Data Mining as a Technique for Knowledge Management in Business Process Redesign

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Abstract: Business Process Redesign (BPR) is undertaken to achieve order-of-magnitude improvements over 'old' form of the organisation. Practitioners in the academia and business world have developed a number of methodologies to support this competitive restructuring that forms the current focus of concern, many of which have not been successful. This paper suggests the use of Data Mining (DM) as a technique to support the process of redesigning a business by extracting the much-needed knowledge hidden in large volumes of data maintained by the organization through the DM models.

Keywords: Data Mining, Knowledge Management, Business Process Redesign, Business re-engineering, Artificial Neural Networks.

1. Introduction

Knowledge Managers in any organization need to integrate Information Systems Strategies with Business Strategies in order to attain their vision and mission .The dividend yield a victory over their competitors through connection and interaction with their environment. Therefore, performing surgery on management overhead does not need to be macheted in a dark room instead it requires transparency as suggested by Strassmann (1995). First, one must gain acceptance from those who know how to make the organization work well. Second, the organization must elicit their cooperation in telling them where the cutting will do the least damage. Third, employees must be willing to share with the organization insights about the removal of an existing business process that will improve customer service.

The redesigning of an organization's processes is variously called business re-engineering, business process re-engineering, business process design, business redesign and so on. A useful working definition of BPR is given in Smith (1996) as the fundamental rethinking and radical redesign of an entire business - its processes, jobs, organizational structure, management systems, values and beliefs.

BPR helps rethinking a process in order to enhance its performance. Academics and business practitioners have been developing methodologies to support the application of BPR principles. However, most methodologies generally lack actual guidance on deriving a process design thereby threatening the success of BPR (Selma et al, 2003). Indeed a survey has proved that 85% of BPR projects fail or experience problems (Crowe et al, 2002).

Data Mining (DM) is a field that has recently attracted the attention of various researchers and organisations. According to Mena (1999) "Data Mining is the process of discovering actionable and meaningful patterns, profiles and trends by sniffing through your data using pattern recognition technologies such as neural networks, machine learning and genetic algorithms". DM tools can answer business questions that traditionally were too time consuming to resolve. They search databases for hidden patterns, finding predictive information that experts may miss because it lies outside their expectation.

Given the amount of management attention that has been devoted to the notion of BPR, it is not surprising that a number of tools and techniques (both human and computer based) have emerged to support it. Tools that support BPR can conveniently be categorized into two sets: those that help analyze and model the business from a process perspective, and those that help plan the workflow of the business. Any or all of these tools may be supported in software. The need to deploy Data Mining Technique to BPR was carried out, and it was discovered that the hidden knowledge

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generated by Data Mining tools can serve as a basis for knowledge managers in organizations to redesign the whole business process so as to suite the current business development and challenges and to remain at competitive level with other business organisations.

Therefore, in this study the following research questions need to be investigated.

1. Educational background of the DM users
2. Which organization uses DM techniques?
3. Do you for see any relationship that may exist between DM and BPR?
4. How are relevant BPR data obtained?
5. What categories of Knowledge Managers will use DM techniques for BPR?
6. What are the likely consequences, if DM succeed, making BPR a good KM tool?

We begin in section 2 by defining knowledge management (KM) and specifying KM strategies. Section 3 briefly overviews Data Mining (DM) techniques as a major tool in our study. In section 4, we outline factors, importance and mistakes of BPR. Section 5 presents a framework for data mining as a technique for knowledge management in Business Process Redesign. Finally in section 6, we synthesize those expectations into a set of conclusions.

2. Knowledge Management (KM)

Knowledge is an expensive commodity, which if managed properly is a major asset to the company. Knowledge is a complex and fluid concept. It can be either explicit or tacit in nature. Explicit knowledge can be easily articulated and transferred to others. In contrast tacit knowledge, which is personal knowledge, residing in individual's heads, is very difficult to articulate, codified and communicate (Gupta and McDaniel, 2002). Although KM has achieved a level of popularity among firms worldwide, it has no unique or standardized definition. For the purpose of this paper, we define KM as a systematic process of finding, selecting, organizing, distilling and presenting knowledge in a way that improves the organization's interest. A key objective of KM is to ensure that the right knowledge is available at the right time in a manner that enables timely decision-making (Hariharan, 2002).

KM encompasses the way that organizations function, communicates, analyze situations, come up with novel solutions to problems and develop new ways of doing business. It can also involve issues of culture, custom, values and skills as well as relationships with suppliers and customers.

Wiig (1997), in his work said that organizations might pursue five different knowledge management (KM) strategies:

1. KM as business strategy
2. Intellectual asset business strategy
3. Personal knowledge asset responsibility strategy
4. Knowledge creation strategy and
5. Knowledge transfers strategy.

This paper presents business organizations with data mining techniques as an approach that supports such knowledge creation, sharing and transfer mechanisms.

3. Data Mining techniques

Data Mining, the extraction of hidden predictive information from large databases, is a powerful new technology with great potential to help companies focus on the most important information in their data warehouses. Data mining tools predict future trends and behaviours, allowing businesses to make proactive, knowledge-driven decisions. Most companies already collect and refine massive quantities of data. The application areas of DM as contained in recent literatures as corroborated in Jiawei (2003) include: medical treatment/disease symptoms identification, retail industry, telephone calling patterns, DNA sequences, natural disaster, web log click stream, financial data analysis, bio-informatics, melody track selection, content-based e-mail processing systems, analyzes of data from specific experiments conducted over time, analysis of nation's census database, and so on.

DM techniques can be implemented rapidly on existing software and hardware platforms to enhance the value of existing information resources, and can be integrated with new products and systems as they are brought on-line.

There are three groups of DM users namely, Application users, Designers and Theorists. It is usually common that the theorists based on some principal assumptions usually formulate new ideas. Therefore, some users are primarily interested in this group.

Those concerned with the application of DM such as knowledge Managers which as a direct result of their interest in DM research and design they are referred to as the 'DM researcher /designer'. Finally, the respondents concerned primarily with the using or solving problems, for which DM offered an effective approach, are referred to as the "DM application group.

The most commonly used techniques in data mining are:

1. Artificial Neural Networks: this is a non-linear predictive model that learns through training and resembles biological neural networks in structure.
2. Decision trees: tree-shaped structures that represent sets of decisions. These decisions generate rules for the classification of a dataset.
3. Genetic Algorithms: They are optimization techniques that use process such as genetics combination, mutation, and natural selection in a design based on concepts of evolution. It tries to mimic the way nature works. It is an adaptive heuristic search algorithm premised on the evolutionary ideas of natural selection and genetics.
4. Rule Induction: the extraction of useful if-then rules from data based on statistical significance.
5. Regression Methods: this tries to identify the best linear pattern in order to predict the value of one characteristic we are studying in relation to another.

3.1 DM tasks

Some of the tasks solved by Data Mining are:

1. Prediction: a task of learning a pattern from examples and using the developed model to predict future values of the target variable.
2. Classification: a task of finding a function that maps records into one of several discrete classes.
3. Detection of relations: a task of searching for the most influential independent variables for a selected target variable.
4. Explicit modeling: a task of finding explicit formulae describing dependencies between various variables.
5. Clustering a task of identifying groups of records that are similar between themselves but different from the rest of the data.
6. Market Basket Analysis: processing transactional data in order to find those groups of products that are sold together well
7. Deviation Detection: a task of determining the most significant changes in some key measures of data from previous or expected values.

3.2 Benefits of DM techniques to web information management

A company or an organization encompassing data mining techniques can enjoy a number of benefits; these includes understanding customers' behaviour, making a judgement on the effectiveness of the company's web site- if there is one, and benchmarking marketing campaigns (Doherty, 2000 & Mena, 1999).

3.2.1 Understanding customers' behaviour

The benefits that fall under this category are summarized below:

1. Establishing the probability of customers coming back to the company or their web site.
2. Calculating the number of new customers coming to the company or their web site.
3. 3. Identify patterns relating either to navigation routes that customers follow or to what they buy.
4. Discover whom byes what and look for any cross-relationships between clients.

3.2.2 Understanding the web site's strong points

In this category, we can find the following benefits:

1. Developing a better layout of the company's web site.
2. Identifying popular and non-popular areas of the web site.
3. Personalizing online advertisement.

4. Business Process Redesign (BPR)

When BPR is used carefully, it can take organisations into a new realm of competitive effectiveness. However, the redesign of individual processes will always have a limited impact unless it is implemented as part of a wider view of the organization as a whole and that wider view must take root into the corporate culture. According to Wendy (1997), this is the difference between business re-engineering and process re-engineering since the first takes this wider perspective while the second is far more focused.

The purpose of this paper is to present a data mining technique that would allow business practitioners, senior managers and decision makers in organisations to extract useful, relevant, previously hidden knowledge from the organisation's database which after careful management of this knowledge yields the much knowledge needed to actualize the Business Process Redesign (BPR).

Ascari et al, (1995) found that certain factors are common to all BPR initiatives. Common features are:

1. The need for IT solutions tailored to fit the business
2. The focus on processes
3. The intent to use a pilot project approach
4. The need for top management commitment
5. The need for the communication of plans

The importance of other factors however, varied by whether the organization was competitively successful or was in a crisis situation. Features strongly sought by those in a competitive crisis were:

1. The need for a refocusing on the customer
2. The need to create coherent incentive programme
3. An emphasis on training
4. The redefinition of jobs
5. The need for cross-functional teams
6. The move towards empowerment

Kotter (1995) identified what he saw as the eight key mistakes that organisations engaged in BPR make. They are:

1. Not establishing a great enough sense of urgency
2. Not creating a powerful enough guiding coalition.
3. Lacking a vision.
4. Under-communicating the vision by a factor of ten.
5. Not removing obstacles to the new vision.
6. Not systematically planning for and creating short-term wins.
7. Not anchoring changes in the corporation's culture.

4.1 The BPR framework

The idea behind a framework is to help practitioners by identifying the topics that should be considered and how these topics are related (Alter, 1999). In this perspective the framework should identify clearly all views one should consider whenever applying a BPR implementation project.

For BPR, we suggest to use the framework described in figure 1. It is derived as a synthesis of the WCA (Work-Centred-Analysis) framework (Alter, 1999), the MOBILE workflow model (Jablonski and Bussler, 1996), the CIMOSA enterprise modeling views (Berrot and Vemadat, 2001) and the process description classes of (Seidmann and Sundarajan, 1997). In this framework, six elements are linked as shown in figure 1.

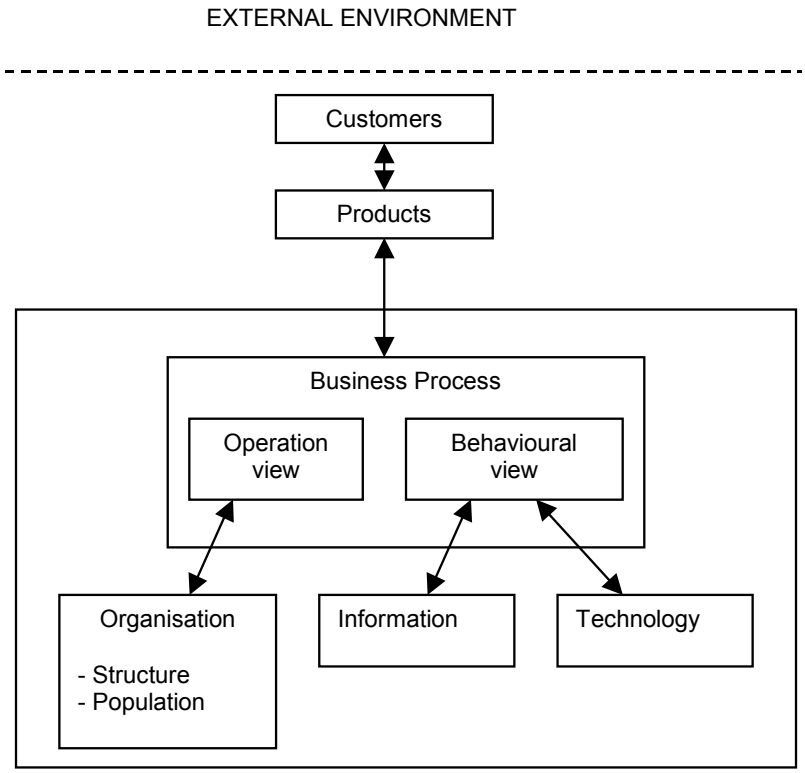

Figure 1: Framework for BPR implementation (Adapted from Selma et al, 2003)

4.2 Methodology

4.2.1 Sample

Surveys were administered to 207 Computer Science Students covering some academic institutions in the southwestern Nigeria.

Participation in the data gathering exercise was voluntary after the researchers had explained the importance of the study to the Students. The participants returned 190 useable responses (64.9 % male, 35.1% female) and 16 questionnaires either were not filled or contain missing data. Thus, the response rate was 92.27%. All participants are in full-time employment with University and Research Institutes, Banks, Insurance, Ministries of Science & Technology, Accounting and Business Consultancy firms. A total of 32 work organizations were represented, with no more than nine participants from an organization type. The significance of this heterogeneous sample is that the respondents are not uniformly influenced by the contextual constraints of any single organization (Ronssean & Fried, 2001). The mean age of the participants was 36.39 years (SD = 6.19 years), 74.3% were married. 68% of the respondents use primary data as their source of BPR data while 32% rely on secondary data.

The scale design phase of the questionnaire used focuses on construct validity and reliability, operational issues investigating whether the scales chosen are true constructs describing the events or merely artefacts of the methodology itself (Campbell & Fiske ,1959 ; Cronbach, 1971). The process started by arranging the selected items in a questionnaire format in preparation for data collection. The items were arranged in random order to reduce bias. The response options for some of the question items, anchored on a five-point Likert scale, ranging from (1) strongly disagree to; (5) strongly agree.

4.3 Results and discussion

Due to the scope of this research work, all the respondents either have theoretical or practical knowledge of Data mining techniques. Some criteria are used to determine knowledge manager's idea of DM. Their knowledge about relevant BPR data, theoretical or practical knowledge of DM. The Knowledge Manager's ability to describe any of these criteria gives him a score of one (1) mark. So, a knowledge manager who can explain all two (2)

criteria has a score of (2) while one who cannot explain any of the criteria has a score of zero (0)

Table 1: Percentage distribution of KM was on their knowledge of DM techniques

Knowledge Score	Percentage ratio	Interpretation
0	28.0	Very poor
1	41.0	Average
2	31.0	Good

As shown above, twenty-eight percent of the respondents had very poor knowledge of DM and thus scored zero.

The majority of the respondents scored forty-one percent, while over seventy-two percent had above average knowledge of DM.

This implied that twenty-eight percent of respondents have below average knowledge of DM. The more reason for having larger proportion having the DM knowledge is that most of the respondents work in IT department of their various organizations.

Table 2: Analysis of respondent's view on the use of DM for BPR

	Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
1	I foresee a relationship that may exist between DM and BPR	1	5	12	36	136 (71.6%)	190
2	There would be consequences if DM actually succeeds in making BPR with KM	5	14	3	61	107(57.4%)	190
3	DM can affect the power within the organization and the power of the organization	5	3	13	56	113(59.5%)	190

In table 2 , it was discovered that 71.6% of the respondents strongly foresee a relationship between DM and BPR this a greater proportion .This called for more research in this area while 57.4% of the respondents strongly suspected consequences when DM actually succeeds in making BPR with KM. This will eventually affect the power within the organization and the power of the organization.

5. The DM/BPR framework

In order to achieve our purpose for this paper, it is very important to explain how the DM/BPR tool shown in figure 2 will extract and transfer the much-needed knowledge necessary for implementing the new business. Data on past business processes including vision, technology, management, sales, services, accountability and leadership is accumulated over time in a database. A clear understanding of this is required after which careful examination and analysis is carried out to organize the data in order to suit our purpose. The DM model (Algorithm) is then built which could be a neural network model, genetic algorithm model, association models, decision tree models, clustering model or regression models as the case may be. The selected model is tested on the data to yield fruitful DM results previously unknown to managers and decision makers in the organization. The top managers and decision-makers take this new knowledge and implement on the BPR framework described in figure 1 to activate the new business process.

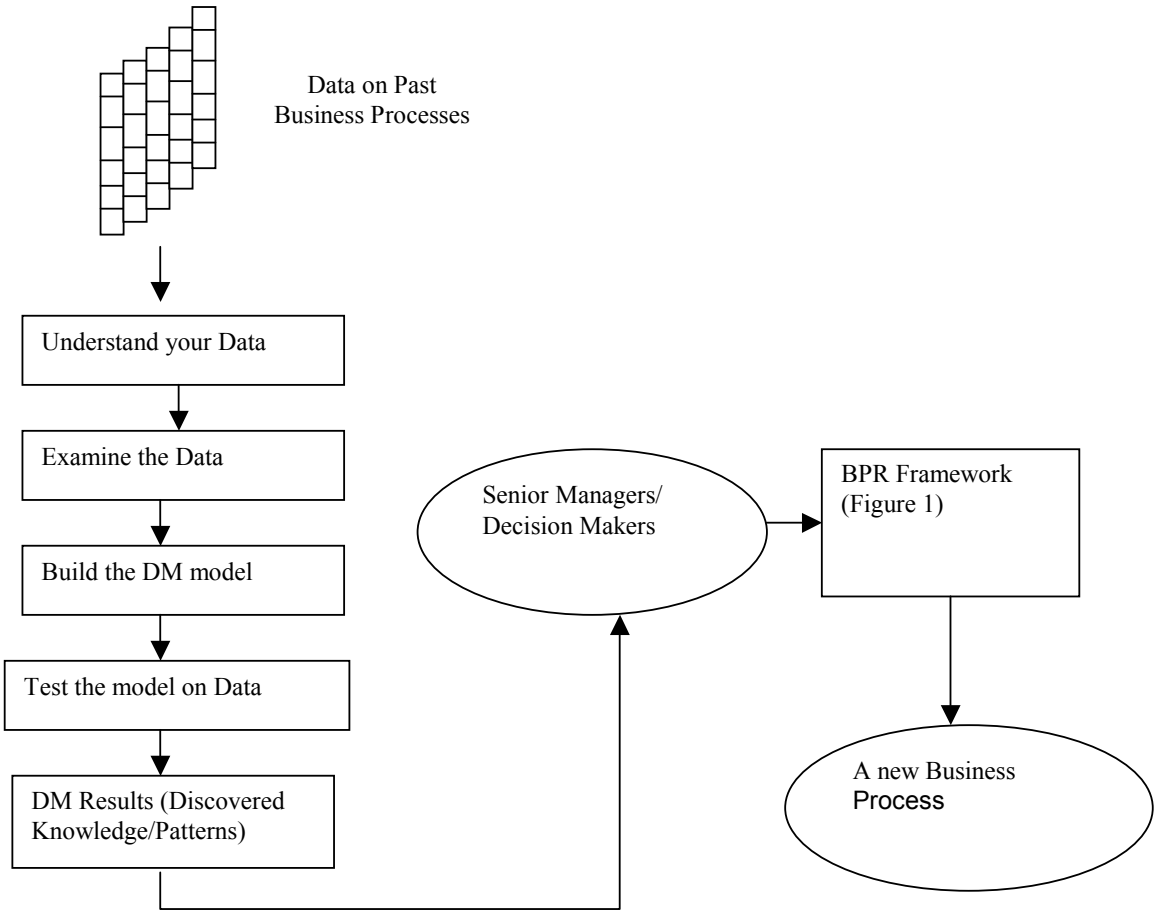

Figure 2: DM/BPR Framework

5.1 DM as a technique for knowledge management in BPR

5.1.1 Getting the relevant data

As it was formerly stated that DM is the extraction of hidden predictive information from large databases, allowing businesses to make proactive, knowledge-driven decisions. Most companies already collect and refine massive quantities of data. Data management today is required of the ability to extract interesting patterns from large and raw data to help decision-making. The importance of collecting data that reflect your business or scientific activities to achieve competitive advantage is widely recognized now. Powerful systems for collecting data and managing it in large databases are in place in all large and mid-range companies.

However, the bottleneck of turning the data into success is the difficulty of extracting knowledge about the system you study from the collected data. For instance, there is an unprecedented growth of the use of World Wide Web for commercial and scientific purposes in the past few years, most especially in the commercial sector where people are encouraged to conduct all their transactions online. This coupled with the advances in communication technology resulted in the accumulation of data on the Internet. This data, which indicates the user's behaviour is kept in files specially, created for that purpose called, **log files.**

There is therefore need to extract meaningful but hidden patterns from these large files through data mining techniques. In a constantly changing business environment, people or managers in various departments of industries or organizations can make their organization become much more competitive if they could get this vital information about their customer's habits.

If this vital information is gotten by managers responsible for the promotion of company's products, it would be possible to apply direct marketing techniques to every customers so that no money is wasted in vain advertisement. This could

also lead to the alteration of the organization's web page layout to suit the new developments. All these could be achieved through data mining.

According to the webopedia encyclopedia of computing technology (The Webopedia's web site, 2000) a log file is defined as "a file that lists actions that have occurred". These files are generated by servers – a computer or a device on a network that manages network resources – and contain a list of all requests made to the server by the network's users.

Information in the log files has to be written in a specific format that will facilitate the analysis of the file and instruct the computer as to how to read and use it. Log files are generated and kept on web servers; there are a variety of them in the market e.g. Apache web server (at the Apache server Website, 2000).

5.1.2 Examine the Data

In addition to the choice of the web server to take care of the user's requests, there are a wide variety of options as to how the data will be stored; that is, there are varieties of formats in existence. The common log file formed would be explained in this paper. A typical entry of this common log file format might look like the line below:

83.172.199.21 - - [24/oct/2003:09:15:36 + 0100] "GET / ~ tom / business / P205 / src / TicTacTve / docs / Board view.html HTTP / 1.0" 200 9436

The first field – 83.172.199.21 is the host making the request (The Apache Webster, 2000: Perl Tutorial website, 2000), this is a symbolic name and in the case it is not available, the IP address of the site making the request can be gotten.

The second field is the login name of the user who is making the request. Most servers may not give this for security reasons, which is the reason why a dash (–) is recorded in the log file.

The third field comprises the full name of the person who is making the request, as in the above case it is disabled in most servers and a dash (–) is recorded. Note that if a request is made for a file that is password – protected, then the user's identity should appear in this field.

The next entry in brackets comprises the data and the time the request was made and of the format dd/m/yyyy and hh:mm:ss respectively. An obvious problem here is that of the number of different time zones around the world. The time zone used is the Greenwich Mean Time (GMT).

The next in a set of double quotes after which a request is made to the server through the relevant command GET. After which we have the specific file request, which in the case of the above example is:

tom / business / P205 / src / TicTacTve / docs / Board view.html, under the directory of tom.

The next entry is the protocol – in which HTTP 1.0 is used in most cases. The next entry is a three – digit code that shows the result of the request, that is, the success or failure of the server to accommodate the request. The first digit can take five values:

Table 3: The meaning of the first digit of the status code (Adopted form Perl Tutorials website, 2000)

Value of first digit	Meaning
1	Informational
2	Success
3	Further action needed
4	Mistake from the person making the request
5	Server's failure

A number of sample codes and their meanings are shown below:

Table 4: Some status codes and their meanings (Adopted from Perl Tutorials website, 2000)

Status code	Description
200	OK
204	No content
301	Moved permanently
302	Moved temporarily
400	Bad request
401	Unauthorized
403	Forbidden
404	Not found
500	Internal server Error
501	Not implemented
503	Service Unavailable

In table 4, the code returned was 200, which means that the request was successfully completed. The final entry of the log file's format is the length of file

transferred and this is 9436 bytes for the above example.

5.1.3 Analysing web log files

Many log analyzers have been developed today. Some of these can be downloaded from the Internet as commercial program, freeware or shareware. Some examples are: WebTrends, HitListPro, SurfStats, FastStats, Sawmill.

In the market place, there is a large number of ready–made programs that help us analyse the log files our server has generated. Their processes differ, some are free and some sophisticated one can be bought at very high prices. The choice depends on our organization's special needs.

5.1.4 Evaluating web log files

The step that follows the analysis stage is evaluation. Once the mining tools i.e. the log analyzers have been applied, we have some result–which are figures only a step away from fulfilling the initial goal of turning our raw data into usable information. These results can then be analyzed by managers or decision–makers in the organization or by experts brought in from outside the company and valuable associations and patterns previously unknown to them can be generated.

5.1.5 Building and testing DM Models (Algorithms) to parse the log file

As discussed above, there are a large number of packages available in the market place that will perform the parsing and analysis of the log file for us. It is also possible for someone to write his/her own program to do the same task. There are two major benefits that can be enjoyed in doing that. They are:

1. Extensibility: this means the user can extend, add or remove components from the program rather than waiting for the next upgrade of the commercial program
2. Customizability: this means a user can write and perform his/her own queries and get the results of choice rather than some general statistics e.g. one might be interested in the nationality of customers that access our home page between a particular time of the day.

5.1.6 Factors to consider in writing your own program

There are two factors to bear in mind.

- Size of log files: a log file of a medium sized company can be anything in size up to thirty or forty megabytes or more. Note that, we need not load the whole file into memory, as this would have some disastrous effects on the performance of the computer. Loading and manipulating one line at a time better do it.
- Speed of expected result: a language that would perform these tasks quickly is needed and which will give us the opportunity to perform the tasks we want at a very high speed. For example, Perl, C++ etc are good for that kind of programs.

5.2 Consequences that may arise from the BPR through DM and KM

Consequences that may arise are:

1. Predicting cross–sell opportunities and making recommendations: whether you have a traditional or web–based operation, you can help customers quickly locate products of interest to them and simultaneously increase the value of each communication with your customers.
2. Identifying your best prospects and then retaining them as customers: By concentrating your marketing efforts only on your best prospects your organization will save time and money; thus increasing effectiveness of your marketing operations.
3. Segmenting Markets and personalizing communications: it is possible now to identify distinct group of customers, patients, students or natural phenomena that require different approaches in their handling.
4. Learning parameters influencing trends in sales and margins: Now you can know what combination of parameters is actually influencing trends in sales and margins and general operations.
5. Saving costs and time by: streamlining processes (limiting the number of departments/people involved in a single process), removing non-value adding activities and identifying where systems support is inadequate.

6. Conclusion

The process of extracting knowledge hidden from large volumes of data (DM) has proved very successful in solving many business or scientific problems to achieve competitive advantage. As suggested in the DM/BPR framework, the DM model can be deployed on the massive data collected from past business processes of the organization which then yields the much needed previously unknown knowledge and trends needed by top managers or decision makers in the organization for effective business process redesigning.

The unprecedented growth of the World Wide Web coupled with the recent advances in the telecommunication networks has made possible the transmission of large amounts of data in a short period of time – resulting in the accumulation of data on the Internet. This data are stored in files specially created for this purpose called – log files, generated by servers showing list of actions that occurred e.g. user's behaviour at a particular organization's web site. There are many data mining tools in existence to turn the raw data in the log files to useful information. Also, a customized computer program could be written to achieve a better result. If these potentials are fully and properly harnessed, decision–makers in organizations would be able to answer many questions that have been difficult to answer in time past such as: what goods should be promoted to the customer?, what is the probability that a certain customer will respond to a planned promotion?, can one predict the most profitable securities to buy/sell during the next trading session?, will this customer default on a loan or pay back on schedule?

The proposed DM/BPR framework transforms the old business into a new prospect oriented business organization by carefully re-engineering the old system incorporating the new discovered knowledge which helps the manager to make wise and informed business decisions in the area of accountability, business change management expertise, business process analysis, business model design, business model implementation and others.

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Appendix

The Perception of Knowledge Managers towards Data mining as technique for Knowledge Management in Business Process Redesign.

Please kindly tick the appropriate choice
1. Sex :
 1.1 Male _____ 1.2 Female_____
2. Age (Years) :
 2.1 18-22 _____
 2.2 24-28 _____
 2.3 29-33_____
 2.4 34- 38_____
 2.5 39- Above____
3. Marital Status:
Single ____
Married ____
4. How do you have access to relevant BPR data?
 4.1 Primary Data
 4.2 Secondary Data

Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5. I foresee a relationship that may exist between DM and BPR					
6. There can be consequences if DM succeeds making BPR with KM					
7. DM can affect the power within the organization and the power of the organization.					

Describe your knowledge about relevant BPR data _____
_____
_____
_____
_____
_____
_____

Give your idea of theoretical and practical Knowledge of Data Mining
_____
_____
_____
_____
_____

Please indicate your organization:_____