The Role of Data Warehousing in the Infrastructure of E-Commerce

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Abstract—A data warehouse is a repository of data that can be analyzed to gain a better knowledge about the "goings on" in a company. The value of better knowledge can lead to superior decision making. Although this architecture has been around for a long time its use is not wide spread. Many researchers have noted the absence of its penetration in business. So, while on the one hand we find a rapid growth in the e-commerce industry and advances in hardware and software, on the other hand, very few companies seem to know how to use data warehousing technologies to succeed in e-commerce. There are companies that have successfully incorporated a data warehouse and have become pioneers and leaders in e-commerce. This article presents the success of Amazon. com in the business to consumer sector of e-commerce and the success of Wal-Mart as the leader in the business to business sector of e-commerce.

Data warehousing and electronic-commerce are two of the most rapidly expanding fields in recent information technologies. In this paper, we discuss the design of data warehouses for e- commerce environment. We discuss requirement analysis, logical design, and physical design issues in e-commerce environments. We have collected an extensive set of interesting OLAP queries for e-commerce environments, and classified them into categories. Based on these OLAP queries, we illustrate our design with data warehouse bus architecture, dimension table structures, a base star schema, and an aggregation star schema. We finally present various physical design considerations for implementing the dimensional models. We believe that our collection of OLAP queries and dimensional models would be very useful in developing any real-world data warehouses in e-commerce environments.

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INTRODUCTION

Business conducted over the Internet is referred to as electronic commerce or e-commerce. There are many variations among the vendors who rely on the Internet to do business. These variations are business to consumers (B2C), business to business (B2B). The Gartner group projects that the B2B sector of e-commerce is expected to reach a US$7.29 trillion industry by 2004, and is expected to surpass the B2C sector (Wilson & Abel, 2001). Forrester research has estimated that by 2003 global B2B revenues will reach US$3.95 trillion, by 2020 the B2B e-commerce will represent 317% of the forecasted US$905 trillion total global sales transactions. These are significant statistics to note and companies need to examine how to harness the power of information technologies to support their e-commerce ventures. In order to be successful in the ecommerce industry you need an infrastructure. That infrastructure is the corporate information system, at the center of which is the data warehouse. Data warehouses were conceptually conceived in the 1970's amidst the development of the fourth generation non- procedural programming languages. They have been referred to as databanks, repositories and knowledge bases. However, with the advances in software and hardware technologies today, they are increasingly sought after for leveraging information for identifying new sources of competitive advantages. In the words of Inmon who is considered as the father of data warehousing, a data warehouse is a subject oriented, integrated, time variant, and non-volatile collection of data to support decision making. A review of literature reveals that researchers have noted the lack of application of Information Technologies in crucial business areas. For instance, price which has an immediate financial impact on a business is reported as the most ineptly managed variable (Shipply & Jobber, 2001; Wyner, 2002; Monroe, 2001; Yelkur et all, 2001). In a recent survey done by Professional Pricing Society in March of 2002, it was found that 28% of the companies surveyed did not have any consistent strategy to set prices.

Many companies had large amount of inconsistently captured data but no information systems implemented to analyze this data. While technologies for generating and collecting data have advanced significantly, applications to transform data to useful information and knowledge are still not widely recognized and used (Lee & Siau, 2000). In the area of forecasting, it can be said that the process is still driven by intuition of so called "experts" who are company executives, sales force, and industry analysts whose prognostications have been far from satisfactory (Golicic et all, 2001) . As a result companies stand on the verge of losing their competitive advantage, profitability and reliability.

The data warehousing design methodologies are still evolving as data warehousing technologies are evolving and we do not have a thorough scientific analysis on what makes data warehousing projects fail and what makes them successful. According to a study by the Gartner group, the failure rate for data warehousing projects runs as high as 60%. Our extensive survey shows that one of the main means for reducing the risk is to adopt an incremental developmental methodology [MC98, AM97, KRRT98]. These methodologies let you build the data warehouse based on architecture. As we gain more experience with data warehousing projects, the design methodologies will also become mature. There are several design methodologies discussed in the literature. Meyer and Cannon [MC98] present a detailed 22 steps to develop a data warehouse from team building to the implementation phase. Anahory and Murray [AM97] also presents an architecture-based methodology for a data warehouse development. In this paper, we adopted the data warehousing design methodology suggested by Kimball and others. The methodology to build a dimensional model consists of the following four steps:

1. Choose the data mart

2. Choose the grain of fact table

3. Choose the dimensions appropriate for the grain

4. Choose the facts. Our design methodology is based on [KRRT98] and can be summarized. We have collected an extensive set of OLAP queries for requirement analysis. We used the OLAP queries as a basis for the design of the dimension model. Determine the need for a data warehouse Collect OLAP queries Categorize OLAP queries Determine subject areas and dimensions for the data warehouse bus architecture.

THE REVIEW OF BUSINESS INFORMATION SYSTEMS

A cursory survey of e-commerce businesses shows that successful businesses have relied on a sound data warehousing architecture. The presence of such an architecture provides knowledge about the business which is crucial in developing business strategies in volatile business environments. Decision support systems can increase the degree of information readiness in organizations, so that they can counter complex business trends and uncertainties. It is in this regard that Wal-Mart and Amazon.com come to mind. Both of them have recognized the value of investing in an information system to gain knowledge about their customers. A data warehouse has played a pivotal role in gaining this knowledge. It enabled them to collect data from many sources, perform analyses and make informed decisions in real time. On account of their wise decisions, initiative and leadership they stand as examples worth emulating. Today, data warehousing has become a multibillion dollar industry, with NCR's Teradata systems taking the lead. More and more software and hardware vendors are joining the business and are offering competitive products and services. However, it is hardly noticed by the academic research community. Therefore, the purpose of this paper is to examine why e-business need a data warehouse. What are the strategic benefits of using a data warehouse? And what are the crucial issues in setting up a data warehouse? This paper is organized along the following topics. In section one, the dynamics of e-commerce markets is presented. This is followed by a description of pricing issues in e-commerce in section two. In section three integrating technology in the e- commerce business is presented. In section four the critical success factors in ecommerce are mentioned. This is followed by a presentation of successful e-commerce ventures in section five. The paper concludes in section six with a set of recommendations for implementing a data warehouse.

MARKET DYNAMICS

Customer satisfaction in e-commerce means being able to deliver the right product at the right price and at the right time and being able to answer customer inquiries quickly and accurately. Traditional sources of market advantage such as economies of scale are no longer enough to make a firm secure in the e-commerce market place. This is because today's customers are well informed about the products and prices. Information brokers replace traditional brokers with offering of product and price comparisons. These information brokers match sellers and buyers and vice versa (Wilson and Abel 2001). WWW.Carpoint.com,

www.pricewatch.com are cases in point. These sites list competing company's products and prices for car and computer components respectively. Customers are able to bargain for the best value for their money because they are well informed. Therefore, e-commerce businesses compete with each other and strive to meet the needs of the customers. Consequently, the e-commerce market place has become intensely and savagely competitive and major sustainable competitive advantages seem almost non existent (Mellahi & Johnson, 2000). The dynamics of ecommerce market place is such that firms constantly face challenges, disequilibrium and shifts thereby necessitating adjustments and changes to the rules of the game to meet customer satisfaction.

PRICING IN THE E-COMMERCE MARKET

The Internet has increased the number of customers, competitors, amount of information and the timeliness and availability of information about products and services. In such a dynamic environment, price uncertainty and demand volatility have risen and businesses are finding that using a fixed price mechanism in such an environment is ineffective and inefficient (Bichner et all, 2002). The trend is to move towards flexible pricing which includes differential pricing wherein different buyers receive different prices based on their expected valuations and dynamic pricing mechanisms such as auctions, where prices and market conditions are based on bids by market participants. Internet marketing can result in extreme price competition when products are similar, because other factors that moderate competition are absent. However when products and services are capable of significant differentiation, the Internet can serve as a method of segmenting consumers and directing them toward the appropriate product or The Review Of Business Information Systems Volume 8, Number 3 13 service. So, price can be used to build competitive advantages by enhancing customer satisfaction and loyalty and by meeting the demands of specific segments which have the potential to improve the firm's profit position.

DIFFERENTIAL PRICING

When firms adjust their prices according to customer, location or product, they are said to follow the strategy of segmented pricing or differential pricing. Segmentation needs to take into account the what, where, how and why of demand. Once customer segments are identified, the next step is to estimate the demand for each of these segments.

DYNAMIC PRICING

Auctions and competitive bidding often known as dynamic pricing mechanisms help to find a price in cases where no individual knows the true value, and each individual's estimate may be highly imperfect. The lack of knowledge may stem from volatile demand and supply conditions or it may be because that the item being traded is unique. For instance, objects of art. Dynamic pricing mechanisms ensure that by matching prices with current market conditions an optimal outcome for both the buyer and the seller is reached that might not be possible otherwise. In traditional markets, high transaction costs associated with dynamic pricing mechanisms have limited their application to specific sectors such as finance, commodities and art. On the Internet companies such as on sale or eBay successfully run live auctions where people outbid one another for computer gear, electronics components and sports equipment. However the shift from fixed pricing to dynamic pricing is expected to be most evident in the B2B sector of electronic commerce (Bichner et all, 2002). Although the future penetration of dynamic pricing is unknown, predictions by some industry analysts are very optimistic. Forrester Research predicts that sales involving dynamic pricing models will reach $746 billion by 2004 across all industries in the United States compared to $30 billion in 2000.

Integrating Technology in E-commerce:- Developing and executing a pricing strategy effectively calls for an understanding of the strategic rationale behind price, having a knowledgeable team of marketing personnel who can reach sound pricing decision through various model building strategies), having suitable technology tools to support pricing decisions and having a continuous motivation to execute the strategy over time (Wyner 2002). Most of the companies forego a formal demand analysis before setting prices and compromise with a reliance on managerial judgment which can be very risky. A demand analysis is important because it measures how much demand varies in response to a change in price. The demand curve measures the customer's price sensitivity. Measuring this price sensitivity is by no means simple, and imperfect estimates tend to be the norm (Shipley & Jobber, 2000). Most firms face competition at the segment level, the market level, and this can have major implications concerning the prices they set. Ignoring rivals' price would be a perilous strategy. Firms need to continuously monitor their rivals' prices and price adjustments and react appropriately to them. Moreover,

before taking a price initiative themselves, firms need to predict how their competitors are likely to respond and plan counter reactions of their own. Knowledge of customer behavior, consumer valuation of product features and price and motivations for purchasing are all at the heart of e-commerce. The following paragraphs discuss some of the tools that are part of a data warehouse architecture.

CUSTOMER MANAGEMENT SOFTWARE

Customer management software makes it possible to maintain detailed and accurate information about customers' preferences and about the costs of servicing different groups of customers. As customers have more purchasing choices, it is important for a firm to know what customers want and the costs of providing this to them. The constant reductions in the cost of data transmission, storage and analysis has had a significant impact on marketing a wide range of products and services in a variety of industries. As a result, detailed transaction The Review Of Business Information Systems costs little to capture, little to store and almost nothing to analyze. Record keeping, analyses and customized sales profiles can now be performed on individual households and purchasers. Defending an existing customer now becomes even easier and even more cost effective, making it difficult for competitors to capture valued customers. By capturing marketing information from individual customer transactions, and maintaining and working with historical databases built from these transactions, firms can know who their profitable customers are and woo them and win more of their business. Further, they can defend their existing business from the advances of aggressive competitors. Additionally, firms can know which active customers are unprofitable and cost money to serve; thus, in addition to knowing whom to woo, and whom to defend, firms can also know whose business to downsize, or to re-price. Firms that cannot do this will find that their competitors successfully target their most attractive and most profitable customers. These changes imply a fundamental change, even a painful change in corporate strategy. But the irony today is that very few firms have experience or a strategy to use the customer level detailed data that is captured and stored and which is available for access (Lee & Siau, 2001; Clemons & Weber, 1994). This is precisely the kind of information you need to succeed in the B2C sector. Customer management software is the latest management tool that is used for collecting detailed customer profiles. The growth of this software category is expected to hit the $21.8 billion mark by the year 2003 (Hamm & Hoff, 2000).

Data Mining:- Although the technologies for generating and collecting data have advanced, the inability to generate useful information from data is still a problem (Lee & Siau, 2001). To extract hidden predictive information from large volumes of data and transform them to useful information and knowledge intelligently, data mining techniques are used. Organizations are beginning to realize the importance of data mining in their strategic planning and successful application of data mining techniques can be large payoffs for companies.

WEB MINING

Another feature of data mining is web mining, which reports behavioral data about web visitors, such as who is visiting what content did they access, where did they come from and why did they purchase. Knowledge gained from such a tool can be used to measure the return on investment of marketing campaigns and make better online business decisions. One second can turn a browser into a buyer. The key is making the right suggestion to the right buyer at the right time. This is called suggestive selling and data mining tools can do this job exceedingly well.

EXPERT SYSTEMS

Pricing strategies such as cost-plus, competitor referenced, and demand driven can be supported by expert systems that can make price determination in the context of competing goals such as company image, revenue optimization and demand. Such expert pricing systems can be almost 90% accurate when compared to human experts who would be responsible for price determination. Relying on expert systems can therefore lead to effective pricing in the present era of electronic marketing. As new product features are developed and price adjustments are made marketing managers can update product databases instantly. Data in these product databases can help customers receive up to date price information when needed so that they can participate in dynamic pricing. According to AMR research the license for a price optimization system averages between $1 million and $350.5 million. These systems allow companies to take advantage of data from enterprise resource planning systems (ERP) systems, supply chain management (SCM) and Customer Relationship Management (CRM) systems.

CRITICAL SUCCESS FACTORS IN E-COMMERCE MARKETS

The Wharton center for leadership and change management reports three ways in which companies

have gained competitive advantages and leadership in e-commerce:

1. Being the first entrant in the market.

2. Having a physical presence in addition to being online.

3. Constantly monitoring and analyzing the value chain and understanding where the missing links in the chain are and filling these missing links.

The Review of Business Information Systems. A discussion of businesses that have demonstrated the above follows in the next section.

CASES IN E-COMMERCE

The case of Amazon.com in the business to consumer sector According to Jeff Bezos founder and manager at Amazon.com the company is "customer centric", "we want to be the world's most customer centric company... to that extent we focus increasingly on trying to get the customer experience right. Within that we want to build a place where people can come and discover anything they might want to buy online". Amazon has been able to assemble a great store of information on the buying habits of each of its customers. As such the company has been able to be proactive and second guess what customers want. For instance, their website software can track a customer's purchases and recommend similar titles. It can recommend books and CDs to customers on the basis of their previous purchases. Further, early customers are encouraged to submit reviews of books, which are posted with publisher's information about the book. In addition a customer can request notification whenever a particular author publishes a new book. Bezos saw the power of the Internet in reaching small, highly focused market segments, but he realized that this comprehensive bookstore could not be all things to all people. Therefore, he created a sales associate program in which web sites devoted to particular topic such as "home and gardening" could provide links to Amazon. com books that related to that topic. In return, Amazon. com would remit a percentage of sales to the referring site. By being "customer centric" and by relentlessly paying attention to every process involved in buying, promoting, selling and shipping books and by working to improve each process continuously, Bezos and Amazon. com have become one of the first highly visible success stories in electronic commerce. Their success has stemmed to a large extent from better knowledge of customers and technology. Today, the company is worth more than $240 billion. Amazon is able to forecast demand more accurately and has been able to get a better deal from publishers as evidenced by their return rate which is less than 25% compared to 30% for the industry's overall average. By being first to market on the Internet, Amazon.com has set the industry standards (Wildman, 1999). So far, it seems that being first to market has allowed Amazon.com to capture more customers and market share with other online competitors playing catch up. Further, psychological switching cost for customers resulted in higher repeat customer purchase surpassing 66% of orders (Machlis, 1998), once customers get used to Amazon.com they become reluctant to switch to another one. The challenge for Amazon.com has been to sustain their first mover advantage (Mellahi & Johnson, 2000). In e-commerce no organization can build a competitive advantage that is sustainable, every advantage erodes. With low barriers to entry and the ability to imitate easily, firms have been able to copy Amazon's successful innovations.

Amazon has been striving to develop innovative ways to keep the online customer satisfied. Some of the lessons learned from Amazon's experience include: Continuous innovations per se are not adequate to sustain competitive advantages. Innovations must be implemented quickly and effectively and must be protected through patenting to stay ahead of new entrants at least for a short while.

THE CASE OF WAL-MART IN THE BUSINESS TO BUSINESS SECTOR

Wal-Mart is a forerunner among retailers to recognize the value of investing in an information system to support their forecasting process. On account of their wise decisions, initiative and leadership in Collaborative Planning, Forecasting and Replenishment (CPFR) they have taken a "great" leap forward". Business relationships based on CPFR lead to synergies. Buyers and sellers leverage each other's assets and knowledge to create a supply chain whose value is greater than the sum of the parts. Wal-Mart, the world's largest retailer, achieved excellence in retailing by incorporating a data warehouse. By doing so, the company has achieved The Review Of Business Information Systems Volume 8, Number 3 16 competitive advantages and accuracy in its forecasting operations in an unprecedented manner. Businesses aspiring to be successful can learn a lesson or two from the Wal-Mart Model.

WAL-MART STORES

In 1962, Sam Walton opened his first Wal-Mart store. Today its retail reach is limitless and market penetration enviable. Wal-Mart has annual revenues of nearly $100 billion. From the start, one of the goals of WalMart was

to be the best store in town and to continue to grow and be successful. To this extent, Sam Walton believed in managing the chain "one store, one day at a time". Soon, Wal-Mart became successful and continued to grow and become a nationally recognized retailer (Walton & Huey, 1992). With the rapid growth it became difficult for Wal-Mart to meet satisfactorily the needs of its increasingly divergent customers. Consequently, management started losing its ability to manage "one store, one day at a time".

MANAGEMENT GROWTH DILEMMA

Wal-Mart's initial systems were capable of reporting only averages and summaries of their operations. Soon Wal-Mart realized that relying on averages was not prudent, as it was not a true representation of any specific store at any specific time and for any specific market basket in the chain. Management realized that their decisions had to be very specific to a store level in order to meet the needs of the customers who came to that store. This triggered the need to obtain detailed information at a store level. Senior executives turned to Information Technology and Data Warehousing to regain their capability of managing their stores "one day at time". And so, Wal-Mart searched for a strategic partner capable of meeting their standards and their plans for the future. They found their match with NCR. NCR's Teradata software, a data handling system, which is a core component used in the Wal-Mart's data warehouse, consists of 101 terabytes. It is believed to be the largest commercial database in the world. (One terabyte is equivalent to 250 million pages of text). Teradata System provides substantial parallel computing and data storage infrastructure. The system stores 7.5 terabytes of data such as inventory, forecasts, demographics, markdowns, returns and market baskets. The data warehouse runs on a 32 node NCR World Mark TM 5100M, with a massively parallel server and a 365 AMP NCR 3600 server, used for running the NCR Terdata database (NCR.com, 2000). Wal-Mart's buyers, merchandisers, logistics, and forecasting associates, as well as 3,500 of Wal-Mart's vendor partners, have direct access to the data warehouse which contains data not only about Wal- Mart's operations but also about its competition. For example, let us say that a competitor expands his fabric and notions department. When this happens Wal-Mart might want to know whether this will impact its sales performance. A competitive store sales analysis can help executives identify and analyze such trends so that they can develop a strategy to recoup sales or minimize the impact.

THE WAL-MART MODEL

Wal-Mart provides each of its major suppliers with a monthly profit-and-loss statement for each of the goods received from that supplier. Collaborative Planning, Forecasting and Replenishment (CPFR) are a business model that takes a holistic approach to supply chain management among a network of trading partners. Several major retailers like Wal-Mart have introduced this initiative to help suppliers and retailers collaborate on a single, short term forecast, and then to freeze it. Because the retailers and the suppliers are committed to the forecast, it becomes a plan that enables better management of internal processes, and, consequently, better control over fulfillment and inventory levels. The CPFR has the potential to deliver increased sales, organizational streamlining and alignment, administrative and operational efficiency, improved cash flow, and improved return on assets. Data is at the heart of CPFR. The data warehouse represents a time-aligned, cleaned view of data steams coming from different sources. Trading partners in the supply chain can benefit by identifying relevant streams of The Review Of Business Information Systems Volume 8, Number 3 17 data, aggregating and adjusting them to make them comparable, organizing data according to each organization's perspective, and then establishing rules for handling exception conditions.

AMAZON VS WALMART

From a comparative stand point it can be said that the race is on between the two giants in their own respective sectors. Having achieved success in the online arena, Amazon.com has embarked on building back end systems to compete with the Bricks and Mortar (B&M) ventures. Walmart on the other hand is trying to expand its operations in the e-market economy. According to Mullaney (2000), the race between Walmart.com and Amazon.com is not anywhere close. What is wrong with Walmart.com is that it settles for taking orders for the products people come looking for rather than enticing them to buy things they hadn't even thought of buying like the way Amazon.com does (Mullaney 2000). In an effort to stay competitive, increase profits and increase market share B&Ms are trying to go online. In doing so these companies have certain advantages over those companies that are entirely online. B&Ms enjoy lower costs per order and can attract customers at as little as one fourth the cost of the companies that are entirely Internet reliant (Chen & Pollard 2003). The reason being that B&Ms have established brands, customer bases, good relationship with vendors, greater access to products. Going online creates an additional channel of sales for B&Ms because it allows

customers the opportunity to browse online first before going to make the purchase in a physical store. Further, returns can be handled more easily because it allows customers who buy online to return the merchandise to be returned to a physical store in a nearby location. The major disadvantage is fulfilling individual orders. B&Ms are set to deal with shipping mass quantities of products at one time. Therefore, they have to develop an entire fulfillment process to meet the needs of their online customers (Chen & Pollard 2003). Many B&Ms that are unable to do this are forming alliances with companies that can ship individual orders. For example Wal-Mart has an alliance with Fingerhut one of the largest catalog retailers to help it with fulfilling its online orders. According to Nielson/Net Ratings (Harrisinteractive June 2001), the world's fastest growing Internet audience measurement service reported that Internet mass retailers with strong offline brands are driving mainstream shoppers online. Walmart.com led the top brick and mortar (B&M) mass retailers, attracting more than two million unique visitors and reaching 133% in growth since 2000. Walmart.com, JCPenny.com, Kmart.com, Target.com Sears.com are the top five B&Ms that are enjoying success in converting their regular offline customers to online shoppers, matching and exceeding 34% year over year growth of online giant Amazon.com (Harrisinteractive, 2001). Therefore, it appears that the bricks and clicks ventures would be the successful models in e- commerce.

SEVEN STEPS FOR A SUCCESSFUL DATA WAREHOUSE IMPLEMENTATION

The Data Warehousing Concept:- The concept of a data warehouse is really quite simple. Data from older systems is copied into a new computer system dedicated completely to analyzing the data. The purpose behind data analysis is to better understand what is happening, or what did happen within a company. The value of better understanding is translated into better decision-making. Here are some of the recommendations for retailers aspiring to integrate business forecasting models using Data Warehousing Technology. These guidelines are by no means complete, but they do highlight the prominent components of a computer based information system that supports forecasting. The components are Hardware, Software, Data, People and Procedures.

1. **Know your business needs and stay focused on it**:- Before you look toward technology for solutions to business problems, you must remember that technology is an enabler of business strategy. Your technology solutions will be only as good as your business strategy, and so, you must have a clear statement of what your business strategy is. For example, "Grow the customer base by 15%" The Review Of Business Information Systems Volume 8, Number 3 18 can be described as a business strategy. The goals of the new data warehouse must be aligned with business goals. When the company goal is the same for everyone and the data warehouse complements the goal and is in alignment with business goals, the entire company will be moving in the same direction. The entire company will be able to pull together to ensure a successful design, construction and implementation of a data warehouse. Technology plans should not be undertaken per se. Business needs must be the driving force behind the technology plans.

2. **Obtain business sponsorship:**- After you have determined that there is an alignment between the data warehouse and the business strategy, the next step is to form a core group of business executives who can serve as sponsors of the data warehouse project. These people should have sufficient authority and decision-making powers, so that requisite resources can be committed to the development and implementation of a data warehouse project. In the words of Paul Westerman, "No business sponsorship, no data warehouse". Sponsoring a data warehouse is a crucial responsibility for the business executives. They must be well informed about the business and must have the expertise in making quick decisions. Consider for example a situation where you wish to determine the reason for an increase in sales. If, for instance, you are missing a crucial element in the equation, the question may arise as to what substitution to make. Using a wrong variable can result in imprecise forecasting and completely change the outcome of the analysis. The business sponsor must be able to facilitate appropriate business issues and must be able to guarantee a quick resolution.

3. **Establish a long term vision in conjunction with a short term plan of action:**- A business view of the data warehousing initiative rather than the technical viewpoint must be communicated to the employees in the organization. The purpose of this long-term vision is to communicate to employees what the presence of a data warehouse will mean to the company. Broad outlines and discussions broken down to comprehensive levels about the ideas of data availability, flexibility and standardization must be expressed, and short term, e.g., 18 month plans for implementation must be identified. In the absence

of this plan, you may not be able to achieve proper alignment with business goals and may not be able to get continued business support. If short-term plans are not well thought out, then the data warehouse implementation plan is doomed to fail.

4. **Effective communications and appropriate corporate culture:-**At Wal-Mart, a combination of responsible leadership, effective communication and a unique corporate culture was crucial in developing a successful data warehouse project. Paul Westerman gives valuable insights into the Wal-Mart culture. Westerman believes that the Wal-Mart corporate culture was the unique driving force behind their data warehouse construction. He describes Wal-Mart as the fastest growing atypical retailer who is fiercely competitive, constantly watching its competition, and aggressively copying and improving on what competitors are doing. In his book entitled, "Sam Walton – Made in American," Walton maintains that he basically copied his ideas from his competitors and improved on them. Westerman believes that it is Wal-Mart's compulsive obsession to improve, rethink and improve that sets it apart from other retailers. He says that at Wal-Mart, people try a new idea, change it several times and then either adopt it or throw it out before other retailers even try to plan for it. There is a "just do it" attitude throughout the company whereby employees take individual responsibility and action to resolve daily issues. The lesson to be learned from this is that top management must be able to foster a good work ethic and reward risk taking, and be able to attract quality people.

5. **Save Data:-** Based on his experience in building the data warehouse at Wal-Mart, Paul Westerman strongly recommends retailers to save their data. Westerman argues that data should be saved for at least 65 weeks back as this can give a full quarter-to-quarter comparison, current year with the past year for the same quarter. Some of the important considerations in this context are: What data to save and where. Westerman suggests saving POS data, and making two copies of tape backup. Maintaining data on-line for comparable periods is invaluable for front-end analysis. The Review Of Business Information Systems.

6. **Hardware and Software:-**For fast growing companies, the issue of linear growth is very important. Linear growth is the ability to maintain a database with the same performance requirements as the size of the database grows. If the volume of data doubles the database should be able to maintain the same response times. Using parallel processing techniques, as the flow of data increases, the response times can be managed, by adding new hardware, without changing the database or the applications. Massively Parallel Processing (MPP). These computers can have thousands of CPUs. Each CPU operates independently; uses its own memory, disk drives, and software. They communicate with other CPUs by passing messages to each other via a high- speed bus. The MPP architecture can be thought of as multiple PCs connected together with a very high-speed network. MPP databases are managed as a single computer. An advantage of MPP computers is that the data from a single file can be spread across the entire system, allowing each CPU to analyze a smaller subset of data simultaneously. Each CPU searches a small subset of data, sorts the results and then they all return the data to the user. In the case of the SMP architecture, an entire task is assigned to only one CPU at a time, but in the case of the MPP architecture, the systems processes smaller set of data in parallel. As a result, such a system can provide faster response times for queries. The MPP architecture remains the major contender for real-time or near real-time data warehousing platforms. NCR Teradata's Active Data Warehouse, based on MPP architecture, stresses complex strategic queries. In this system, data remains in third normal form without impeding query performance. This provides users with the total view of the data. Further, through a technique called messaging the system allows continuous updates to take place without being affected by geographic time zones. When Wal- Mart was deciding on a database, Teradata (now NCR) was the only practical choice. Today, companies seeking data warehousing solutions have a wide array or choices. Compaq's Zero Latency Enterprise (ZLE) is a major contender. ZLE stresses short tactical queries. However, it needs to be strengthened in terms of complex query optimization.

7. **ROI Analysis:-** It is strongly recommended that, a year after implementing a new system, one should undertake a Return on Investment (ROI) analysis to determine the value of one's investment. The query statistics of just a few power users using the business decision support system for analysis work showed that, at Wal-Mart, their ROI far exceeded the cost of initial implementation. The store earned over $12,000 per query, and their few power users in their study showed that they were running about a thousand queries a day. Therefore, it is not

surprising why Wal-Mart continues to invest in its Data Warehousing projects. It is a matter of public record that Wal-Mart has invested over $4 billion to support data warehousing technology. While this may be mind boggling for some people, to Wal-Mart it is a matter of simple math. Conclusion Having the right information at the right time is crucial for making the right decision. The problem of collecting data which used to be major concern for most organizations is almost resolved today. In the present decade generating knowledge from data would be the greatest interest. Industry survey indicate that more than 80% of the 500 companies believe that data warehousing technologies would be a critical factor for business success by the year 2003. Therefore, it behooves of e-commerce ventures to see the value of investing in technology to realize success.

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