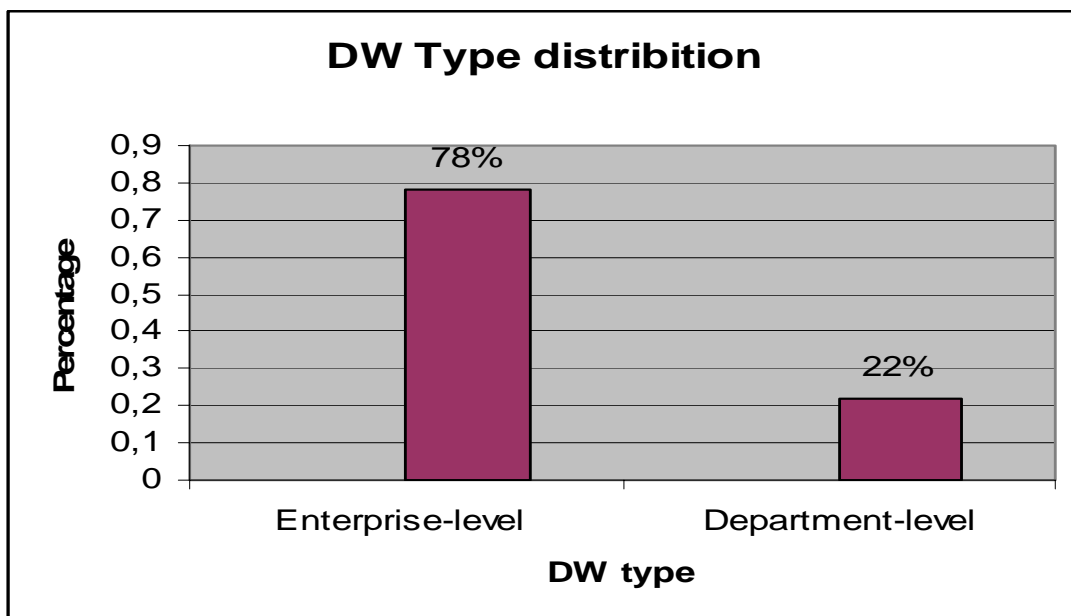


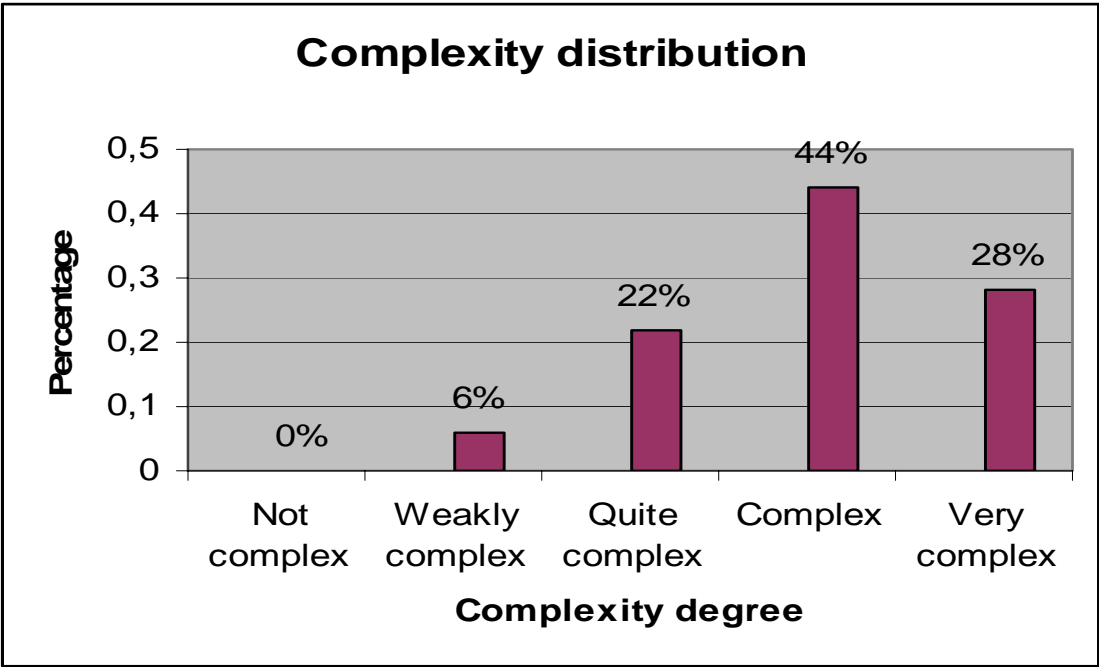
Figure 5.5

As observed, 78% of the respondents' companies (14 responses) installed enterprise-level data warehouse. 22% of the respondents' companies (4 responses) installed department-level data warehouse.

**5.6.1.1.8 Degree of complexity of the data warehouse project**

This question intends to explore the degree of complexity of the data warehouse adoption project in the respondents' companies. This question is a multiple choice question, which has the following predetermined answers: not complex, weakly complex, quite complex, complex, very complex.

The figure below highlights the complexity distribution. The x axis represents the complexity degree and the y axis represents the percentage.



**Figure 5.6**

As shown by the above figure, 44% of the respondents (8 responses) considered the data warehouse project as a complex project. 28% of the respondents (5 responses) considered the data warehouse project as a very complex one. 22% of the respondents (4 responses) thought that it is a quite

complex project. 6% of the respondents (1 response) thought that it is a weakly complex project.

#### **5.6.1.1.9 The company size (measured by number of employees)**

This question is applied to measure the size of the respondents' companies. This question goes hand in hand with the last year's turnover question for defining the size of the organization.

#### **5.6.1.2 Analysis of the second section of the questionnaire**

The second section is the major part of the questionnaire. In this section, the data regarding critical success factors as well as data about the benefits gained from data warehouses in Finnish companies is gathered and collected.

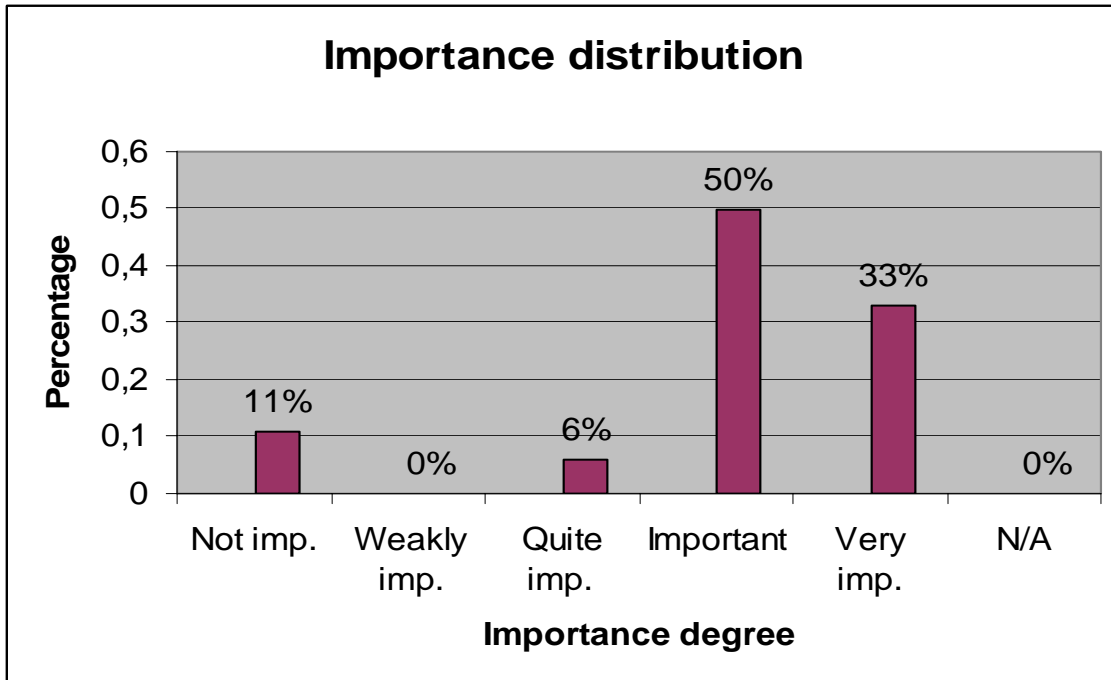
This section includes a six-scale method of ranking the contribution of key success factors. (1- Not important. 2- Weakly important. 3- Quite important. 4- Important. 5- Very important. N/A).

This part of the analysis aims to analyze the data gathered from the second section of questionnaire, to test the significance of proposed hypotheses.

#### **5.6.2.2.1 Existence of champions**

The existence of champions factor has a crucial impact on the embracing of data warehouse technology. They play an integral role in providing necessary information, required resources, needed assistance, political support and stimulating the staff to adopt new technology.

The figure below illustrates the importance distribution of the existence of champion factor. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.7**

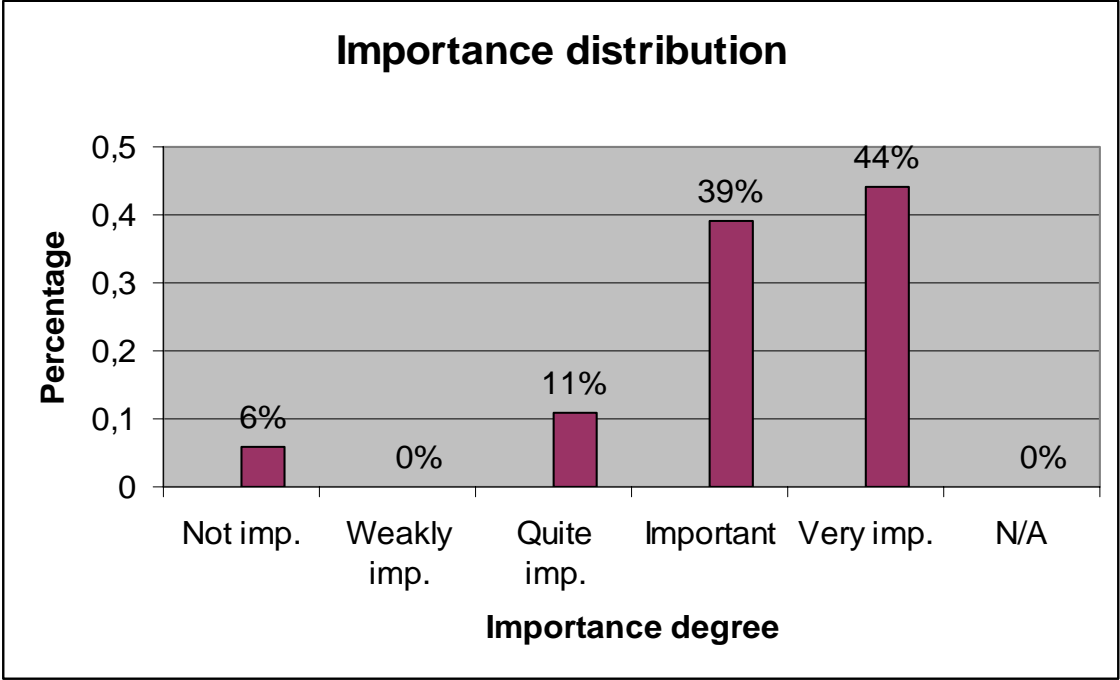
As observed, 50% of the respondents (9 responses) ranked the existence of champions factor as an important factor. 33% of the respondents (6 responses) ranked this factor as a very important factor. 11% of the respondents (2 responses) ranked this factor as a not important factor. 6% of the respondents (1 response) ranked it as a quite important factor.

Based on the above analysis, 83% (Important + Very important) of the respondents believed that the existence of champions factor is a critical factor influencing data warehouse technology. On the other hand, 11% of the respondents believed that the existence of champions factor is not a critical factor. It seems that the data supports strongly the first hypothesis (**The existence of the champion has a critical and positive impact on the adoption of data warehouse technology in the Finnish companies**).

#### **5.6.2.2.2 Top management sponsorship**

The commitment of top management support is very important to pass over sudden barriers and complexities faced from adopting data warehouse technology.

The figure below shows the importance distribution of the top management sponsorship factor. The x axis represents the degree of importance and the y axis represents the percentage.



**Figure 5.8**

As shown by the above figure, 44% of the respondents (8 responses) considered the top management sponsorship factor as a very important factor. 39% of the respondents (7 responses) considered this factor as an important factor. 11% of the respondents (2 responses) considered this factor as a quite important factor. 6% of the respondents (1 response) considered this factor as a not important factor.

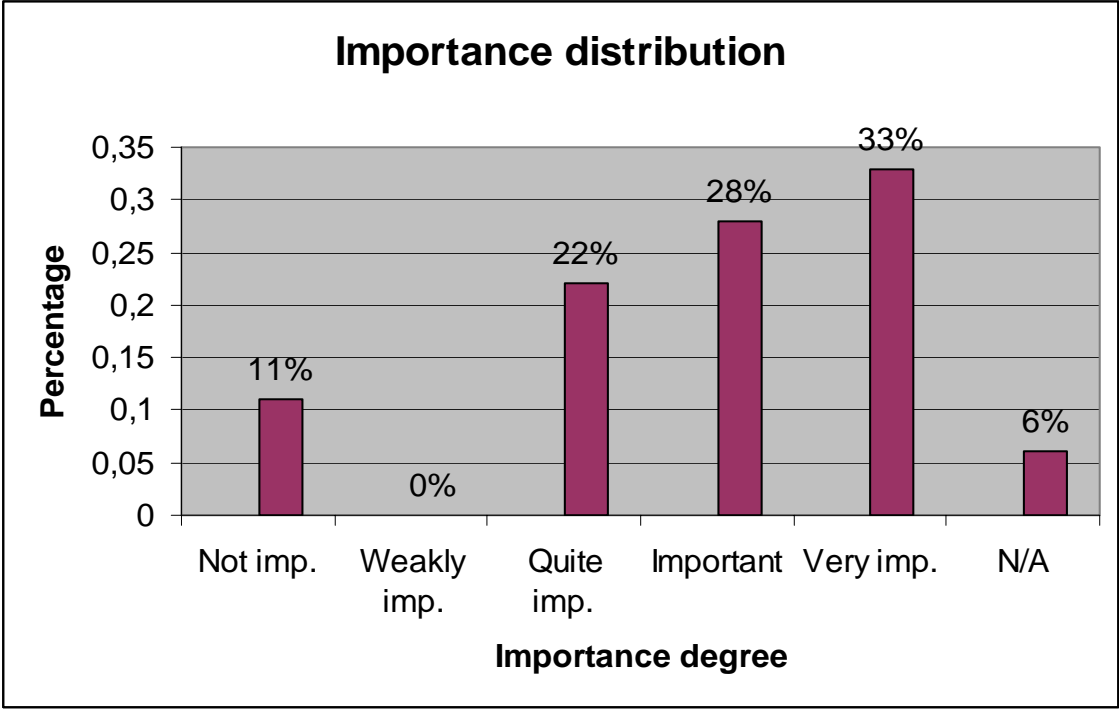
Based on the above analysis, 83% (Very important + important) of the respondents evaluated the top management sponsorship factor as a critical factor that impacts the success of data warehouse technology. On the other side, 6% of the respondents evaluated the top management support factor as a

not important factor. As a result, The data seems to validate strongly the second hypothesis. **(The Top management has a great influence in the adoption of data warehouse technology in the Finnish companies).**

**5.6.2.2.3 Business internal needs**

The alignment of a data warehouse to business needs is a crucial step in a data warehouse adoption project. Before starting such a gigantic effort it is important to clarify strategic business objectives and needs that a data warehouse would be expected to meet.

The figure below illustrates the importance distribution of the business internal needs factor. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.9**

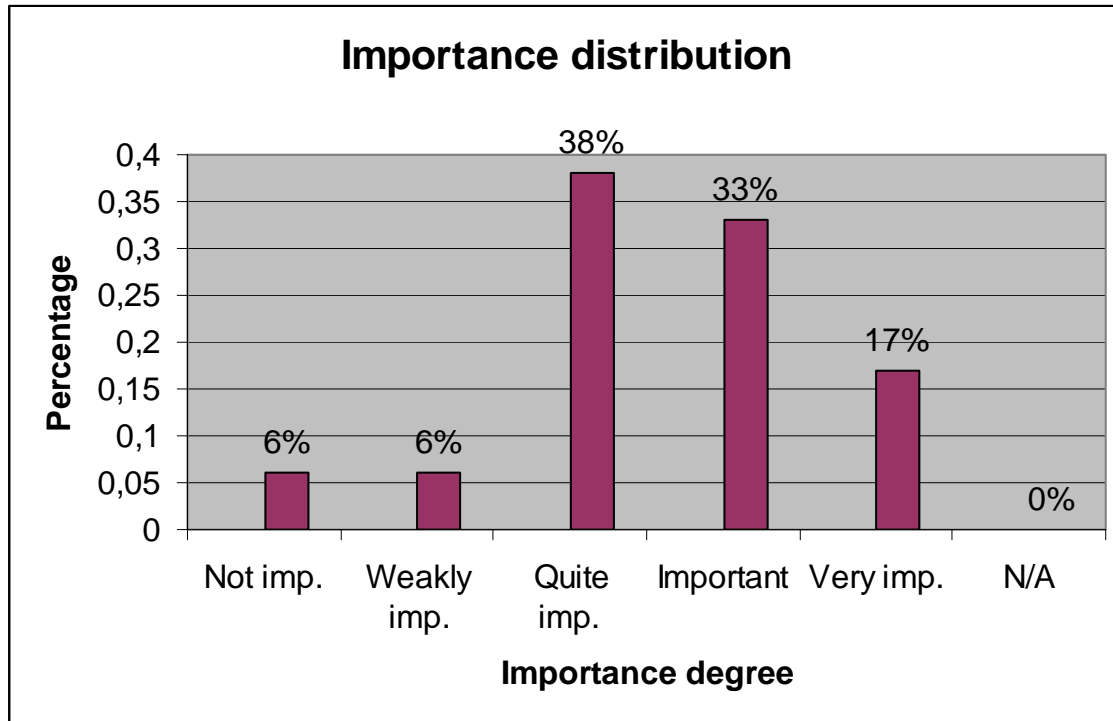
As indicated by the above figure, 33% of the respondents (6 responses) considered the business internal needs factor as a very important factor. 28% of the respondents (5 responses) considered this factor as an important factor. 22% of the respondents (4 responses) considered this factor as a quite

important factor. 11% of the respondents (2 responses) considered this factor as a not important factor. 6% of the respondents (1 response) didn't have an answer to this question.

Based on the analysis, 61% (very important + important) of the respondents evaluated the business internal needs factor as a critical factor influencing the adoption of data warehouse technology. On the other hand, 11% of the respondents believed that the business internal needs factor doesn't affect the success of the data warehouse. Hence, the data supports the third hypothesis (**The business internal needs have a constructive influence in the adoption of data warehouse technology in the Finnish companies**).

#### **5.6.2.2.4 Selection of vendors**

Companies must be aware while selecting vendors, because the data warehouse project is a huge and risky project. The plans suggested by vendors may not be completely convenient for an enterprise itself. Consequently, the enterprise can't adapt whatever is recommended and suggested by the vendors. The figure below indicates the importance distribution of the selection of vendors factor. The x axis represents the importance degree and the y axis represents the percentage.



As observed, 38% of the respondents (7 responses) were neutral in their opinions toward ranking the importance of selecting appropriate vendors in successful data warehouse project. 33% of the respondents (6 responses) identified this factor as an important factor. 17% of the respondents (3 responses) identified this factor as a very important factor. 6% of the respondents (1 response) identified this factor as a weakly important factor. 6% of the respondents (1 response) identified this factor as a not important factor.

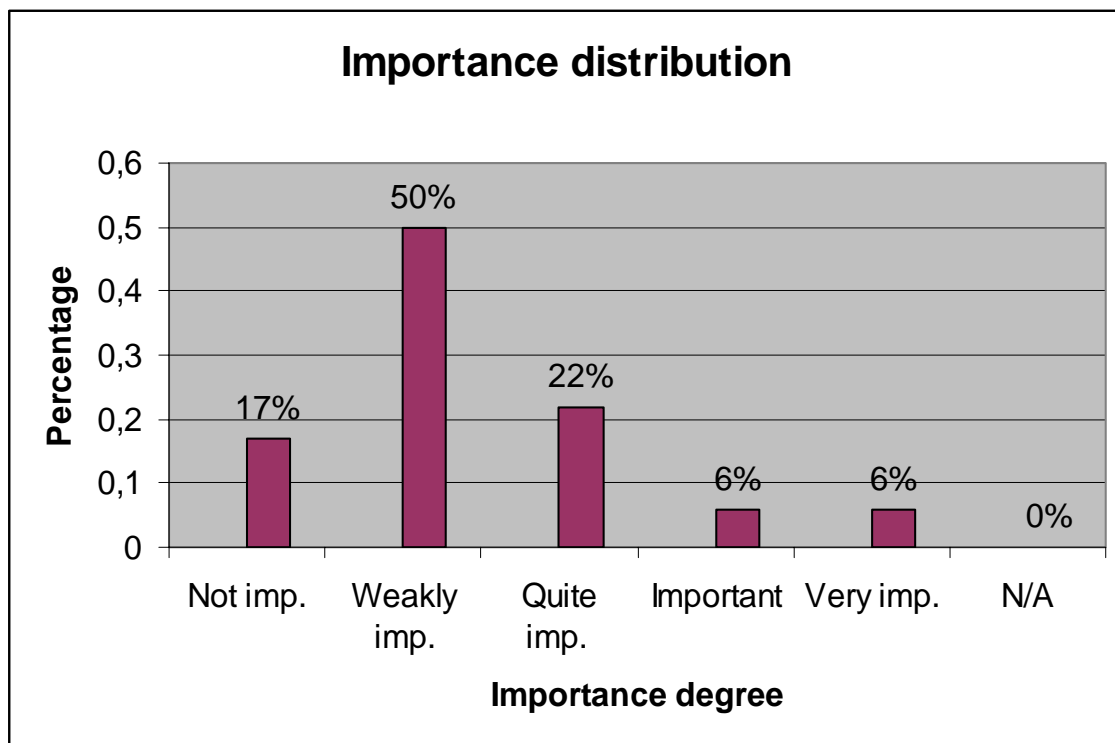
Based on the analysis, 50% (very important + important) of the respondents assessed the good selection of vendors as a crucial factor for successful adoption of data warehouse technology. Alternatively, 12% (weakly important + not important) of the respondents agreed that the good selection of vendors is not a critical aspect in successful data warehousing. Consequently, the data is believed to support fairly the fourth hypothesis (**There is a positive**

correlation between the business competition and the successful implementation of data warehouse technology).

#### 5.6.2.2.5 Compatibility with partners

It is important to understand the systems adapted by direct partners in the supply chain. This leads to facilitate exchange of knowledge and information between Supply Chain members, which will enhance the performance and the profit of overall supply chain members.

The figure below indicates the importance distribution of the compatibility with partners factor. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.10**

As shown by the above figure, 50% of the respondents (9 responses) thought that compatibility with partners systems has a weak impact on successful implementation of data warehouse technology. 22% of the respondents (4 responses) thought that this factor is a quite important factor. 17% of the

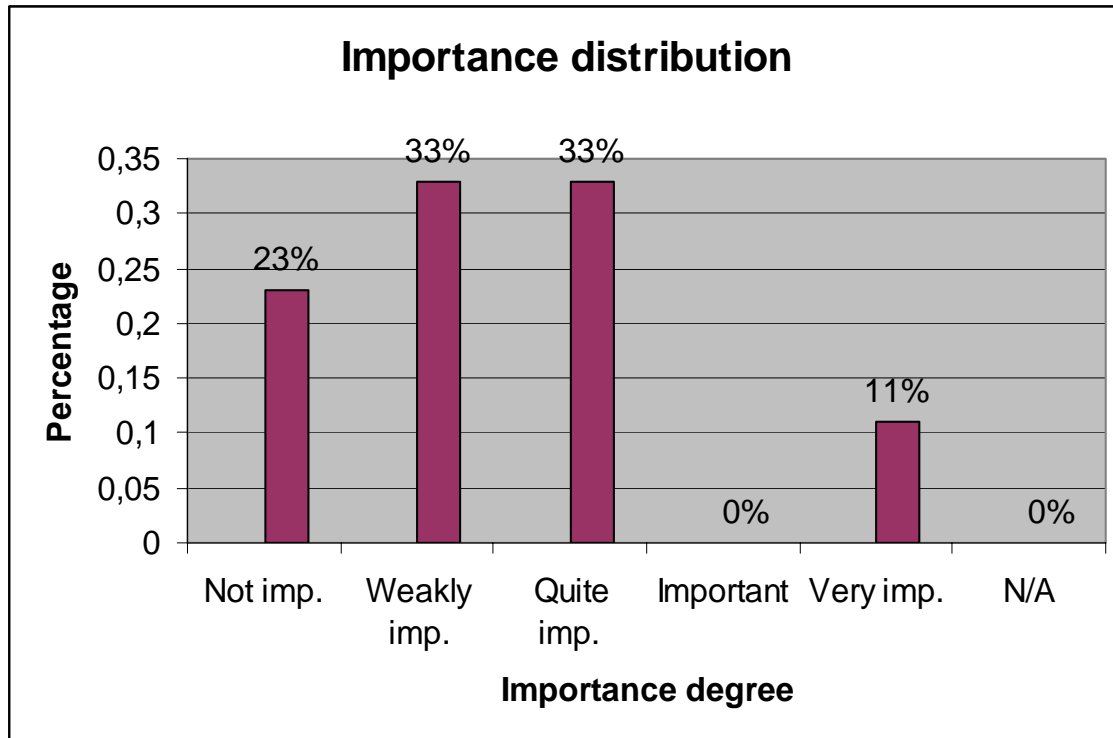
respondents (3 responses) thought that this factor is not important factor and doesn't affect the adoption of data warehouse applications. 6% of the respondents (1 response) believed that this factor is a very important factor. 6% of the respondents (1 response) believed that this factor is an important factor.

Based on the above analysis, 67% (not important + weakly important) of the respondents assessed the compatibility with partners factor as a non-critical factor. 12% (very important + important) of the respondents considered the compatibility with partners factor as a critical factor. As a result, It looks like the data dose not support the fifth hypothesis (**The selection of vendors has a positive effect in the adoption of data warehouse technology**).

#### **5.6.2.2.6 Extent of business competition**

The organization can no longer maintain the piloting edge in its industry without the adoption of new technology, especially if the competitors are adopting or have adopted this technology.

The figure below highlights the importance distribution of the extent of business competition factor. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.11**

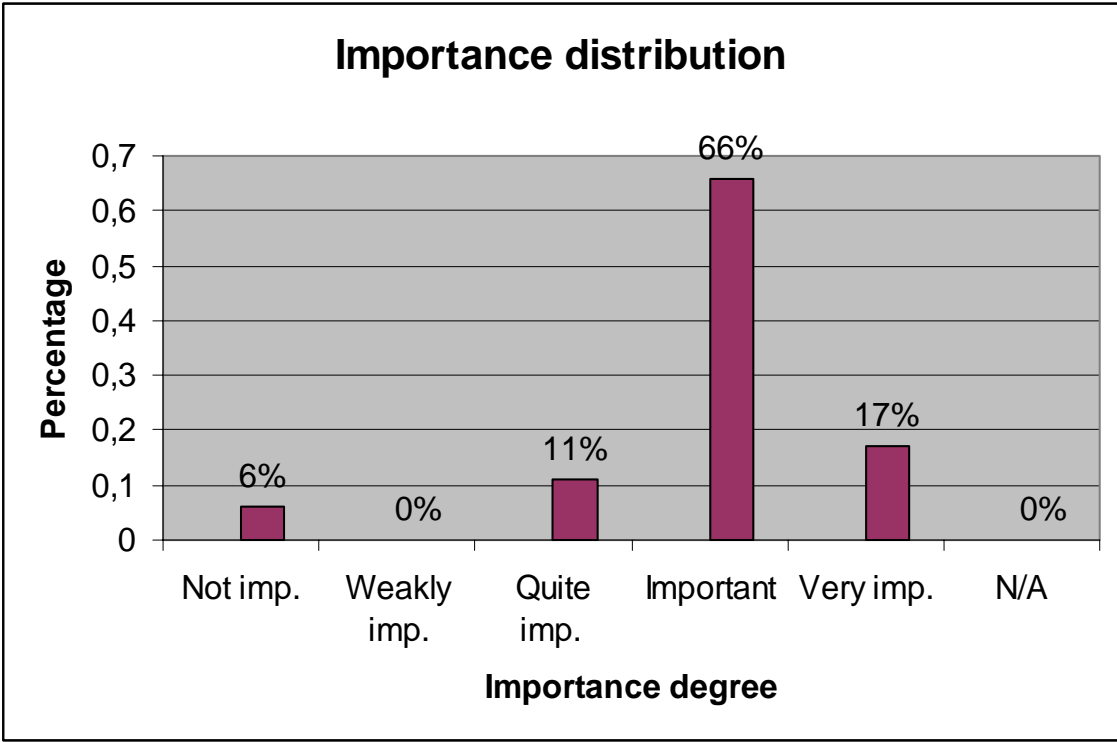
The figure above proves that 33% of the respondents (6 responses) assessed the business competition factor as a quite important factor. 33% of the respondents (6 responses) assessed this factor as a weakly important factor. 23% of the respondents (4 responses) assessed this factor as a not important factor. 11% of the respondents (2 responses) assessed this factor as a very important factor.

As observed, 66% (not important + important) of the respondents agreed that the business competition factor is a non-critical factor influencing the success of data warehouse. On the other side, 11% of the respondents assessed this factor as a critical factor. As a result, the data is deemed not to support the sixth hypothesis (**The compatibility with partners' system has a positive impact in the adoption of data warehouse technology**).

#### **5.6.2.2.7 Skills of project team**

The skills of the project team have an endless impact on the smooth running of a data warehouse project.

The figure below shows the importance distribution of the skills of project team factor. The axes x represents the importance degree and the axes y represents the percentage



**Figure 5.12**

The figure demonstrates that 66% of the respondents (12 responses) evaluated the skills of project team factor as an important factor. 17% of the respondents (3 responses) evaluated this factor as a very important factor. 11% of the respondents (2 responses) evaluated this factor as a quite important factor. 6% of the respondents (1 response) evaluated this factor as a not important factor.

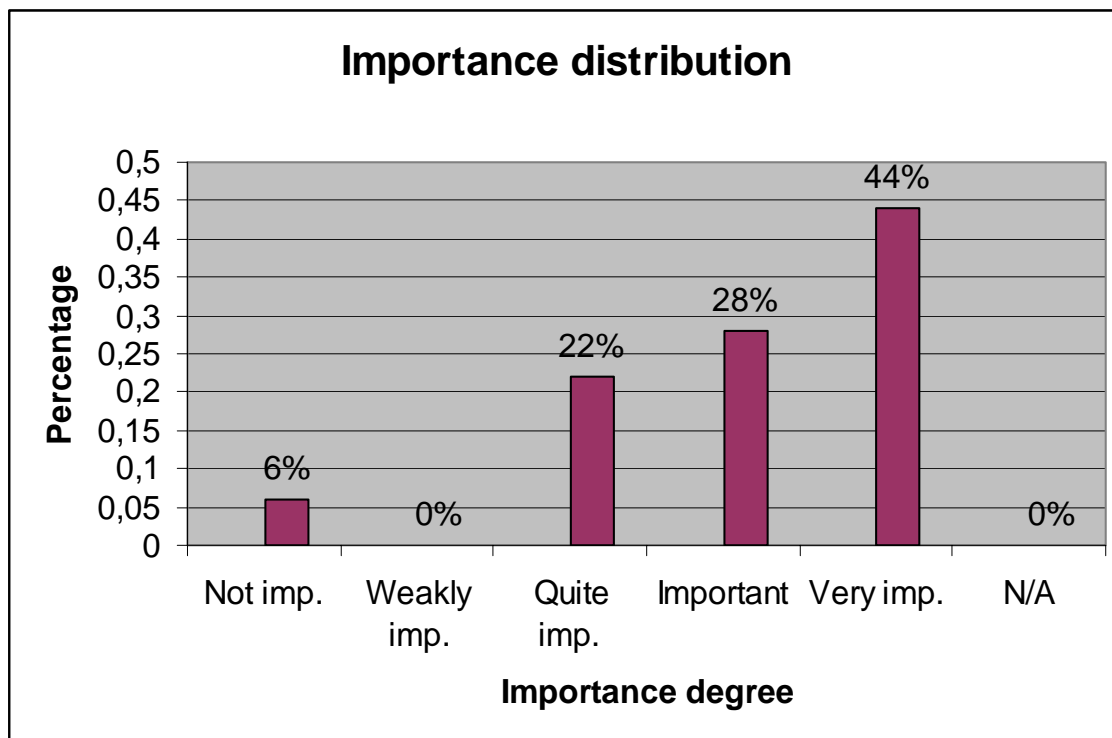
Based on the above analysis, 83% (very important + important) of the respondents believed that having a skilful team is a critical factor that affects the success of data warehouse technology. On the other hand, 6% of the respondents believed that the skills of project team factor is not a critical

factor. Therefore, It looks like the data strongly validates the seventh hypothesis (**The skills of project team effects greatly and positively the adoption of data warehouse technology**).

#### 5.6.2.2.8 Availability and Coordination of organizational resources

Availability of enough resources (people, money, and time) and allocating them correctly in a data warehouse project are necessary requirements.

The figure below shows the importance distribution of the availability and coordination of organizational resources factor. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.13**

As noticed, 44% of the respondents (8 responses) considered the availability and coordination of organizational resources factor as a very important factor. 28% of the respondents (5 responses) considered this factor as an important factor. 22% of the respondents (4 responses) considered this factor as a quite

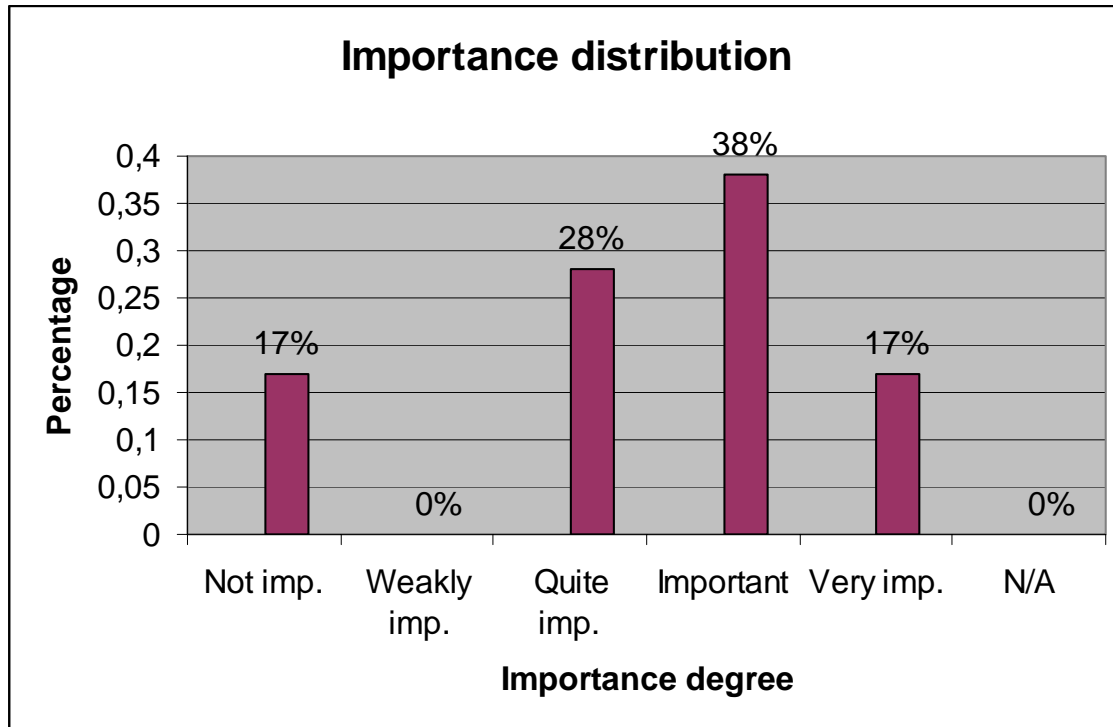
important factor. 6% of the respondents (1 response) considered this factor as a non-important factor.

Based on the above discussion, 72% (very important + important) of the respondents evaluated the availability and coordination of organizational resources factor as a necessary and critical factor. Alternatively, 6% of the respondents evaluated the availability and coordination of organizational resources is not important factor. Hence, it seems that the data is aligned with the eighth hypothesis (**The emergence and coordination of organizational resources affects the adoption of data warehouse technology positively in the Finnish companies**).

#### **5.6.2.2.9 Support from outside consultants**

The consultants, who possess much experience, are employed to provide ideas and lend a hand to the organizations that lack the experience to adopt, install and maintain a new information technology.

The figure below highlights the importance distribution of the support from outside consultants. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.14**

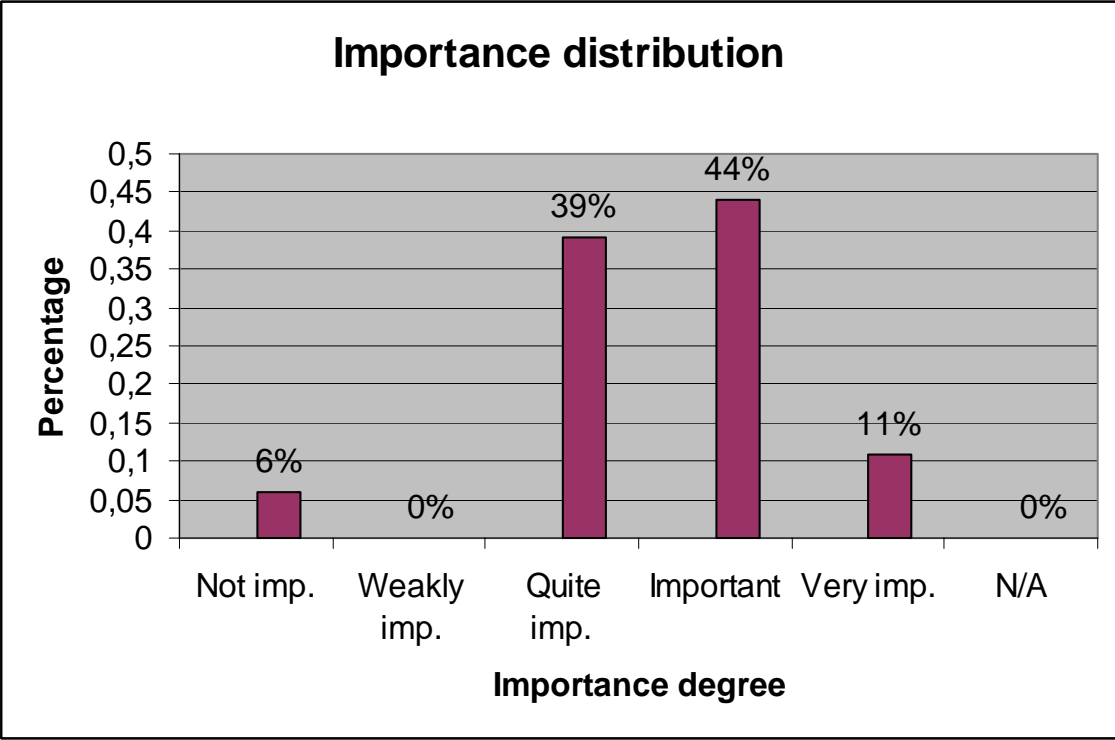
As indicated, 38% of the respondents ranked the support from an outside consultant factor as an important factor. 28% of the respondents ranked this factor as a quite important factor. 17% of the respondents ranked this factor as a very important factor. 17% of the respondents ranked this factor as a non-important factor.

Based on the above discussion, 55% (very important + important) of the respondents evaluated the support from outside factor as an essential factor influencing successful adoption of data warehouse. On the other side, 17% of the respondents assessed the support from outside consultants as a not important factor. Therefore, it looks like the data supports fairly the ninth hypothesis (**The support from outside information consultants and expertise influences greatly and positively the successful adoption of the data warehouse technology**).

#### **5.6.2.2.10 End-user involvement**

Better user participation increases the probability of managing users' expectations, reduces their resistance and satisfies user requirements.

The figure below highlights the importance distribution of the end-user involvement factor. The x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.15**

As shown by the above figure, 44% of the respondents believed that the user-involvement factor is an important factor. 39% of the respondents believed that this factor is a quite important factor. 11% of the respondents believed that this factor is a very important factor. 6% of the respondents believed that this factor is a non-important factor.

Based on the above analysis, 55% of the respondents assessed the user-involvement factor as a critical factor affecting the success of data warehouse technology. On the other hand, 6% of the respondents considered the user-involvement factor as a not critical factor. Consequently, the data endorses

fairly the last hypothesis (**The End-user involvement has a positive impact on the adoption of the data warehouse technology**).

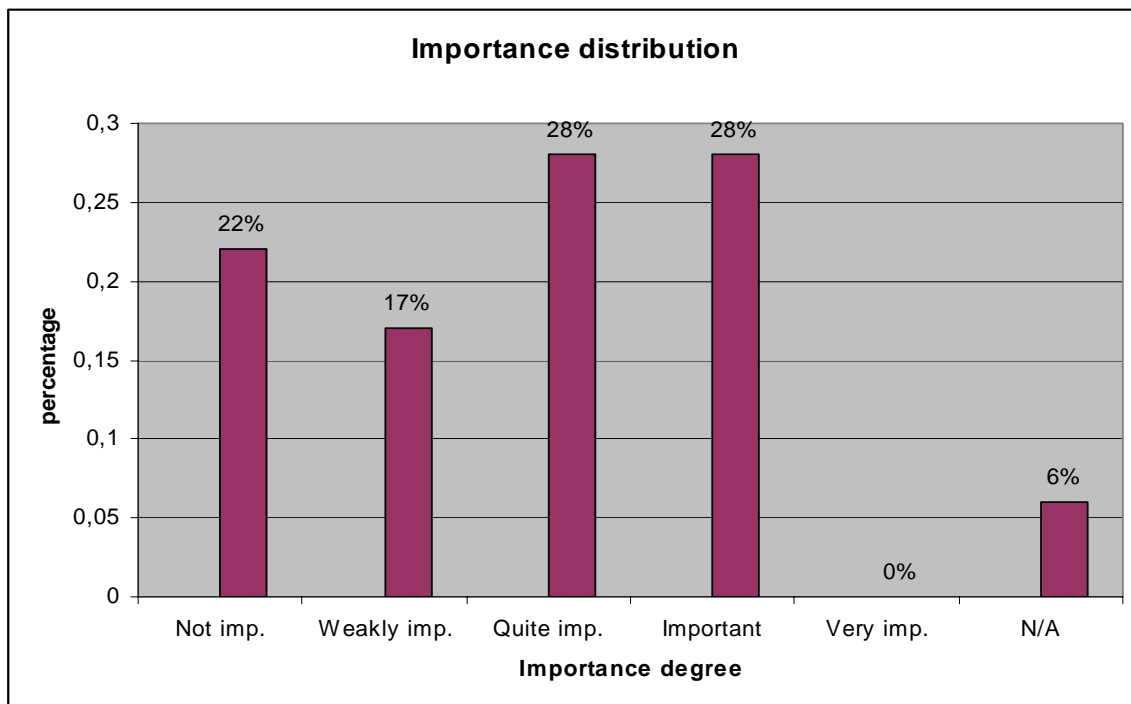
## 5.7 General analyses

Under this section advanced investigations are going to be held regarding the benefits gained from the installation of data warehouse technology in Finnish companies. Then the ranked list of critical success factors and the observations of current status related to data warehouse adoption are presented.

### 5.7.1 Product profitability

This part intends to discover the value added to the product due to data warehouse adoption.

In the figure below, the x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.16**

As noticed, 28% of the respondents (5 responses) considered that it is important to have a data warehouse for increasing the product profitability. 28% of the respondents (5 responses) were neutral in their opinion about the contribution of a data warehouse in product profitability by selecting the quite important alternative. 22% of the respondents (4 responses) realized that a data warehouse doesn't affect product profitability. 17% of the respondents (3 responses) realized that a data warehouse has a weakly important role in increasing the product profitability. 6% of the respondents (1 response) didn't have answer for this question.

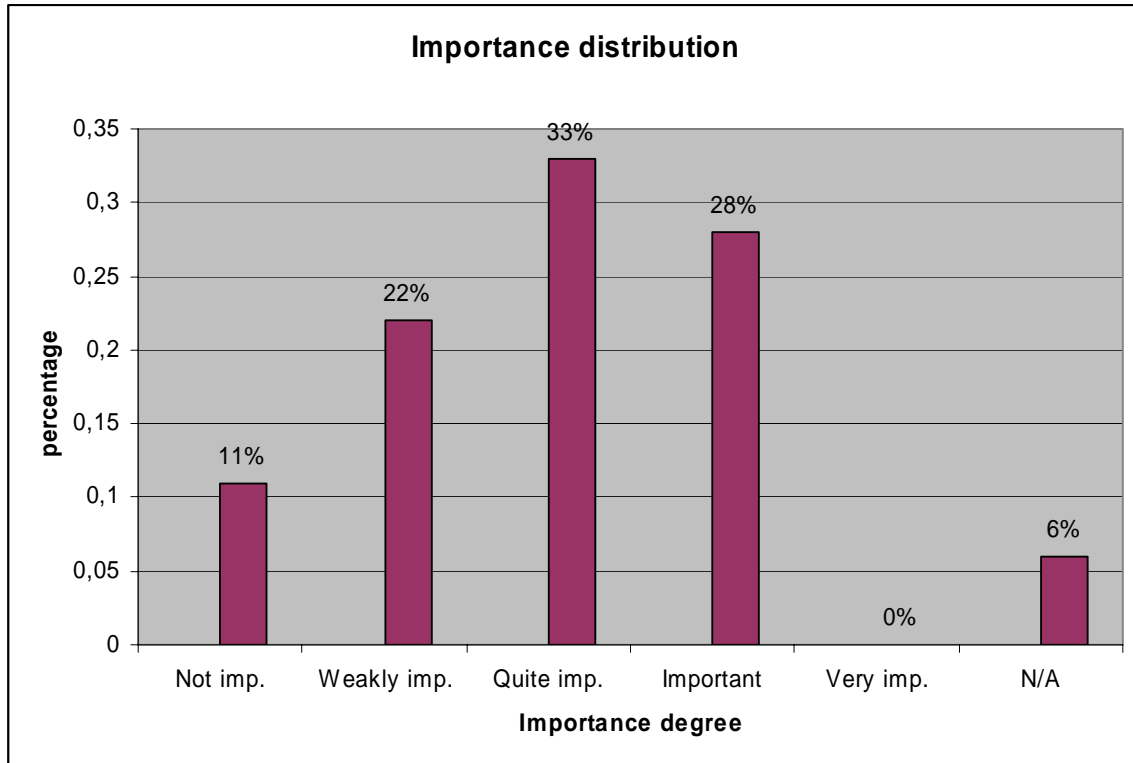
Based on the analysis, 39% (not important + weakly important) of the respondents believed that adapting a data warehouse doesn't enhance the product profitability. On the other hand, 28% of the responses believed that it is important to have a data warehouse to increase the product profitability. As a result, data warehouse technology is not an important element to increase the product profitability in Finnish companies.

### **5.7.2 Customer profitability**

This part collects the insights of the respondents about the effect of data warehouse technology on customer profitability.

Data warehouse technology (as a data repository stores, analyses and reports the needed information accurately and in-time) can affect largely the overall performance of the supply chain. This effect can be measured and noticed by increasing the availability and the accessibility of relevant and important data in real-time. This functions to reduce production cycle, lessen expenses, increase product quality and maximize the profit of overall supply chain members (suppliers and customers).

In the figure below, the x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.17**

As indicated by the figure, 33% of the respondents (6 responses) thought that it is quite important to install a data warehouse for increasing customer profitability. 28% of the respondents (5 responses) believed that a data warehouse is an important tool for increasing customer profitability. 22% of the respondents (4 responses) believed that it is weakly important to install a data warehouse for maximizing customer profitability. 11% of the respondents (2 responses) thought that there is no need for a data warehouse to increase customer profitability. 6% of the respondents (1 response) didn't have an answer.

Based on the discussion, 33% (weakly important + not important) of the respondents considered the existence of data warehouse applications not to be an important component in increasing customer profitability. Conversely, 28% of the respondents thought that having a data warehouse is an important aspect in increasing customer profitability.

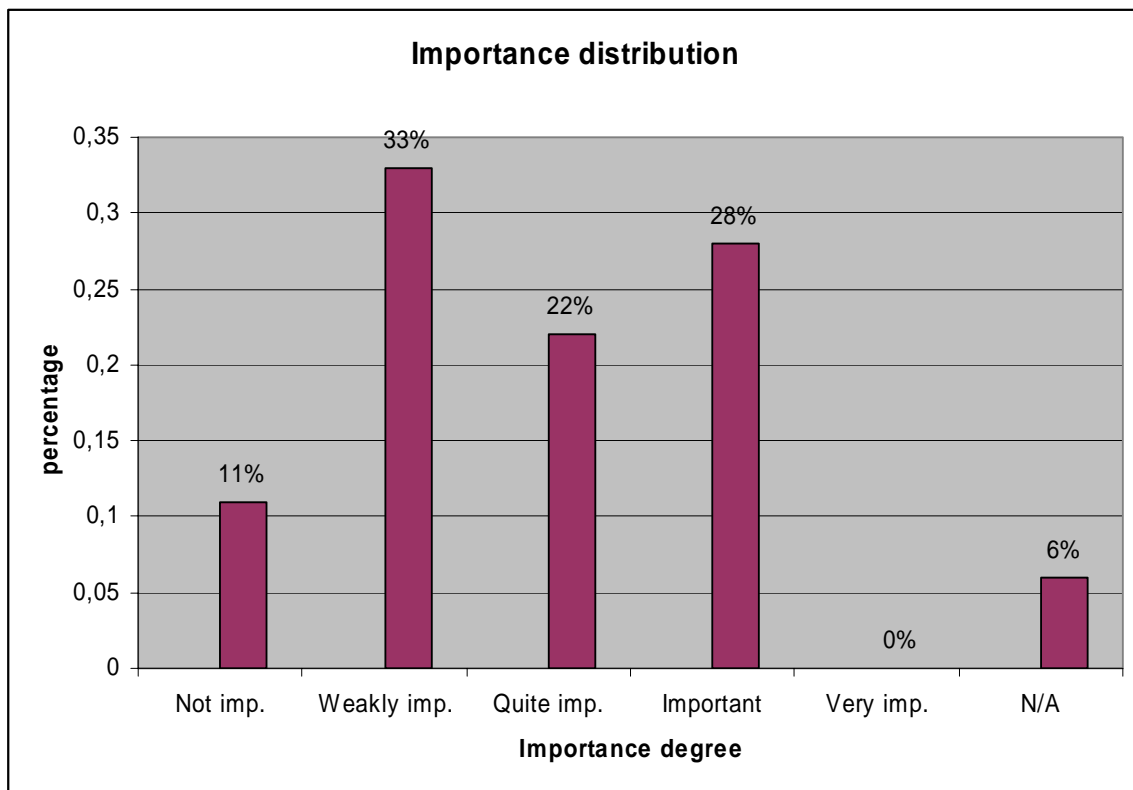
Thus, Data warehouse technology is not important to raise the customer profitability in Finnish companies.

### 5.7.3 Employee profitability

In this part, the effect of installing data warehouse on increasing the employee profitability is introduced.

These benefits can be measured through increasing the employees' willingness and satisfaction toward a data warehouse.

In the figure below, the x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.18**

As observed, 33% of the respondents (6 responses) deemed that a data warehouse is a weakly important tool for increasing employee profitability. 28% of the respondents (5 responses) deemed that a data warehouse is an important tool for increasing employee profitability. 22% of the respondents

(4 responses) ranked the existence of data warehouse as a quite important component. 11% of the respondents (2 responses) believed that there is no association between installing the data warehouse and increasing employee profitability. 6% of the respondents (1 response) didn't have answer.

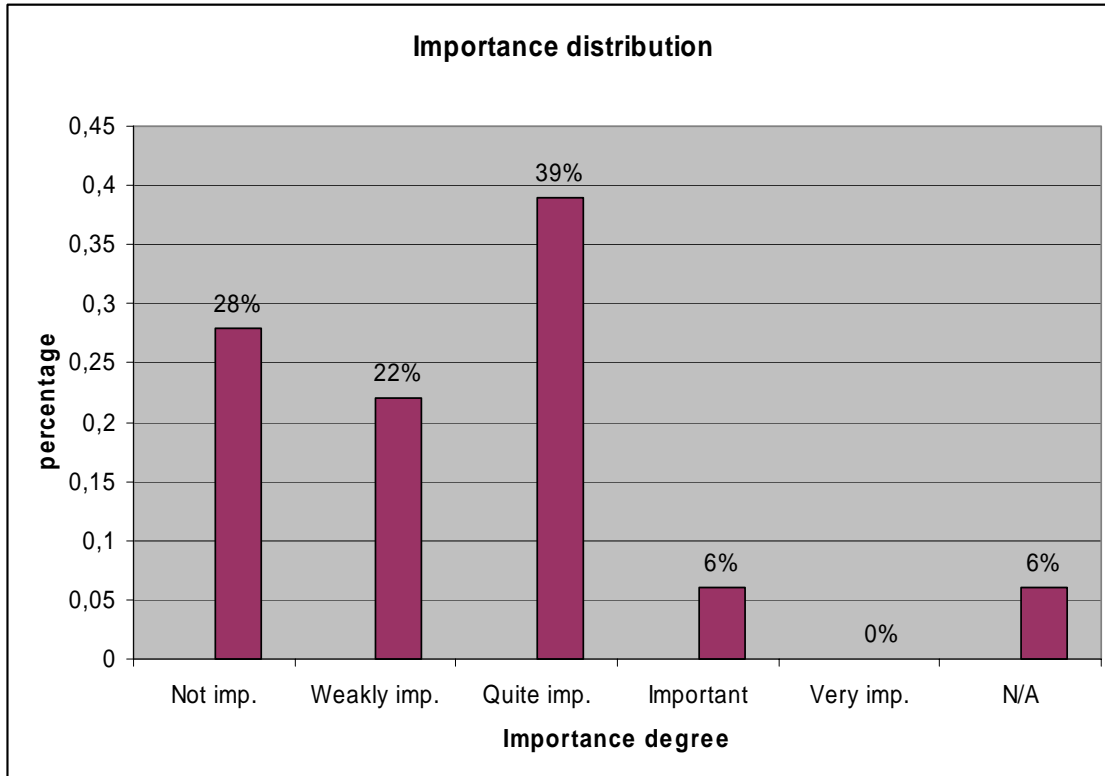
Based on the discussion, 44% (weakly important + not important) of the respondents believed that it is not important to have a data warehouse in order to boost employee profitability. On the other hand, 28% of the respondents thought that it is important to have a data warehouse to enhance employee profitability.

Therefore, having a data warehouse does not affect the employee profitability in Finnish companies.

#### **5.7.4 Branch profitability**

In this part, the following question is going to be answered: Does a data warehouse affect the branch profitability in terms of increasing the profits and reducing the expenses if a branch of a complex organization has adopted this technology?

In the figure, the x axis represents the importance degree and the y axis represents the percentage



**Figure 5.19**

As noticed, 39% of the respondents (7 responses) assessed the contribution of data warehouse technology in increasing the branch profitability as a quite important element. 28% of the respondents (5 responses) believed that there is no need for a data warehouse to increase the branch profitability. 22% of the respondents (4 responses) assessed the data warehouse technology as a weakly important tool for increasing the branch profitability. 6% of the respondents (1 response) agreed that data warehouse technology is an important tool for increasing the branch profitability. 6% of the respondents (1 response) didn't have answer.

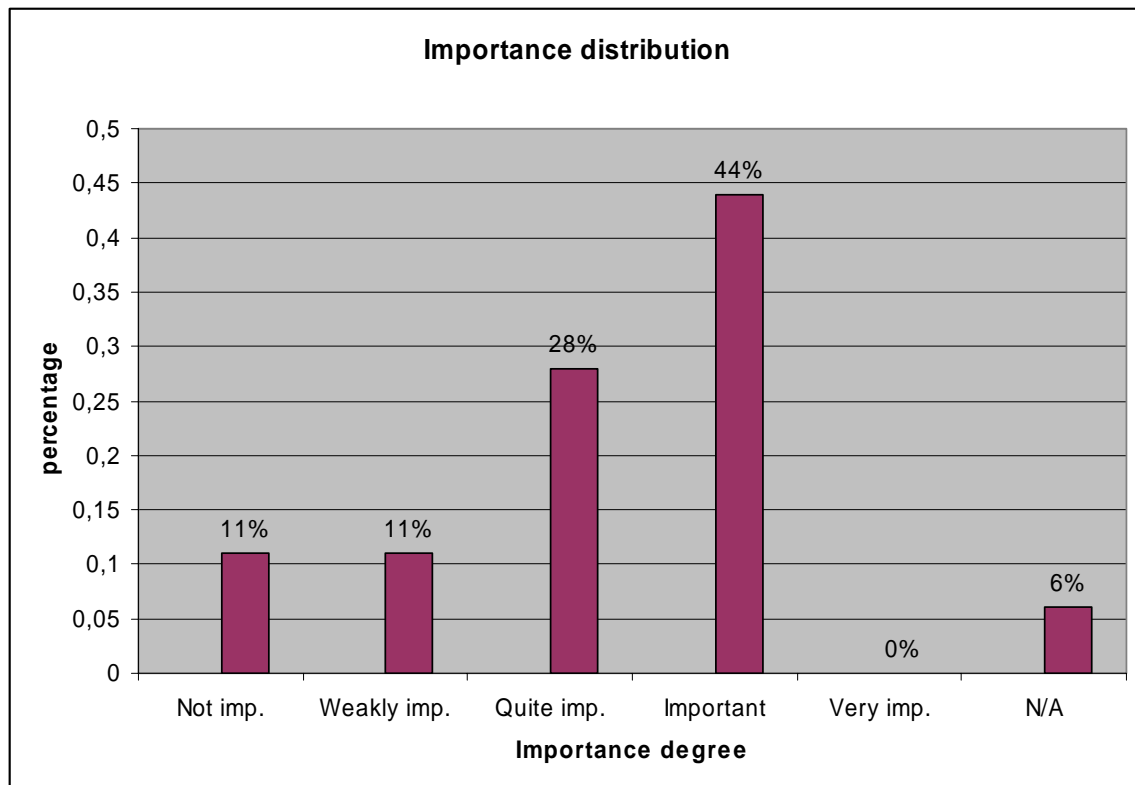
As indicated in the figure, 50% (weakly important + not important) of the respondents agreed that having data warehouse applications doesn't raise the branch profitability. On the other side, 6% of the respondents thought that it is important to have a data warehouse to increase the branch profitability.

Therefore, owning a data warehouse doesn't increase the branch profitability of a complex Finnish company.

### 5.7.5 Productivity

Productivity is a measure of efficiency and is usually considered as output per person-hour, or the amount of output per unit of input (labor, equipment, and capital) used in accomplishing the assigned task. It is measured as a ratio of output per unit of input over time.

In the figure below, the x axis represents the importance degree and the y axis represents the percentage



**Figure 5.20**

As highlighted by the figure, 44% of the respondents (8 responses) evaluated a data warehouse as an important technique to maximize the productivity. 28% of the respondents (5 responses) evaluated a data warehouse as a quite important factor to maximize the productivity. 11% of the respondents (2

responses) believed that the productivity is not affected positively by the installation of data warehouse technology. 11% of the respondents (2 responses) evaluated the data warehouse as a weakly important technique to increase the productivity. 6% of the respondents (1 response) didn't have an answer.

As observed, 44% of the respondents agreed that possessing a data warehouse is important to increase the productivity. Where as 22% (not important + weakly important) of the respondents believed that data warehouses don't affect the productivity.

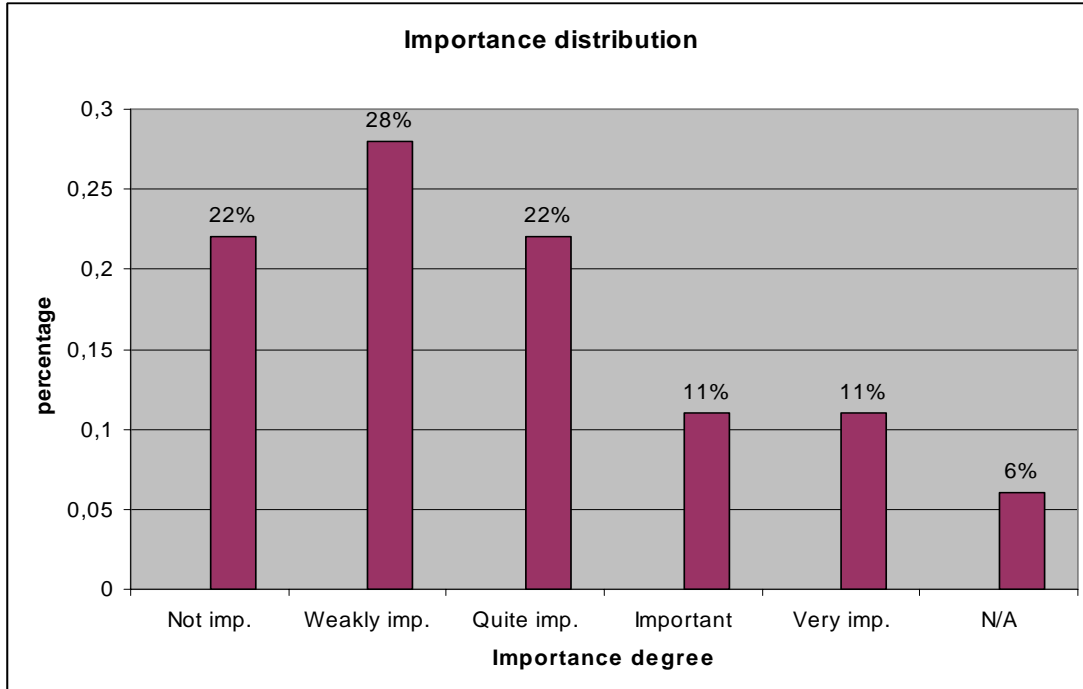
Therefore, data warehouse technology is a critical aspect to increase the productivity in Finnish companies.

#### **5.7.6 Customer satisfaction**

This part aims to discover the value added to the customer satisfaction due to adopting a data warehouse technology.

The customer satisfaction can be quantified by increasing the loyalty of the customers and their willingness to keep a relationship with the company.

In the figure below, the x axis represents the importance degree and the y axis represents the percentage.



**Figure 5.21**

Based on the above figure, 28% of the respondents (5 responses) evaluated a data warehouse as a weakly important tool to increase customer satisfaction. 22% of the respondents (4 responses) believed that the existence of a data warehouse doesn't affect customer satisfaction. 22% of the respondents (4 responses) assessed data warehouse technology as a quite important tool. 11% of the respondents (2 responses) assessed a data warehouse as an important tool. 11% of the respondents (2 responses) assessed a data warehouse as a very important element in customer satisfaction. 6% of the respondents (1 response) didn't have answer.

As noticed, 50% (weakly important + not important) of the respondents looked at the data warehouse technology as not an important element in increasing customer satisfaction. Where as 22% (very important + important) of the respondents looked to data warehouse as an important element in increasing customer satisfaction.

As a result, a data warehouse does not effect customer satisfaction in Finnish companies.

### 5.7.7 List of critical success factors and discussion of observations:

The Table below introduces the ranked list of critical success factors, which is rated by the respondents in the investigated companies. The factors were rated based on the respondents' estimations as to what extent these factors influence the adoption of data warehouse technology. The rankings of factors were made based on the ratings in the important column. The rankings start with the factor that has the highest rating and end with the one that has the lowest rating in the important column.

The ratings in the important column were the results of the addition of the very important rating and the important rating for each factor. If two factors have the same rating in the important column, then the criteria used to select the higher one is which of the two has the greater very important rating. For more clarity in this regard see key words and explanations below the table.

Factor	Important	Quite important	Not Important	N/A
Top management	83%	11%	6%	0%
Champions	83%	6%	11%	0%
Skilful project team	83%	11%	6%	0%
Availability of resources	72%	22%	6%	0%
Business internal needs	61%	22%	11%	6%
Outside consultants	55%	28%	17%	0%
End-user involvement	55%	39%	6%	0%
Selection of vendors	50%	38%	12%	0%
Compatibility with partners	12%	22%	67%	0%
Business competition	11%	33%	56%	0%

**Table 5.4**

**Key words:**      **Important = Very important + Important**

**Not important = Weakly important + Not important**

**Explanation:**

As noticed, Top management support, Existence of champion and skills of project team have similar ratings, which is the highest rating, but top management was ranked as first among the investigated critical factors.

The main reason is that the Top management support factor has the highest, very important rating (44%).

Support from an outside consultant and end-user involvement have the same rating as well, but support from an outside consultant was ranked higher than the End-user involvement factor.

The reason is that the Support from an outside consultant factor has higher, very important, rating (17%) than the End-user involvement factor.

This table summarizes the findings and results from the second section of the questionnaire.

#### **5.7.7.1 Discussion about the Findings in the organizational dimension**

The findings in this study are in line with the findings from preceding empirical research in regard of Top management support. Top management sponsorship was cited as a key factor affecting the adoption of new technology in many research projects, theoretical (Nah et al. 2001), (Bingi et al. 1999), (Mukherjee and D'Souza, 2003) and empirical ones (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002), (Mabert et al. 2001), (Akkermans and Helden, 2002), (Umble et al. 2003), (Parr and Shanks, 2000).

This study believes that greater top management support will lead to more resources and capital (money, time, and labor) to adopt data warehouse technology. As a result, the support from top management will be a strong sign that the adoption of data warehouse technology will go smoothly.

The lack of this significant factor will lead to loss of the assistance needed to obtain the required resources, and thus negatively effect the adoption of data warehouse applications.

Based on the results from the questionnaire, the top management support factor was ranked as the most critical factor among the key factors investigated in the thesis.

Champions are people from inside the organization, who appreciate the contribution of new technology and convince the staff and even their superiors to adopt new technology. Consequently, the existence of champions should greatly effect the adoption of new technology as cited by former, related research, empirical (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002), (Akkermans and Helden, 2002), (Parr and Shanks, 2000) and theoretical ones (Nah et al. 2001).

The existence of champions factor was ranked as the second most important factor, which influences the adoption of data warehouse technology in Finnish companies. Hence, the results of this study validate the belief in the great contribution of this factor as has prior research.

As indicated by the earlier studies, internal needs stimulate organizations to find good solutions. A data warehouse is the best solution for companies, which strive to have enough relevant, easy-to-access, reliable and real-time data around the clock, stored in one place. This data repository would have a large positive effect on the analysis process, which leads to better decision making initiatives, as cited in the prior research papers, both empirical (Mukherjee and D'Souza, 2003; Joshi and Curtis, 1999) and theoretical (Hwang et al., 2004; Watson et al. 2002).

The internal needs factor was ranked in the fifth among the factors, which affect the adoption of the data warehouse in the Finnish companies. Therefore, the result from this study is aligned with the previous studies.

#### **5.7.7.2 Discussion about the findings in the environmental dimension**

An enterprise cannot longer maintain its competitive advantage and not be a star performer in its industry without responding effectively and efficiently to

the myriad challenges of the market. One technique could be adapting powerful information technologies. Theoretically, if you as a company face severe competition in the market you must react quickly to maintain your market share. Otherwise, you will lose your seat among the market leaders. Therefore, if the competitors have installed powerful technologies to increase their market share you must adopt at least the same level of information technology, especially in the keen competition and highly computerized advancement of today's markets.

In this study, the findings indicated that the degree of business competition factor does not affect the adoption of data warehouse technology in Finnish markets, not as found in prior research papers (Hwang et al. 2004).

The reasons would be that data warehouse technology is not widely used by Finnish companies, due to its expensive and risky nature. In addition, the obtainable benefits from using it are intangible benefits (not easily quantified) or need some time to be realized. For these reasons, the companies can not easily recognize the benefits from using this technology in the short-run.

Good selection of vendors has a positive impact on the process of adopting data warehouse technology. Vendors provide the company with products, expertise, and required technological abilities to facilitate the adoption process.

The vendors can not do the work without the assistance of internal expertise. Thus, integration must be established between the outside expertise represented by the implementation partner and the in-house expertise represented by functional employees.

In this study, the selection of vendors has a fair impact on the adoption of data warehouse technology in Finnish companies. This study agrees with prior studies, both theoretical (Bingi et al. 1999) and empirical (Hwang et al. 2004; and Harris, 1997; Akkermans and Helden, 2002), which approved the contribution of this factor in the adoption of new technology.

Compatibility with partners has not been discussed by prior researchers as a key factor in the adoption of data warehouse technology. On the other hand, this factor can no longer be ignored and must be considered seriously. In our highly competitive market the company incorporates with a group of upstream and down stream partners. To earn an advantage from such a relation, it is a must to create a common harmony among the supply chain members in systems, operations, sharing applications and information and so on, to maximize the overall performance of the supply chain.

The results from this study revealed that compatibility with partners doesn't have an effect in the process of data warehouse adoption in Finnish companies.

The reason might be the lack of coherent understanding about the great contribution of data warehouse technology, as a tool for storage, multi-dimensional analyses and reporting internally and externally generated data in SC matters. By deploying compatible data warehouse among the SC members, the data can be reached more easily by the partners. In other words, if the data warehouse system in a focal company is not compatible with the system adapted by direct partners, then the data flow between the two companies will be influenced negatively. For more clarity read the following example: if a focal company has adapted a Datuim DW solution and the direct partner uses SAP as an ERP solution, then it might happen that both systems do not integrate and talk to each other easily. As a result, the flow of information would be greatly affected in negative way, which decreases the performance of overall SC.

### **5.7.7.3 Discussion about the Findings in the project-related dimension**

Many prior research papers, both theoretical (Nah et al., 2001; Bingi et al., 1999) and empirical (Wixom and Watson, 2001; Watson et al., 2002; Hwang et al., 2004; Mabert et al., 2001; Hurley and Harris, 1997; Akkermans and Helden, 2002; Umbel et al., 2003; Parr and Shanks, 2000), have indicated the

major contribution of the existence of a skillful project team factor in adopting data warehouse technology.

In this study, the results indicated that the skills of project team factor has a great and positive impact in the adoption of data warehouse projects in Finnish companies. This factor was ranked as the third most important factor among the investigated factors.

As known, data warehouse projects are time-consuming, expensive and risky projects. Therefore, the availability of sufficient resources may reduce the obstacles during the implementation of data warehouse projects and facilitate the adoption process, as cited in the earlier research, both theoretical (Bingi et al., 1999) and empirical (Wixom and Watson, 2001; Hwang et al., 2004; Akkermans and Helden, 2002).

The empirical results supported the belief constructed by prior research. The availability of enough resources was ranked as fourth among the investigated factor in the thesis.

The user involvement in data warehouse project has a great impact in terms of defining the actual needs and expectations of the project. Also the project manager can use their knowledge and expertise according to their functional areas. Since the users are the people who will interact with new system and use the data, they can draw clear pictures about their expectations regarding required data. Identifying needed data can be done by defining its characteristics, meanings, usefulness and relationship with other data, as discussed by the previous research, both theoretical (Bingi et al., 1999; Mukherjee and D'Souza, 2003; Solomon, 2005) and empirical (Wixom and Watson, 2001), (Hwang et al. 2004), (Watson et al. 2002).

In this study, the results indicated that the user involvement has a good impact in the process of adopting data warehouse technology in Finnish companies. This factor was ranked seventh among all the investigated factors.

Prior research papers highlighted the importance of outside consultants' participation in new technology projects. The company can use the consultants' knowledge and expertise to smooth the implementation process and reduce unnecessary barriers, as mentioned in the empirical (Hwang et al. 2004), (Mabert et al. 2001), (Akkermans and Helden, 2002) and theoretical research (Mukherjee and D'Souza, 2003), (Bingi et al. 1999), (Parr and Shanks, 2000).

This study has concluded that the existence of outside consultants has a good impact on the adoption of data warehouse technology in Finnish companies. This factor was ranked sixth among all the investigated factors.

#### **5.7.7.4 Findings and observations of the current status related to the adoption of the data warehouse technology:**

In this part of the analysis, the companies are further investigated utilizing the data gained from the first part of the questionnaire (which is general data about the respondents and their companies). The cross-tab tables are used to study and deeply analyze these data. This part builds increased knowledge toward the current status related to the adoption of data warehouse technology in Finnish companies.

The discussion below presents the observations and related explanations concerning the current status of data warehouse technology in the sample.

##### **Observation 1:**

**The more matured data warehouse technologies are possessed between the four-walls of larger companies in the Finnish market.**

The table below indicates the data of the last year's turnover and the year of installing data warehouse technology.

Last-year turnover	Year of installation								
	1991	1999	2000	2001	2002	2003	2004	2005	Cont.
250000000€-1000000000€								1	
100000000€-5000000000€		1	2	1	2		2		
500000000€-10000000000€				3					1
More than 1000000000€	1	1				1	2		

**Table 5.5**

Moving from top to bottom through the table, the experience in data warehouse aspects is rising. The logical reason is that the larger companies are the more competent to adapt expensive technology before the others due to the availability of sufficient resources and capacities.

As noticed in the third and fourth classifications, the year of installation seems to be a bit confusing. The companies, which installed their data warehouses in 2003 and 2004 and have continuous development of data warehousing under the fourth and third classifications respectively had previous data warehouse systems before the current ones. These companies moved to the systems, which are better suited to their needs. This observation is based on respondents' answers to the question number 7 in the questionnaire, which explores the reason of changing the previous data warehouse. After reviewing the current suppliers of the aforementioned companies, 3 out of 4 have installed SAP data warehousing solutions and the last one has installed a mix of data warehousing solutions (their data warehouse was assembled from different suppliers).

As a result, the larger companies in the Finnish market have more experience in data warehousing and most likely have changed their data warehouse solutions to better ones.

**Observation 2:**

The larger companies in the Finnish market have adopted their data warehousing solutions from the biggest IT-solution providers for companies, such as (SAP, Oracle, PeopleSoft ...)

Last-year turnover	Vendor's name						
	self made	E-big	Cognos	Datium	Oracle	SAP	mix
250000000€- 1000000000€	1						
1000000000€- 5000000000€		1	2	1	3	1	
5000000000€- 10000000000€					1	3	
More than 10000000000€						3	2

**Table 5.6**

As observed from the table, the larger companies in the sample have installed SAP data warehousing solutions (which are considered the biggest software provider for companies around the globe). The possible reasons, for this high demand, are the wide range of functionalities and adoption of the so-called, “best practices,” of doing the core work of data warehousing, provided by SAP data warehouse solutions (Hashmi, 2000). In the fourth classification two companies have installed their data warehouse technology from different IT providers. On one hand, this technique is better for companies to meet their needs and requirements. On the other hand, this technique demands many resources and much experience to interface the different software with one another and to apply the future modifications (next versions) to them.

The results from the above discussion can be summarized into three points:

- Larger Finnish companies intend to adopt their data warehouse from the most dominant IT-solution providers in the globe (SAP or Oracle) or adopt mixed data warehouse solutions.
- Adopting data warehouse technology from those two sources is more expensive than adopting it from other sources (less dominant IT-solution providers).

- The reason behind the high pricing of a data warehouse supplied from those two sources is the extra functionality provided by those data warehouses.

Therefore, we can conclude that larger companies are more willing to spend additional resources on acquiring their data warehouse technologies.

**Observation 3:**

**Larger companies in the Finnish markets intend to build their data warehouse applications in phases.**

The table below illustrates the sizes of the companies measured by the last year’s revenue and the data warehouse types.

Last-year turnover	Data warehouse types	
	Department-wide	Enterprise-wide
25000000€- 100000000€		1
100000000€- 500000000€	2	6
500000000€- 1000000000€		4
More than 1000000000€	2	3

**Table 5.7**

As mentioned in section 5.6.1.1.7 regarding the data warehouse types, 78% of the sample installed enterprise-wide data warehouses. Based on analyzing the above table, 40% of the companies who had more than 1000000000€ in revenue as of last year installed department-wide data warehouses.

After reviewing the year of installation and name of the data warehouse vendor for those two companies, the results revealed that those companies have installed SAP and mix of data warehousing applications in 2004 after changing their previous data warehouse technology. It seems that those companies intended to implement the phased approach of data warehouse implementation by adapting department-wide data warehousing. Through implementing the phased approach, the larger adopters can gain better

experience for further data warehousing implementation (enterprise-level). In addition to overcoming the high probability of failure in the implementation that may appear by utilizing the big bang technique (implementing the system all at once).

It is better to adopt the phased approach with expensive systems, especially if the adopters are large-sized companies where the costs of adoption is double or triple the costs paid by the other ones(O’Leary, 2000).

**Observation 4:**

**The larger companies in the Finnish market consider the data warehouse project as a complex project.**

Last-year turnover	Degree of complexity				
	Not complex	Weakly complex	Quite complex	Complex	Very complex
250000000€- 1000000000€			1		
1000000000€- 5000000000€		1	3	3	1
5000000000€- 10000000000€				2	2
More than 10000000000€				3	2

**Table 5.8**

Moving from top to bottom through the table, the complexity of data warehouse project is growing. For the reasons that follow, the complexity of data warehouses in larger companies was evaluated highly:

- Realizing larger set-up and ongoing costs to get the job done
- The need for a longer implementation period to install the system
- Involving a larger workforce to complete the system.

**5.8 Summary of the chapter**

In this chapter, research objectives, research model, hypotheses, data collection methods and techniques, data analysis and observations from the research were cited and discussed.

The response rate was 8%. The data collected through the questionnaire from 18 companies in Finland was analyzed through descriptive statistics and analytical tables.

The ranked-list of critical success factors was presented. The results from the aforementioned list revealed that factors such as top management sponsorship, champions, skillful project team, availability and coordination of resources, business internal needs, the existence of outside consultants, end-user involvement, and selection of vendors would affect the adoption of data warehouse technology in Finnish companies.

Finally, the observations of the current status related to the adoption of data warehouse technology were carried out and discussed.

## **6. Conclusion**

### **6.1 Objective and structure**

This chapter aims to outline the conclusions of this study, and the implications for further research.

Section 6.2 presents the general conclusions of the thesis. In section 6.3 the validity, reliability and generalizability of this study are indicated and described. Finally, section 6.4 introduces the possible propositions for future research on data warehouses.

### **6.2 General Conclusions**

This section is divided into three parts:

#### **6.2.1 Conclusions about the critical success factors of data warehousing in Finnish companies**

Data warehouse technology is a powerful tool to overcome data-related obstacles and enhance decision making initiatives in our highly globalized and competitive market.

A data warehouse solution is not only a software package. It is a complex process to establish sophisticated and integrated information systems. The adoption of this technology requires massive capital expenditure, utilizes a certain deal of implementation time and has a very high likelihood of failure. Therefore, many adoption-related factors must be carefully assessed before the real adoption is actualized.

The results from this study revealed that all organizational and project-related factors, and one factor under the environmental dimension (vendor selection) are important considerations for Finnish organizations.

Specifically, these factors include top management sponsorship, existence of champions, a skillful project team, availability of resources, company internal needs, support from outside consultants, end-user involvement, and vendor selection.

The results revealed, as well, that these factors influence the success of data warehousing in pre-implementation and implementation phases.

No wonder that the Top management sponsorship got the highest percentage among all the investigated factors. If the high-level management supports the adoption of data warehouse, then needed resources will be obtained.

The existence of a champion is considered one of the most important factors effecting the adoption of data warehouse technology. Champions play a vital task in persuading the staff to see their own personal visions to adopt new technology and secure required capital and information.

Having a proficient project team may effect largely the smooth progression of the data warehouse adoption project.

Data warehouse technology is an expensive and risky undertaking. Therefore securing required resources is important to continue this project and make the new technology come to life.

This study believes that the internal needs of a company have a great influence on the decision to adopt data warehouse technology or not.

With outside consultants the company can go on easily in the project and meet its expectations. Companies hire the consultants, who are knowledgeable about new technology, to overcome the lack of knowledge about new technology amongst the in-house staff.

Involving the end-users in the data warehouse project has an endless impact on promoting the vision of adopting this technology. Understanding users' needs and expectations and trying to meet them lead to reduced resistance and increased acceptance of the new technology.

This study believes that the company cannot accept and rely fully on the suggestions and plans given by the vendors. Therefore, careful consideration must be paid when selecting a data warehouse supplier (implementation partner).

The data has supported the first eight factors as critical success issues to be considered by high-level managers when adopting a data warehouse technology in Finnish companies.

Compatibility with partners' information systems and the degree of business competition were considered as non-key issues that influence the adoption of data warehouse technology in Finnish adopters.

### **6.2.2 Conclusions about the benefits obtained from installing data warehouse applications**

Theoretically, any organization that adapts and sustains a data warehouse correctly will realize payoffs.

Hard benefits can be achieved through cost savings, increased revenue and raised quality of marketing analysis.

Soft benefits can be measured by the technology's effect on the user. By securing faster access to more accurate and reliable data the user can better serve their clients.

Empirically, the results from practical research have indicated that data warehouse technology is an important element to boost the productivity value in Finnish adopters.

On the other hand, values such as product profitability, customer profitability, employee profitability, branch profitability, and customer satisfaction wouldn't be affected by adapting data warehouse technology in Finnish companies.

### **6.2.3 Conclusions about the current status related to the adoption of data warehouse technology**

Based on performing a cross-tab analysis on the data gathered from the first part of the questionnaire, the following conclusions can be highlighted in regard of the current status of data warehouse technology in the investigated companies.

1. Larger companies in the Finnish market possess mature data warehouse technology because they are capable of adopting this technology before others.
2. The larger Finnish companies adopted their data warehouse solutions from the biggest IT-solution provider (SAP) or adapted a mixed solution of data warehousing from different data warehouse providers.  
The data warehouse supplied from those two sources is more expensive than the data warehouse supplied from other sources (from other data warehouse solution providers).
3. The larger Finnish companies intend to build their data warehouse technology utilizing the phased approach. The reasons might be to reduce the probability of failure in the implementation and increase their expertise for advanced data warehouse implementation.
4. The larger Finnish companies consider a data warehouse project to be a very complex project.

### **6.3 Validity, reliability and generalizability**

The research instrument in this study is a questionnaire sent to 220 companies in Finland. This instrument was assessed for its reliability, validity as well as generalizability.

The response rate was about 8% (18 responses). As known, a larger response rate is associated with a stronger validity in research. This rate was normal, based on the reasons cited in the section 5.6.1. This should not significantly affect the research findings, especially for the convenience of explanation and testing proposed hypotheses.

In terms of validity and reliability of the research instrument, a three-round process of revision was formulated.

The questionnaire was checked by my supervisor Mr. Anders Tallberg to review each question and make necessary modifications. Then, the questionnaire was sent and further reviewed by a panel of PHD students. Finally, the questionnaire got the approval from Mr. Anders Tallberg after his second assessment and review.

As for the generalizability of the study, although this study reports good empirical data on critical success factors influencing the adoption of data warehouses for Finnish companies, the results are seemed to be difficult to be generalized. One logical reason is that, it is difficult to statistically test the significance of the hypotheses with 18 responses in hand. Therefore, the results and conclusions from this study can not be generalized for the entire population.

### **6.4 Implications for further research**

This study provides a good insight concerning the investigation of factors effecting the adoption of data warehouse technology in Finnish companies. The next and normal step will be to introduce the key issues, which effect

effective and efficient stability of data warehouse technology in adopters. In addition to knowing the best ways to integrate this emerging technology with other technologies such as ERP systems, SCM systems, CRM systems, in order to heighten the overall performance of companies and maximize profit.

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## Appendix

### Questionnaire

#### **Objectives and Definitions:**

The objective of this questionnaire is to build a comprehensive understanding of the critical success factors, which influence the data warehouse technology in Finnish companies.

**Data warehouse** is a huge data repository or database which collects data from different data sources and then accumulates, and stores them in one place for further analysis, prediction and decision making initiatives.

**Enterprise-wide data warehouse:** The data in this type of data warehouse is enterprise-level data (example, the amount of sales for the overall organization) and collected from different data sources across the enterprise.

**Department-level data warehouse:** The data is department-level data (example, the amount of sales for the entire department) and collected from different data sources across the department

#### **Section 1: Company-related questions:**

1. Title of post of the respondent:
2. Company size (number of employees):
3. Last year revenue:
4. The type of industry in which the company incorporates:
5. When was the data warehouse installed?
6. Name of the vendor of your current data warehouse system:
7. Was there any previous system installed? Why have you changed it?
8. What type of data warehouse do you have? (Enterprise-wide or department-level data warehouse)

9. In terms of complexity, can you define how complex is the data warehouse implementation project? (very complex, complex, quite complex, weakly complex, not complex, N/A)

**Section 2: Subject-related questions:**

**Please indicate how important you think the following factors were for the successful implementation of the data warehouse in your company:**

**1- Not important. 2- Weakly Important. 3- Quite important. 4- Important. 5- Very important. N/A**

1. Champions (people inside the organization who drive and advocate the adoption of the new technology). 1.2.3.4.5.N/A
2. Top management sponsorship (support and approval of the data warehouse project from the top management of the company). 1.2.3.4.5.N/A
3. Business internal needs (that the data warehouse fills a perceived need for improvement of business operations). 1.2.3.4.5.N/A
4. Vendors (the suppliers of the required software, hardware, perhaps also the implementation team and the plans for the data warehouse project). 1.2.3.4.5.N/A
5. End-users involvement (the participation of the end users in the data warehouse project). 1.2.3.4.5.N/A
6. Consultants (experts in data warehouse technology from outside the organization). 1.2.3.4.5.N/A
7. The business competition affects the data warehouse adoption especially if the competitors are adopting or have adopted this technology? 1.2.3.4.5.N/A

8. The company interacts with a group of partners (suppliers and customers). Does the compatibility with the partners systems affect the selection and successful adoption of the data warehouse technology? 1.2.3.4.5.N/A
9. The diversity of skills and the background of the project team influence the successful adoption of the data warehouse technology. 1.2.3.4.5.N/A
10. The resources available (money, time, and people), coupled with efficient cooperation and use, have a critical impact on the data warehouse adoption? 1.2.3.4.5.N/A
11. According to your observations, the data warehouse technology has led to changes in:
- Product profitability 1.2.3.4.5.N/A
  - Customer profitability 1.2.3.4.5.N/A
  - Employee profitability 1.2.3.4.5.N/A
  - Branch profitability 1.2.3.4.5.N/A
  - Productivity (Efficiency in the business process i.e. less effort and money consumed) 1.2.3.4.5.N/A
  - Customer satisfaction 1.2.3.4.5.N/A

**Thank you for your time! Your participation is greatly appreciated.**