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The Data Warehouse Industry

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THE DATA WAREHOUSE

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INDUSTRY

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ABSTRACT

Estimates of the size of the data warehouse industry in the public literature vary over a broad range. Estimates are typically point estimates, giving either the current or future size of the industry. This paper examines this industry, in terms of such factors as its total size over time, the components of cost, and the principal vendors and their products. It also discusses anticipated benefits, reasons for the occurrence of failures, and the skills required by practitioners.

The data are obtained from a variety of public sources. These sources are often contradictory or use different assumptions. Thus, the values given here are approximations. We believe, however, that they are sufficiently close to actual values to be useful in gaining an over-all understanding of the industry.

Keywords: Data warehousing, industry estimates, warehouse vendors, warehouse costs, warehouse success and failure.

Introduction

Data warehousing is a major industry. Large sums are being spent by many organizations both internally for labor and externally with vendors. The vendors are prepared to sell full data warehouses (including hardware, software, and training), packaged data marts, cleansing software, security systems, and more. The industry evolved to its present stage as three major applications were being adopted:

- OLAP (on-line analytic processing);
- database marketing;
- data mining.

The industry itself is a phenomenon of the 1990's, although many of the products have histories that go back to previous decades.

The purpose of this paper is to examine this industry, in terms of such factors as the total size of industry over time, the components of cost, the principal vendors and their products, and skills required by practitioners.

The numbers are obtained from a variety of public sources. The sources are often contradictory and the assumptions used are not defined well in the source documents. Thus, the values given here are approximations. We believe, however, that they are sufficiently close to actual values to be useful in gaining an over-all understanding of the industry.

Size of the Industry

Data about total size of the industry is highly variable. Sources differ on what they include in their totals, often not stating their assumptions clearly. Table 1 and Figure 1 show the information from these multiple sources.

The data in the table were published between 1996 and 1998. Since only highlights of the findings are publicly available, it is not always clear what is being estimated; some discuss only software and others consider both software and hardware. Figures may be United States or worldwide. The values given in Table 1 are point estimates. The growth rates implicit in these estimates range from 25 to 50% and beyond. Table 2 and Figure 2 interpolate and extrapolate these point estimates to fill in the entire 1996-2001 period.

Table 1. Estimates of Size of the Data Warehousing Industry
(Billions of Dollars)

Source ¹	1996	1997	1998	1999	2000	2001	Implied Annual Growth Rate
Meta Group(1996)	4.5				15		35%
Investors Business Daily			8.1			23.8	40%
Dataquest	1.1	1.47	1.88				30%
Tower Group		3.5		5.4			25%
Palo Alto Mgmt Group	8.8	14.5	23.2	36.3	54	80	50%
Rudin	2		8				100%

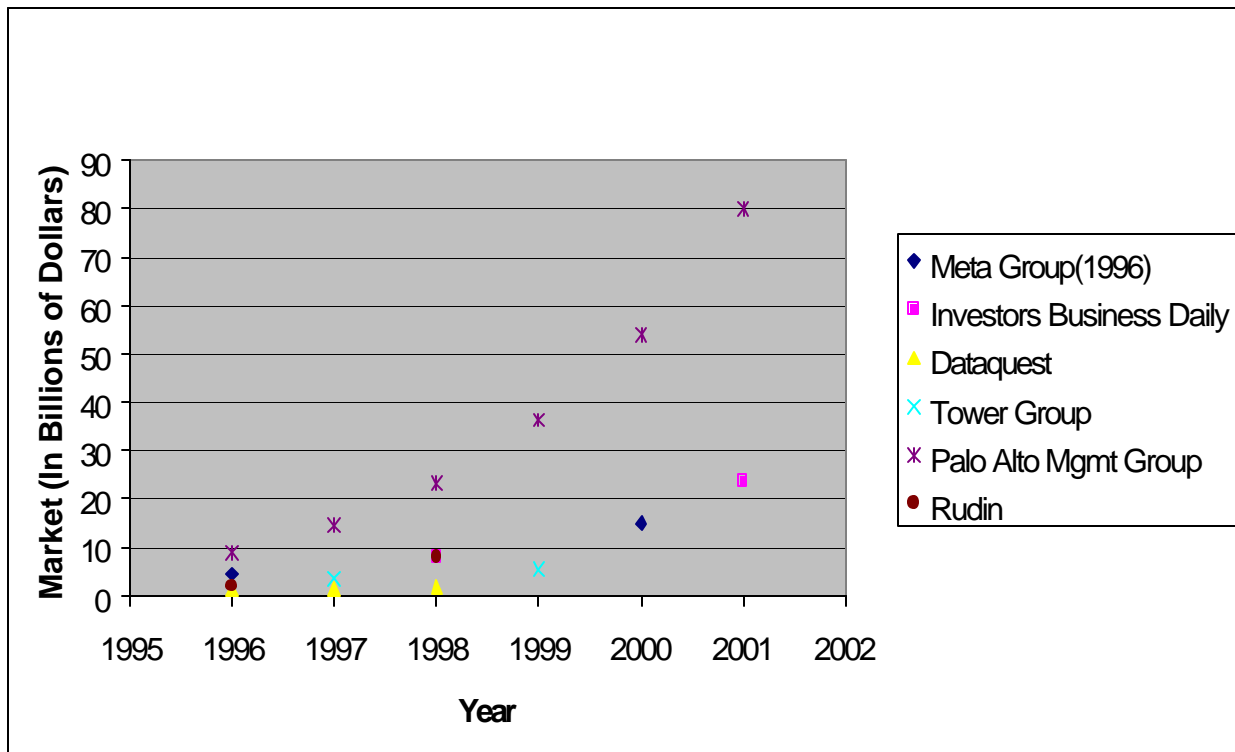


Figure 1. Plot of Data Warehouse Industry Estimates in Table 1

¹Internet URL addresses for each source in Tables 1 and 2 are given in the list of References at the end of this working paper.

Table 2. Data in Table 1 with Interpolated and Extrapolated Values
(in Billions of Dollars)

Source	1996	1997	1998	1999	2000	2001	Implied Annual Growth Rate
Meta Group(1996)	<i>4.5</i>	6.1	8.2	11.1	<i>15</i>	20.2	35%
Investors Business Daily			<i>8.1</i>	11.6	16.6	<i>23.8</i>	40%
Dataquest	<i>1.1</i>	<i>1.47</i>	<i>1.88</i>	2.4	3.2	4.1	30%
Tower Group		3.5	4.4	<i>5.4</i>	6.8	8.5	25%
Palo Alto Mgmt Group	<i>8.8</i>	<i>14.5</i>	<i>23.2</i>	<i>36.3</i>	<i>54</i>	<i>80</i>	50%
Rudin	2	4	8	16	32	64	100%

Values from Table 1 are repeated in italicized bold face; extrapolated and interpolated values are in conventional typeface.

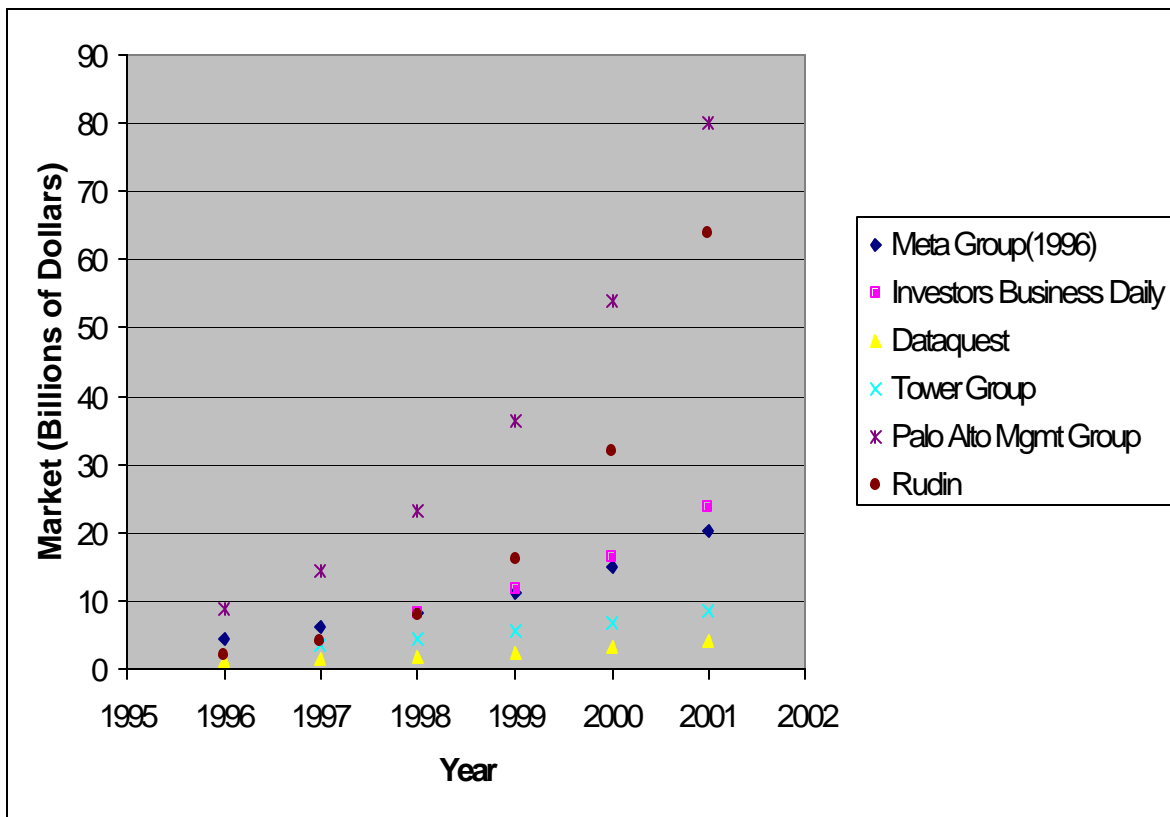


Figure 2. Plot of Table 2 Estimates with Interpolated and Extrapolated Values Included

The results in Table 2 and Figure 1 show the diversity of the estimates. By 2001, the estimates range from 4 billion to 80 billion, a factor of 20.

The only things that can be said with certainty are:

- Data warehousing is a multibillion dollar market
- Data warehousing is expected to grow at a rate above 20% per year into the 21st century.

Two of the forecast descriptions indicate the pervasiveness of warehouses. Meta Group estimates that 90% of Fortune 500 companies will have one by 2000. Dataquest, which is concerned with the software market, estimates that 80% of the software investment will be for business intelligence applications.

The investments in data warehouses are particularly large in some industries. In banking, for example, the estimated annual expenditures information management and data warehousing in 1997 were 1.2 billion and were expected to grow to 1.75 billion by 2000 (American Banker, 1997).

Cost and Time to Implement a Warehouse

A data warehouse is a major investment. The following estimates were found in the literature:

1. A 1 terabyte (Tb) warehouse is estimated to cost \$3 million, of which \$1 million is for professional services. Warehouses of this size typically require 2 years to implement. (Dukart, 1997)
2. Hammond (1998) quotes a Meta Group survey that the average cost for an enterprise warehouse is \$3 million.
3. A data mart, with up to 50 gigabytes (Gb) of disk storage, the estimated cost is under \$1 million. Implementation time is 90 days. (Dukart, 1997)
4. Costs as large as \$30 million and implementation times as long as three years are reported. Typical estimates to implement a full warehouse range from 6 to 18 months.

Reports of company expenditures for warehousing in millions of dollars include:

American Express	30
Nations Bank	10
American Red Cross	4.5
J.C. Penney	4

Table 3 lists representative implementations including hardware, software, and size. The warehouses listed range from 3m's 70 Gb to Wal-Mart's 7.5 Tb. Internet addresses show where more complete descriptions of these warehouses can be found.

Table 3. Representative Data Warehouse Implementations

Company	Hardware	Software	Size	Internet Address
3M	HP9000 Model T500	Intelligent Warehouse Advisor	70 GB	http://www.dw-institute.com/cases/3m.htm
Woolworth	TandemK200 00	NonStop	250 GB	http://www.dw-institute.com/cases/woolworth.htm
Entergy	SunSPARC20 00	Sybase Sys-tem 10/11	100 GB	http://www.dw-institute.com/cases/entergy.htm
FedEx	Multiple	Multiple	1+ TB	http://www.techweb.com/se/directlink.cgi?IWK19971027S0044
Union Pacific Railroad	NCR WorldMark 5100M	NCR Teradata	1.1 TB	http://datamation.com/PlugIn/issues/1996/oct/10dataw.html
MasterCard Internationa l	NCR 3600	Oracle Decision Suite	1.2 TB	http://www.datamation.com/PlugIn/workbench/dwhouse/stories/mc.htm
MCI	IBM SP2	Informix 8.0	3 TB	http://www.dbmsmag.com/9612d13.html
Source Informatics America	Sequent Server	Oracle	2 TB	http://www.sentrytech.com/dw33.htm
Wal-Mart	NCR WorldMark 5100M	NCR Teradata	7,5 TB	http://www.datamation.com/PlugIn/workbench/dwhouse/stories/extreme.htm

In a survey of 50 Fortune 500 firms in 1997, Forrester Research of Cambridge, MA found the status of their warehouses to be:

Planning	4	(8%)
Early implementation	10	(20%)
Late implementation	4	(8%)
In production	31	(62%)
Second generation	1	(2%)

Forrester report the average size of the warehouse in 1997 as 123Gb and estimate that the average will grow to 259Gb by 1999

In a separate analysis, DMReview (Powell, 1998) polled its readership in what is clearly a sample of opportunity. They found 50% of their readers² to be in the early stages of warehouse development. These 50% broke down as follows:

Planning stage	26%
Prototype or pilot	15%
Design	9%

In the DMReview survey, the typical warehouse had 485 users, contained 533 GB of data, and covered 8 subject areas. By contrast, 74 percent of the data marts (see below for further discussion of data marts) had less than 50 GB of data, although 2 percent of the data marts contained over a terabyte.

Major Vendors and Products

The expenditures on a warehouse can be divided into hardware and software. Hardware typically involves either a mainframe or a two-tier or three-tier architecture³ (Gray and Watson 1998). The software includes both the warehouse and the warehouse applications.

More specifically, the market in which vendors compete can be divided into:

- Central hardware (platforms, memory)
- Software (including tools for cleansing the data, OLAP applications, databases, and creating the metadata)
- Professional services from data warehouse consultants (particularly the large accounting firms but also including hardware and software vendors)
- User hardware (upgraded desktops, peripherals)

² Note that 'readers' can include a large duplication of responses from a single organization. Number of organizations polled is not given.

³In a three-tier architecture, the one tier consists of the legacy data and the software for cleansing the legacy data, the second tier is the data warehouse itself, and the third tier includes the application engine and the client. In a two-tier architecture, the data warehouse itself resides on one of the other tiers. In a stand-alone architecture, all three tiers are co-located.

Software: Each of the major database vendors sells data warehouse software. Representative companies are listed in Table 4. These figures show their total their total revenues (in billions) as well as their major data warehouse product. The data were obtained from the company annual reports. Unfortunately, the reports typically did not indicate the proportion of the revenue coming from data warehousing.

**Table 4. Major Vendors Who Also Provide Data Warehouse Software
(In rank order of total 1997 revenue)**

COMPANY	TOTAL REVENUE (Billions)	MAJOR DATABASE
IBM	20.1	DB2
Microsoft	14.5	SQL Server 7
Hewlett Packard	12.2	Open Warehouse
NCR	6.6	Teradata
Oracle	5.7	Oracle 8
Computer Associates	4.7	Ingres II
Informix	1.2	Dynamic Server 7.3
Sybase	1.1	Adaptive Server Enterprise 11.1

Values based on 1997 data

A number of companies specialize in data warehouses and in OLAP. Table 5 shows their total sales for 1997. Unlike the giant companies in the previous table, the total revenue of the specialist companies comes almost entirely from the data warehousing industry.

Table 5. Companies Specializing in Data Warehouse Software

COMPANY	REVENUE(M\$)
Platinum	592
SAS	500
Cognos	197
Arbor ⁴	82
Planning Sciences	39
Red Brick ⁵	36

⁴ Arbor merged with Hyperion in May 1998 in a \$700 million stock swap

⁵ In October 1998, Informix announced that it was purchasing Red Brick

For OLAP, Dataquest reported (Hammond 1998) that the total market was \$443 million and that the five leaders in 1997, based on market share, were:

Oracle ⁶	20%
SAS Institute	16%
Arbor Software	13%
SPSS Inc.	10%
Microstrategy	8%

For low-end query and reporting tools, Dataquest reported a market of \$786 million in 1997 (an increase of 19% from \$660 million in 1996). Table 6 lists categories of products being sold in the data warehousing market and some of the firms selling these products. This list is extracted from the Data Warehousing Institute's (1998) *Atlas of Data Warehousing* that provides a complete categorization of products and lists firms that supply these products.

Table 6. Product Categories and Some Firms Supplying Them

PRODUCT CATEGORY	FIRMS
Data Integrity and Cleansing	Carlton, Prism Solutions, Vality Technology
Data Modeling Tools	Oracle, PLATINUM technology inc., Powersoft
Extraction/Transformation	Ardent Software, Carleton, IBM, Informatica, Sagent
Relational Databases	Computer Associates, IBM, Informix, Microsoft, NCR, Oracle, Sybase
Multidimensional Databases	Arbor Software, Gentia software, IBM, IQ Software Corporation, Microsoft, Oracle, Pilot, SAS Institute, Seagate
Relational OLAP Tools	IBM, if..., Information Advantage, MicroStrategy, PLATINUM technology
Desktop OLAP	Arbor Software, Brio Technology, Business Objects, Cognos, Hummingbird
Query and Reporting Tools	Cognos, Hummingbird, SAS, Seagate
Data Mining	Angoss software, Data Mining technologies, IBM, SPSS, Thinking Machines

Hardware: Hardware for data warehousing depends on the architecture being used. Small data mart systems may be on a single PC whereas client server systems may be three tier or rely on a large mainframe. Table 7 lists hardware suppliers and the principal product they are selling to the data warehouse market (Data Warehousing Institute 1998)

⁶ Oracle serves the OLAP market with Express, a product it bought from IRI Inc.

Table 7. Data Warehouse Hardware Platforms

SUPPLIER	PRODUCT
Compaq Computer Corporation	ProLiant Servers, Himalay Servers
Data General	Aviion Servers
Digital Equipment (division of Compaq)	AlphaServers
Hewlett Packard	HP Enterprise and Technical Servers
IBM	RS/6000, AS/400
NCR Corporation	WorldMark Servers
Silicon Graphics	Origina 2000
Sun Microsystems	Sun Decision Warehouse
Unisys	Aquanta Servers

A niche category is suppliers of parallel processing hardware. They include Sequent, Pyramid, and Unisys.

Consultants: Consulting services for data warehouses are supplied by most of the systems integration firms and the major warehouse vendors. They include the large auditing firms and database firms such as:

- Arthur Andersen
- Ernst & Young
- PriceWaterhouseCoopers
- Oracle
- IBM
- Cambridge Technology Partners

Many of these firms employ large teams of consultants. Oracle, for example, claims its firm has 5000 consultants. In addition, there are many small and large consulting houses with data warehousing practices. These include senior practitioners in data warehousing such as Kimball & Associates and Two Crows Corporation. Among the services consultants perform are:

- determine business requirements
- develop architecture
- create and review both the logical and the physical data warehouse design
- project reviews
- information access architecture
- warehouse implementation
- client mentoring and training

In “client mentoring services”, consultant firms train client personnel to run the warehouse the consultant created. Often, mentoring involves bringing client personnel to a consultant’s demonstration and training center and immersing client personnel in a training course.

Components of Cost

Like all capital investments, costs can be divided into initial costs and operating expenses. The factors that affect initial cost are listed in Table 8

Table 8. Factors Affecting Initial Costs of Data Warehouse

FACTOR
Categories of data to be warehoused
Historical time periods to be kept
Detail level (granularity)
Summary data to be generated
End user sophistication
Amount of external data
Construction Schedule
In-house vs. vendor development
Centralization vs. decentralization of warehouse

The typical breakdown in capital budget costs is shown in Table 9 and Figure 3. (Inmon 1998)

Table 9. Capital Budget Percentages

HARDWARE	BUDGET PERCENTAGE
Disk storage	30%
Processor costs	20%
Network communications	10%
SOFTWARE	BUDGET PERCENTAGE
DBMS	10%
Integration, transformation	15%
Interface, metadata	5%
Access, analysis, systems management	10%

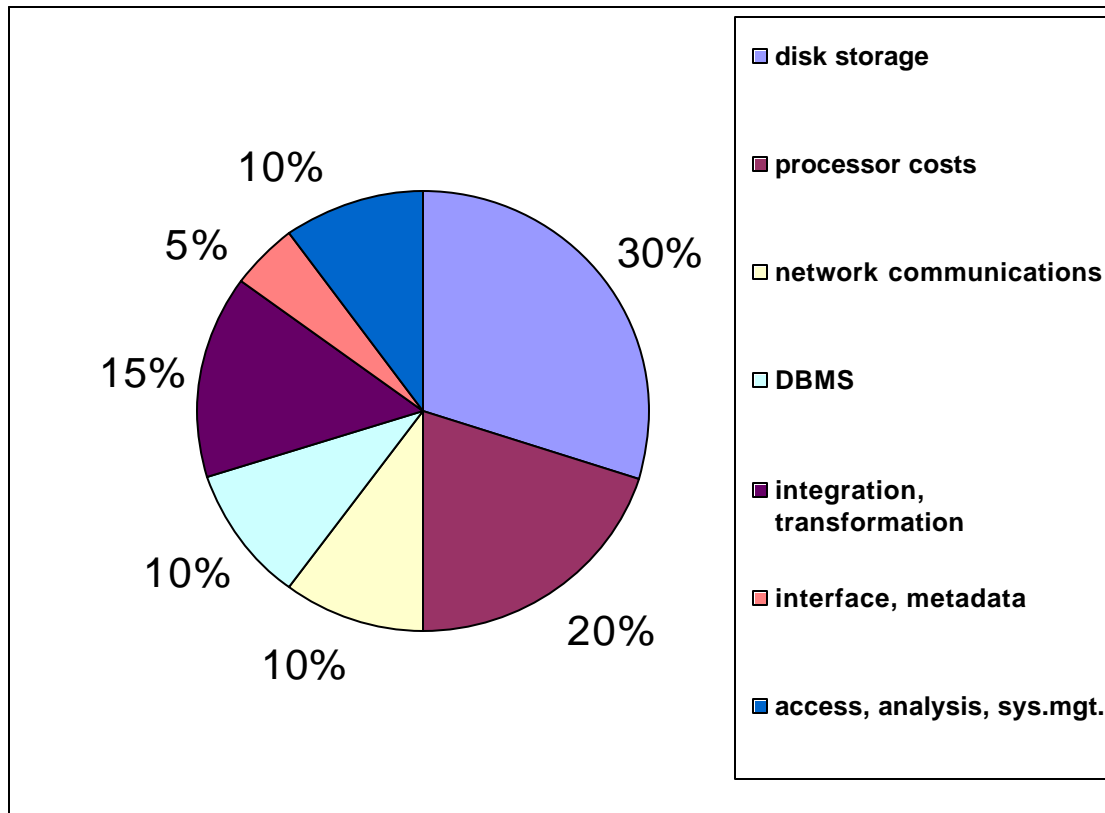


Figure 3. Capital Budgeting Percentages

For operating expenses, the factors involved are shown in Table 10, the percentage allocations in costs are shown in Table 11 and in Figure 4 (Inmon1998).

Table10. Factors Involved in Operating Expenses

FACTOR
Maintenance and update of warehouse
Maintaining metadata
Periodic validation of warehouse data
Providing service to requests for data
Monitoring activity
Archiving
Security

Table 11. Operating Budget Percentages

BUDGET ITEM	PERCENTAGE
Updating warehouse with new data	55%
Data warehouse administration	24%
End user training	6%
Activity monitoring	7%
Other	8%

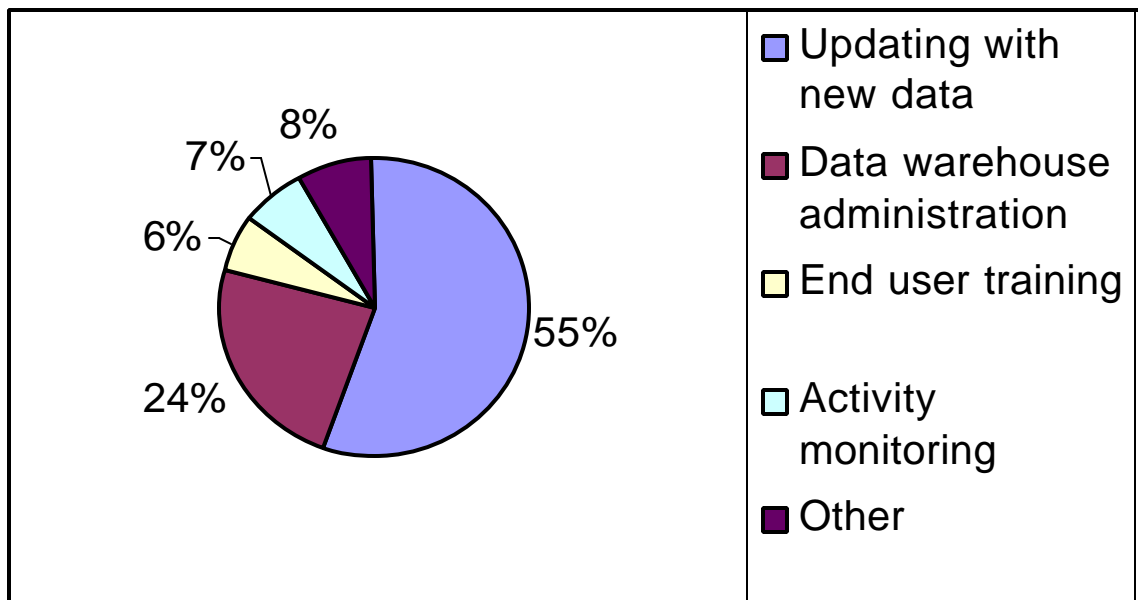


Figure 4. Operating Budget Percentages

In examining the percentages shown, it becomes clear that some unexpected categories absorb large portions of the budget. For example, disk storage of the data itself is particularly expensive (30%). It is also a continuing capital expense because data warehouses grow with time and hence require continual expenditures for disk space. Another example is the 15% of the total capital budget for software that integrates the data warehouse with legacy systems and takes care of the transformation of the data to warehouse standard format. In the operating budget, over half the expenditure is for the continual updating of the warehouse with new data as it is generated.

The User View

Given that 90% of the Fortune 500 are expected to have a data warehouse (see Section 2), the user is funding the data warehouse industry and, in effect is a part of it. The companies that lead the way in data warehousing are those that are data rich and customer focused. They include firms in the following industries:

- Retail
- Telecommunications
- Transportation
- Health care
- Finance

That is, the leaders are firms that have extremely high volumes of transaction data. The drivers for growth in data warehousing among firms is the need to transform business data into useful information, obtaining better demand prediction, lowering inventory costs, and business process reengineering (Meta Group).

Anticipated Benefits

The results of a survey of anticipated user benefits by the Meta Group are shown in Table 12. The numbers in this table add up to more than 100% since respondents were allowed to list multiple benefits.

Table 12. Anticipated Benefits of Data Warehousing

BENEFIT	PERCENTAGE OF RESPONSES
Better data for decisions	42%
Faster decisions	42%
Competitive advantage	38%
Decreased cost	24%
Enterprise view of data	20%
Increased revenues	14%

Note that many of the anticipated benefits listed in Table 12 are intangible (e.g., effect on decision, enterprise view of the data). This reliance on intangible benefits in the decision process is also reflected in the assessment of the Meta Group (1998) whose analysis concluded that organizations choose a data warehouse to obtain:

- Better information
- Better data quality
- Support organizational change

The Meta Group also found that the IT department still dominates the decision process on data warehouses.

Data Warehouse Successes and Failures

Table 13. Example Data Warehouse Successes

COMPANY	OUTCOMES	INTERNET SOURCE
Littlewoods	<ul style="list-style-type: none"> • Savings of \$1.2 Million (1997) from the ability to strategically price merchandise differently in different locations, accounting for regional variation and encouraging sales. • \$1.4 Million in savings (1997) from improved liquidation of stock. • 3% increase in margin (1997). • Decrease in the cost of markdown from \$69.5 Million to \$62.9 Million. • Reduction of merchandising staff by 40%, from 84 to 49. 	http://www.strategy.com/Clients/littlewoods/index.htm
Entergy	<ul style="list-style-type: none"> • Increased reporting flexibility and reduced reporting costs • Faster access to critical information • Improved ability to make complex business decisions 	http://www.dw-institute.com/cases/entergy.htm
Union Pacific Railroad	<ul style="list-style-type: none"> • Savings of over \$1 Million in sales tax by identifying tax-exempt purchases. • Savings of \$2 Million annually by knowing when and where competitors' cars are on UPR line, enabling them to move off-line more efficiently. • \$1.5 Million in savings annually by cutting accounts receivable cycle by one day. 	http://datamation.com/PlugIn/issues/1996/oct/10dataw.html
Concert ⁷	<ul style="list-style-type: none"> • \$1 Million per year savings from identifying and disconnecting unused circuits. • Savings of \$5 Million by discovering circuits usage improperly billed. 	http://www.dw-institute.com/best.htm
U.S. Army Center for Healthcare Education and Studies	<ul style="list-style-type: none"> • Reduced a seven to nine month process to five days. • Realized \$28 Million in savings in three years. 	M2 Communications Ltd.

⁷ Concert is a strategic partnership between British Telecom and MCI

Many corporations succeed with their data warehouses, whereas others fail. The exact failure rate is not known. However, the industry folklore has numbers as high as 60% to 70% or more (Forbes, 1998). Table 13 gives some examples of success stories. Details can be found in the Internet sources listed.

Obstacles to success that have been observed (Meta Group) include:

- Data quality
- Managing end-user and management expectations
- Transforming legacy data
- Business rule analysis
- Business data modeling

These obstacles can, and often do, lead to failure. Reasons for these failures include:

- not overcoming the above obstacles,
- lack of skills in managing large scale projects
- inadequate planning
- poor estimates of organizational, political, and cultural effects of the data warehouse
- lack of coordination among data marts
- lack of sufficient funding
- inability to provide desired user access
- systems integration failures

Reports on specific failures are hard to come by because most corporations prefer to bury their failures rather than talk about them. The following examples are documented in the trade press (Rao, 1998).

When failures occur, they can be quite large.

- American Express spent more than \$30 million building a data warehouse in Phoenix for its travel services division. The expenditure resulted in a product that was only partially functional.
- J.C. Penney incurred a \$4 Million expense constructing a data warehouse. Design problems resulted in scrapping the project in late 1996. The company later constructed a new \$11 Million warehouse utilizing different hardware and software.
- T. Eaton Co. Ltd., in Canada reportedly abandoned a \$2.5 Million 400GB warehouse that failed to handle the volume of cash register data generated by the company.

When failures occur, companies often make a second or third attempt at implementation. The result is that a given company can be a customer for capital items (such as additional hardware, new software) and for consulting services for long periods of time.

Personnel Issues

To create and operate a data warehouse requires a range of skills over and above knowledge of the data warehouse itself. These skills include:

- Business analysis
- Database and database administration techniques
- Object oriented technology
- Communication and presentation skills.

Unfortunately, few firms have all of these skills within their IS department. Some exist in user departments such as marketing, strategy and planning, or research. As a result, firms have to train existing staff in both IS and user departments.

Training firms that provide these and other data warehousing skills include:

- Archer Decision Sciences
- Barnett Data Systems
- Frost & Sullivan
- Learning Tree International

In the last several years, a number of universities (e.g., Claremont Graduate University, Georgia State University, University of California at Irvine) have begun offering data warehousing courses for students majoring in Information Systems.

Training is also provided by the many data warehousing conferences. These conferences, sponsored by organizations such as the Data Warehousing Institute, DCI Data Warehouse World, and IBC, involve tutorial sessions, advanced seminars by leading practitioners, and trade shows at which vendors have booths. Data warehousing conferences are relatively pricey, costing \$1000 or more for registration for 3 days plus travel, hotel, and food expenses.

Final Remarks

It is difficult to determine a single number that describes the annual expenditures attributable to data warehousing. A comprehensive estimate must examine the

- the hardware vendors
- the software vendors
- the consultants
- the users

It must take into account not only the initial expenditures for bringing warehouses and data marts on-line but also the costs of running the systems already in place. This task is made more difficult by the fact that almost all of the vendors are involved are in multiple businesses, not just data warehousing, and large firms often have multiple data warehouses and data marts.

The industry appears to be going through a consolidation phase. Respected names, just as Red Brick and Arbor Software, were acquired or merged during 1998. It is reasonable to expect that this trend will continue. The emergence of major new players, such as Microsoft and SAP, seems to be driving this phenomenon.

Overall, however, the industry appears healthy and should continue to be a major part of the information systems world in the years ahead. It is reasonable to expect that data warehousing will be the fundamental source of input data for emerging developments in knowledge management.

APPENDIX I

CATEGORIES OF VENDORS IN THE DATA WAREHOUSE INDUSTRY

Table A-1 is based on the Atlas of Data Warehousing published by the Warehousing Institute (1998).

Table A-1: Data Warehousing Vendors

CATEGORY	SUBGROUPS
Extraction/ Transformation Tools	Generic
	Application Specific
Data Movement Tools	
Information Servers	Relational Databases
	Specialized Indexed Databases and Accelerators
	Multidimensional Databases and Data Mart Servers
Decision Support Tools	Relational OLAP Tools
	Multidimensional Databases
	Desktop OLAP
	Query and Reporting Tools
	Application and Development Tools
	Data Mining Tools
Turnkey Decision Support Systems	
Data Warehouse Enabled Applications	Finance
	Sales/Marketing
	Balanced Scorecard
	Industry Specific
Administration Management	Meta Data Management
	Monitoring, Capacity Planning and/or Chargeback
	Job Scheduling
	Query Governing
	Systems Management
Data Warehouse Platforms	
Data Warehouse Consultants	

APPENDIX II - INTERNET DATA SOURCES ON DATA WAREHOUSING

Table A-2 lists representative trade press and commercial sites on the Internet that contain large amounts of information about data warehousing.

Table A-2 Internet Sites

INTERNET ADDRESS	DESCRIPTION
http://byte.com	Byte Magazine is now an on-line journal. It tends to cover the more technical aspects of data warehousing in a form that is accessible to the business reader.
http://www.computerworld.com	ComputerWorld is generally considered the prime weekly source of information on all aspects of information technology.
http://datamation.com	Datamation, like Byte, is an on-line journal. It maintains a separate section on data warehousing.
http://datawarehouse.dci.com/links.htm	The Data Warehouse Report is put out by DCI, a firm specializing in running large meetings on data warehousing, knowledge management, and other IT related subjects.
http://dmreview.com	DM Review is a monthly publication by Powell Publishing Inc. Its prime focus is on data warehousing and business intelligence.
http://dw-institute.com	The Data Warehousing Institute is a for-profit membership association that provides its members with large amounts of information about the field. Like DCI, it runs a number of meetings per year. Is dedicated to helping organizations increase their understanding of business intelligence. TWDI provides a comprehensive list of data warehouse vendors.
http://informationweek.com	Information Week is a general IT magazine that covers data warehousing
http://pwp.starnetinc.com/larryg/index.html	Larry Greenfield maintains this site at LGI systems Incorporated. It is quite rich in references to other sources and includes direct links to other internet sources

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