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Contents

Requirements Engineering Domain Knowledge in Information Technology

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ABSTRACT

This research is concerned with identifying and defining domain knowledge obtained during requirements engineering, we term "Requirements Engineering Domain Knowledge". Further, we claim that, with a clear definition of this domain knowledge, and with an understanding of the way it affects information systems implementation, we can develop ways to improve development processes so that Requirements Engineering Domain Knowledge can be utilized in other contexts.

The definition of a scope for domain knowledge, the definition of its content, and the suggestion of methods for its representation. Using the results of this research, domain knowledge embedded in code can potentially be utilized in contexts other than IS development.

Since the introduction of IT in organizations, organizations have gradually become increasingly dependent on it. Business rules and knowledge about the domain, which used to be possessed by individuals, are nowadays often encoded in the organization's information systems. However, the encoded knowledge generally referred to as "domain knowledge". Since its scope and definition is not very clear, and since it is often "hidden" in the code, this knowledge is not readily accessible as a source of knowledge. Extracting domain knowledge from code requires programming knowledge as well as a deep understanding of the software and might not be practically possible even then.

The objective of this research is to develop ways that will advance our ability to explicitly represent domain knowledge gathered during the development processes. Such representation of gathered domain knowledge can be used to support explicit representation in system code so that this domain knowledge will be easier to extract.

Keywords: Explicit, domain Knowledge

1. INTRODUCTION

An approach appealing to our research views RE mainly as a knowledge modelling process. This approach was also taken by Kavakli and Loucopoulo, who suggested that modelling of organizational change encompasses the following four concerns:

1. Understanding the current enterprise situation.
2. Knowledge about how change can take place.
3. Knowledge about the future enterprise system
4. The concern of evaluating enterprise models against the criteria of the parties Involved.

These four types of knowledge bring the RE process to four different states of knowledge respectively:

1. The As-Is knowledge state,
2. The Change knowledge state,
3. The To-Be knowledge state, and
4. The Evaluation knowledge state.

The two knowledge states, in which knowledge about the environment is established, are knowledge states 1 and 3. Domain knowledge consists of As-Is knowledge, which remains valid after the change process. It also consists of To-Be knowledge, which relates to entities that are part of the business environment. It is interesting to note that the order of transition between the states is not strictly defined, but rather the employed RE methodology defines the order in which the different knowledge states are traversed. i.e. the order of arrival at different knowledge states, As-Is knowledge state, Change knowledge state, To-Be knowledge state, and Evaluation knowledge states, is different in different RE methodologies.

While goal-oriented methods put more emphasize on the domain than behavioral and data modeling approaches, domain modeling approaches take the stand that even more emphasize should be placed on the domain rather than on the system. According to this approach goals by themselves do not make a good starting point for requirements engineering. Zave and Jackson illustrate this by considering a project to develop a computer-controlled turnstile guarding the entrance to a zoo.

2. SCOPE, GOALS, AND HYPOTHESIS

They show that domain knowledge is required to define the scope of relevant goals. If the engineers are told that the goal of the system is to deny entrance to people who have not paid the admission charge, it may be suggested that the goal has been stated too narrowly as perhaps the real goal should be to ensure the profitability of the zoo. Thus perhaps the engineers should consider other ways of improving profits, such as cutting costs. Following this line, it may be good to consider whether more money can be made by closing the zoo and selling the land; and so on (Zave and Jackson). Basically, almost every goal is a sub goal with some higher purpose. Zave and Jackson therefore highlight the need to have a clear relationship between requirements and specifications. This relationship talks about the mediating effect of domain knowledge between specifications and requirements.

From the above it follows that specifications can be said to satisfy requirements only when incorporating domain knowledge. The domain knowledge basically guides us to the scope of relevant domain. More specifically, a specification together with relevant domain knowledge should be

sufficient to guarantee that requirements are satisfied. This is formalized in Zave and Jackson :K,Sj-R Where K is a description of the problem domain, S is the specification of the solution, and R is the problem requirement. Parnas and Madey take the approach that requirements are in essence constraints imposed on the environment. They define the relation they designated as REQ, which incorporates constraints on the environmental quantities. Specifically Pamas and Meday define in the System Requirements Document environmental quantities, which are measured or controlled by the computer system. This document includes a specification on each environmental quantity as either monitored (aquantity that the system needs to measure), controlled (a quantity that the system needs to control), or both. The environment knowledge incorporated in this document can be described by a relation defined by Pamas and Madey as the NAT relation (standing for Nature):

- Domain(NAT) is a set of vectors of time functions containing monitored values at different times
- Range(NAT) is a set of vectors of time-functions containing the values allowed by controlled variables.

Work viewing RE under the domain knowledge approach dates back to 1982 with the work of Dubois, who suggested the Entity-Relationship-Attribute-Event, (ERAE) language. This language borrows from ideas in Semantic Networks and Logic.

The Language uses a semantic network type of graphical notation, and supports the use of the fundamental Entity Relationship constructs as well as the construct of Event. To this end, ERAE is also proposed as a possible language to help derive requirements for further validation, basing them on available requirements and temporal logic.

Today this view is mostly reflected in the Problem Frames method. As the name implies, Problem Frames structure the problem domain and describe the effects of the system on the problem domain. By emphasizing problems rather than solutions, Problem Frames can exploit the understanding of a problem class, allowing a problem owner with specific domain knowledge to drive the RE process (Hall et al. 2005).The unique approach of problem frames is in the clear attempt to distinguish between system and environment requirements. The roles of descriptions in the framework are twofold.

1) Indicative descriptions express what is assumed to be true in the problem frame, and
2) Opative descriptions express what is desired to be true once using the system.

According to this, given domains have an indicative role, while the requirement description and machine specification have an optative role. In the context of our work, indicative descriptions about the

domain are naturally the descriptions which relate to domain knowledge. In the Problem Frame framework, a problem diagram captures the characteristics of the problem domain as well as requirements that basically constrain the domain. Within a problem frame a machine domain is defmed. The machine domain is the system to be built together with its underlying hardware. In contrast to the machine domain, other domains, termed given domains, represent parts of the world that are relevant to the problem. These domains include physical events and states that are causally related. The different domains may share events and state information. These are called shared phenomena in the problem frames framework. Phenomenon a shared between two domains are observable by both, but controlled by one of them only.

Operators in the problem frame framework are the human operators. They are termed as biddable domains, meaning that they may obey stipulated procedures, but not reliably, and they may generate events spontaneously. In the problem frames framework, a requirement is defined as a condition in the problem domain that the machine domain must guarantee to qualify as a solution to the problem. The phenomena of biddable domains are events; those of causal domains are states and events (generalized as causal phenomena).The domain constructs of the domain modeling approaches are summarized in the meta model depicted in figure1.

3. INTEGRATION

In this section, our purpose is to create a meta-model of RE domain knowledge that will encompass the four RE approaches, namely the data based, the behavioural, goal-oriented, and domain based. To combine the domain knowledge elements included in the four models, we suggest creating a mapping of these constructs to those of the Enterprise Ontology proposed by Uschold et al. (1998). Uschold et al. (1998) provide a generalized ontology of domain concepts used in business. We are interested in requirements engineering domain concepts, which are only part of the ontology of business concepts.

Relationship
4-relationship Construct Construct
Construct A is Construct A Construct B
a Construct B

Construct B is a
manifistation of , Construct A——"1Construct B
Construct A

Figure 1: A Meta model of domain knowledge approaches constructs

4. APPROACH FOR REPRESENTING REQUIREMENTS ENGINEERING

Domain Knowledge

In this section we provide a way for representing REDK domain knowledge constructs. Our approach is ontology based and object-oriented. The use of object constructs can facilitate the representation of

REDKin Information Systems code. The approach and the outcome representation objects are described in this section.

4.1 Approach Explained

We are looking for a way to represent REDK explicitly in IS code. By representing REDK in system code, the ability to understand the domain using system code may be improved. One could examine knowledge associated with the domain using constructs commonly applied in Requirement Engineering methodologies. Another benefit stems from enabling the validation that an information system is a good representation of the application domain, as defined by Wand and Weber. More specifically, Wand and Weber suggest a set of requirements for an information system, necessary and sufficient for an information system to be a good representation of reality. These requirements all relate to a mapping between the real world defined as a triplet <S,L,E> (S is the possible state space, L is a set of system laws, and E is a set of external events) and an information system defined as <M,P,T> (M is the set of possible states, P is the information system law, and T is a set of external events). Having state variables, events, and laws explicitly represented enables validation that the requirements set by Wand and Weber are met. In our approach we use the widely applied 00 paradigm to enable the representation of REDK constructs. Further, Objects are introduced with ontological representation guidelines in order to have a coherent and well defined representation. Generally, we suggest that using the REDK meta model constructs, explicit representation of REDK can be enabled. Taken to IS code, we will suggest a representation of REDK constructs using objects to enable direct use of the Meta model constructs in IS code.

4.2 Enabling the Representation of REDK -Ontology

While our analysis enabled the conceptualization of different knowledge elements, their representation still requires guidelines. For example, while the Service construct may be conceptually understood, its clear representation remains challenging. We use ontology to guide us in representing knowledge elements in a clear and concise way. Ontology, or metaphysics, the philosophy of existence, is the branch of philosophy that deals with modeling the existence of things in the world . Different ontology's are used within the field of Ontology. The different ontologies take different philosophical positions based on a set of beliefs about the existence of certain entities in reality. In other words, each ontology makes different assumptions about what is perceived to exist in reality and how it behaves. An ontologyprovides a set of constructs for describing the world. This ontology helped analyze concepts of IS (Wand and Webe). It was also used to analyze the meaning of constructs used in different conceptual modeling approaches. Specifically, Wand (1989)used ontology to analyze object-oriented concepts. Much work has also been conducted in analyzing modeling grammars. Finally, there has also been research in which ontology was used to help translate models between different representation-grammars.

4.3 Representation of REDK

4.3.1 General Outcomes of Ontological Foundations

We now turn to the task of representing the REDK in IS code, guided by ontological principles. In the context of this task we seek representation for concepts which are conceptually clear, but for which representation is not clearly set.

CONCLUSION

Domain knowledge is a concept commonly applied and referred to in the Information Systems development literature. However, a clear understanding of the content of domain knowledge has not yet been established. The term "Domain knowledge" has different meanings in different fields of research. When narrowed to the field of IS, domain knowledge has been described as "an area of knowledge or activity characterized by a set of concepts and terminology understood by practitioners in that area". This is most often considered as the application area for which we develop software systems. This makes domain knowledge highly related to RE. Specifically, obtaining proper domain knowledge is recognized in software development as a critical factor for accomplishing the goal of RE, namely identifying complete, consistent, and accurate needs. In other words, during the requirements engineering process domain knowledge must be acquired. In this process, knowledge about the purpose of the information system and about the domain of discourse is established using different types of models. This knowledge shapes the implementation of the information system, and is eventually manifested in software code.

The purpose of this research was to advance our understanding of the meaning of the term domain knowledge, to define its constructs, and to enable its representation based on ontological guidelines. Such an understanding can help us relate the processes taking place during Requirements Engineering to the actual system code. As well, it can enable the use of domain knowledge gathered during RE in subsequent phases of the system lifecycle.

In this research we have examined the term domain knowledge in different phases of the systemdevelopment processes. Given the objective of RE, it is the process most intimately related to the accumulation of domain knowledge We have therefore conducted an analysis of domain knowledge discussion and use within the RE literature. We have found that different requirements engineering approaches emphasize the modelling of different aspects associated with both the domain and the system.

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An ISM-based Analysis for Modelling Factors in Railway Maintenance Task

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ABSTRACT

The objective of this paper is to understand the interaction of the various factors and to identify driving and dependent factors. An interpretive structural model (ISM) is presented, and factors are classified using matrice d'impacts croises-multiplication appliqué à un classement (MICMAC). The research may help maintenance management understand the interaction of factors affecting human failure probability in railway maintenance and help management devise policies and guidelines for railway maintenance related tasks.

Keywords: maintenance, human probability, modelling, factors

1. INTRODUCTION

Railway system has different working conditions, and human performance requirements compared to industries (Donald and Thomas (2007). Maintenance includes a variety of technical fields, work tasks, and personnel interacting with complex technologies (Oedewald and Reiman (2003). Maintenance in railways includes such activities as shunting, cleaning, graffiti removal, overhauls, effective management of spare parts and reprocessing of components such as traction motors, wheels and bogies etc. Maintenance is more or less a human activity; it is nearly impossible to entirely eradicate human error but can be minimized through good maintenance management and an understanding of the issues that affect error (HSE, 2000). . Human factor specialists are attempting to create a suitable framework for the analysis of the human factor in systems reliability. The primary emphasis is on the quantification of human error, which generally reflects a negative attribution but covers diverse situations and events, including management decision errors, design and maintenance errors, and operator errors (Watson and Oakes 1988). In railway maintenance tasks, there can be many reasons for human errors but some are more salient than others. Researchers (Singh et al. 2015; Singh et al. 2014; Dhillon 1986; Meister 1962; Rigby 1970) define the most probable causes of human error as poor training, poor equipment design, complex tasks, poor work and design layout, poorly written maintenance manuals, inadequate work tools, poor verbal communication, poor management etc. As per (HSE 1999), three factor categories, job and organizational factors, affect the performance of any work activity, including maintenance. until now, research has been conducted to measure maintenance performance (Kumar et al. 2011), human errors during operation and maintenance, and performance shaping factors by structural factors

(Yoshino 1996). The research has been conducted in two railway maintenance workshops in Luleå, Sweden. It considers individual factors (stress, fatigue, work station design, maintenance manuals, complexity of tasks, available time to diagnose problems. The main objective of is to prioritize the identified factors, classify them as dependent, linkage, or driving factors, and evaluate the contextual relationship among them using ISM-based analysis. Seven factors affecting the probability of the failure of human operators in railway maintenance tasks were identified through a comprehensive literature review and discussions with experts from industry and academia. The factors include: experience, stress, fatigue, complexity of task, work station design, maintenance manual, available time to act and available time to diagnose. Experience is an important factor in maintenance. An individual gains knowledge and skill through increasing involvement in or exposure to a particular task over time. With fewer years of experience, an individual may not have the knowledge required to perform the necessary task. With more experience less time is required for actions and decisions; it is a better predictor of performance than age (Bruce et al. 1990). Many researchers have noted the relationship between human performance and stress. There are four types of occupational stressors (Hagen 1976; Dhillon 2007): change-related, frustration-related, workload-related, and miscellaneous stressors. Hagen (1976) and Beech (1982) demonstrated the relationship between stress and human performance as a curve. Interestingly, maximum human performance effectiveness occurs at moderate levels of stress and not at low stress. Beyond moderate stress levels, fear, anxiety and other types of psychological stress result in a decline in performance, resulting in errors in maintenance tasks (Dhillon, 2007). Fatigue can affect almost all maintenance tasks, as it causes memory lapses, reduced judgment, difficulty focusing, reduced motivation, and other performance effects (Hobbs et al. 2011). Much has been written on fatigue in the transportation industry and there is a close association between fatigue and human-error related accidents (Dinges 1995; Mitler 1988). Maintenance quality relies on the performance of maintenance staff. Even though high-quality maintenance is extremely important, the increasing complexity of maintenance tasks on today's railway system makes it difficult for operators to fully understand the system's functions, escalating the risk that maintenance is carried out incorrectly (HSE, 2000). Effective maintenance execution in railways will reduce maintenance time at minimum cost with inventive, unified and effective solutions. However, complex tasks can increase the time required to diagnose and act. Therefore, it is essential to evaluate the complexity of tasks when determining their effect on the probability of human failure. In maintenance related tasks, workstation design and layout considers workers' needs, competences, anthropometry, and viewing angles and distances. Poor design can result in risk of damage to users' muscles and joints, (Health and Safety Guidance, 1998), can cause significant forces on lower back (Singh & Kumar 2012a). It is therefore suggested that the workplace should be designed for negligible twisting and moderate lifting frequency (Singh and kumar 2012b) for negligible human failure. A good workstation design and layout supports

achieving their operational objectives. Generally, there are three goals to consider in human-centred design: augment maintenance personnel abilities, overcome human limitations, and encourage user acceptance. Well-developed procedures and clear instructions are a prerequisite to achieving maintenance objectives. A machine that requires its operator to follow a complicated user manual is a source of risk in itself (HSG245 2004). Maintenance manuals/procedures are judged by the speed with which information can be found. A complex or poorly written maintenance manual (procedures) increases the risk that reaction times are longer and maintenance tasks are carried out incorrectly.

2 METHODOLOGY

A questionnaire-based survey was used to rank the factors affecting human performance in railway maintenance tasks and to develop an ISM approach. The questionnaire took into account the opinions of experts from academia and industry. In the questionnaire, maintenance personnel were asked to designate the significance of 11 factors on a 5-point Likert scale. On this scale, "1" and "5" corresponded to "not at all influential" and "extremely influential" respectively. The questionnaire was administered to personnel in railway maintenance workshops at Luleå, Sweden. Cronbach´s alpha coefficients were applied to the responses to determine reliability. In this case, the value of Cronbach´s alpha coefficients is 0.71; this falls within the range of 0.7-0.8, ensuring acceptable reliability (Nunnaly 1987). The questionnaire based survey was further processed with the help of Minitab software version 16. The

mean, standard deviation, variance and rank for each factor are shown in Table 1. The correlation coefficient of factors (Table 2) was classified according to the strength of the correlation coefficient

Table 1 Statistical data analysis

Factors	Mean Score	Std. Deviation	Variance	Rank
Experience (F1)	3,732	1,074	1,154	III
Stress (F2)	3,611	0,698	0,487	V
Fatigue (F3)	3,611	0,916	0,840	V
Complexity of task (F4)	3,056	1,056	1,114	VII
Workstation design (F5)	2,833	1,043	1,088	IX
Maintenance Manual (Procedure) (F6)	4,222	1,003	1,007	I
Available time to diagnose (F7)	3,389	0,850	0,722	VII

Table 2 Classification of factors based on significance of correlation

Variable Numbers	[a]Very strongly correlated	[b]Strongly correlated	[c]Moderately correlated	[d]Weakly correlated	[e]Not correlated
1	1		5	4,7,11	2,3,6,8,9,10
2	2		8	3,4,7,9,10	5,6,11
3	3	8		2,4,5	1,6,7,9,10,11
4	4			1,2,3,5,7,8	6,9,10,11
5	5		1	3,4,6,7,8,9,11	2,10
6	6			5,6,10	1,2,3,4,7,8,11
7	7		8,9	1,2,4,5,6,10,11	3

[a]correlation coefficient between 0.801-1.000; [b]correlation coefficient between 0.601 -0.800; [c]correlation coefficient between 0.401-0.600; [d] correlation coefficient between 0.201-0.400; [e]correlation coefficient less than or equal to 0.200.

3. INTERPRETIVE STRUCTURAL MODELLING

Interpretive Structural Modelling (ISM) has a long history of use (Harary et al. 1965), but was first proposed to analyse complex socioeconomic systems by Warfield in 1974. The basic idea is to use expert knowledge and experience to decompose a complex system into several subsystems and construct a multilevel structural model (Warfield 1974; saga 1977). ISM provides a means to impose an order on complex items in a carefully designed pattern (Singh et al. 2003; Ravi and Shankar 2005; Borade et al. 2011). In this research, the contextual relationship among the factors affecting the probability of failure of human operators in railway maintenance tasks was developed after consulting experts from both academia and industry. A "leads to" contextual relationship was chosen to analyse the relationship among the factors. In the process of developing SSIM, the symbols (V, A, X, O) were used to denote the direction of the relationship between two factors (i and j). In Table 5, V is the relation from factor i to factor j (i.e. if factor i influences or reaches to factor j), A is the relation from factor j to factor i (i.e. if factor j reaches to factor i), X is used for both direction relations (i.e. if factors i and j reach to each other), and O indicates no relation between two factors (i.e. if factors i and j are unrelated). Based on these contextual relationships the SSIM is developed (Table 3).

Table 3: Structural self-interactive matrix (SSIM)

	7	6	5	4	3	2
1	V	O	O	V	O	V
2	V	A	A	X	X	
3	V	A	A	X		
4	V	A	A			
5	V	O				
6	V					
7						

3.2.2 Reachability Matrix

A reachability matrix is a binary matrix (1, 0). The structural self-interactive matrix is transformed into initial reachability matrix by substituting V, A, X and O by 1 and 0. The rules for formulating this matrix are as follows:

a) In structural self-interactive matrix (SSIM), if the cell (i, j) is assigned symbol V, i n the initial reachability matrix, this cell (i, j) entry becomes 1 and the cell (j, i) entry becomes 0.

b) In structural self-interactive matrix (SSIM), if the cell (i, j) is assigned symbol A , i n the initial reachability matrix, this cell (i, j) entry becomes 0 and the cell (j, i) entry becomes 1.

c) In structural self-interactive matrix (SSIM), if the cell (i, j) is assigned symbol X , i n the initial reachability matrix, this cell (i, j) entry becomes 1 and the cell (j, i) entry also becomes 1.

d) In structural self-interactive matrix (SSIM), if the cell (i, j) is assigned symbol O , i n the initial reachability matrix, this cell (i, j) entry becomes 0 and the cell (j, i) entry becomes 0.

Following these rules, the initial reachability matrix is obtained (Table 4).

Table 4: Initial reachability matrix

	1	2	3	4	5	6	7
1	1	1	0	1	0	0	1
2	0	1	1	1	0	0	1
3	0	1	1	1	0	0	1
4	0	1	1	1	0	0	1
5	0	1	1	1	1	0	1
6	0	1	1	1	0	1	1
7	0	0	0	0	0	0	1

The concept of transitivity is to fill some of the cells of the initial reachability matrix (Table 4) by inference. The use of assumptions (Sharma et al. 1995; Watson 1978; Farris and Sage 1975) fills the gap, if any, in the experts' opinions collected during the development of the SSIM, thus helping to maintain the conceptual consistency (Raj et al. 2008). If factor A is related to B and factor B is related to C , transitivity implies that factor A is necessarily related to C. After incorporating the transitivity concept, the final reachability matrix is obtained. The final reachability matrix indicates the driving power and dependence of each factor (Table 5). Dependence is the total number of variables (including itself) which may be impacting a factor. The driving power for each variable is the total number of variables (including itself), which it may impact.

Table 5: Final reachability matrix

Factors	1	2	3	4	5	6	7	Driver Power	Driver Rank
1	1	1	1*	1	0	0	1		
2	0	1	1	1	0	0	1		
3	0	1	1	1	0	0	1		
4	0	1	1	1	0	0	1		
5	0	1	1	1	1	0	1		
6	0	1	1	1	0	1	1		
7	0	0	0	1*	0	0	1		
Dependence									
Dependence Rank									

1* entries are included to incorporate transitivity

3.1 Partitioning Factors

From the final reachability matrix, the reachability and antecedent set (Warfield 1974) for each factor are obtained. Then, the intersection of the sets is derived for all factors. The factor for which the reachability and the intersection sets are the same becomes the top-level factor in the ISM hierarchy. It is clear from Table 6 that "available time to diagnose" and "available time to act" are at level 1. Tables 7 and 8 show levels II and III. The factors at these levels are:

Table 6 Iteration 1

Variables	Reachability set	Antecedent Set	Intersection Set	Level
1	1,2,3,4,7,8,9	1	1	
2	2,3,4,7,8,9	1,2,3,4,5,6,8,9,10,11	2,3,4,8,9	
3	2,3,4,7,8,9	1,2,3,4,5,6,8,9,10,11	2,3,4,8,9	
4	2,3,4,7,8,9	1,2,3,4,5,6,7,8,9,10,11	2,3,4,8,9	
5	2,3,4,5,7,8,9	5	5	
6	2,3,4,6,7,8,9	6	6	
7	4,7,8	1,2,3,4,5,6,7,8,9,10,11	4,7,8	I

Table 7 Iteration 2

Variables	Reachability set	Antecedent Set	Intersection Set	Level
1	1, 9	1	1	
2	9	1, 5,6, ,9,10,11	9	II
3	9	1,5,6,,9,10,11	9	II
4	9	1,5,6,9,10,11	9	II
5	5,9	5	5	
6	6,9	6	6	

Table 8 Iteration 3

Variables	Reachability set	Antecedent Set	Intersection Set	Level
1	1	1	1	III
5	5	5	5	III
6	6,	6	6	III

3.2 ISM model development

The structural model generated from a final reachability matrix is called a diagraph. In this case, the ISM model was developed after removing transitivity links and replacing the node numbers with statements (Figure 1). The model shows that the most significant factors affecting the probability of operator failure in railway maintenance are "experience", "workstation design", "maintenance manual", "training and certification" and "role of management".

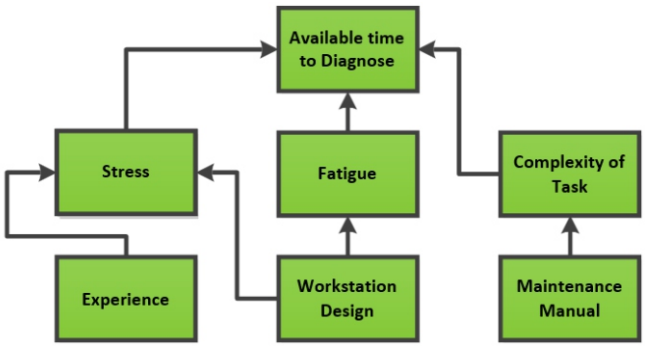

Figure 1: Proposed ISM Showing Factors Affecting Probability of Operator Failure in Railway Maintenance Tasks

3.3 MICMAC Analysis

MICMAC analysis refers to Matrice d'Impacts Croisés Multiplication Appliquée à un Classement (Duperrin, 1973). It involves the development of a graph to classify factors as driving or dependent. In this case, the factors affecting the failure probability of human operators in railway maintenance tasks are classified as: autonomous factors (weak driving power and weak dependence), linkage factors (strong driving power as well as strong dependence), dependent factors (weak driving power but strong dependence) and independent factors (strong driving power but weak dependence power). The drive power-dependence power diagram is shown in Figure 2.

Driving Power								
	7	F1, F5, F6	Driving Factors (IV)				Linkage Factors (III)	
	6							
	5						F2, F3	F4
	4		Autonomous Factors (I)				Dependent Factors (II)	
	3							F7
	2							
	1							
		1	2	3	4	5	6	7
	Dependence Power							

Figure 2: Clusters of factors affecting probability of human failure in railway maintenance tasks

4. RESULTS AND CONCLUSIONS

This paper's objective is to identify and analyse the factors affecting the probability of human failure in railway maintenance tasks. An ISM-based model has been developed to analyse the interactions among the factors. The driver power-dependence matrix sheds light on the relative importance of each factor and the interdependence among the factors. Figure 2 shows that none of the factors fall into category- I (autonomous factors); in other words, all factors considered in the research significantly affect operator failure. "Available time to diagnose" is dependent factor. These have weak driving power but strong

dependence power. “Stress”, “fatigue”, and “complexity of task” have strong driving power as well as high dependencies and are linkage factors. If these factors are accommodated, there will be a positive influence on maintenance with a reduction in human error. It Figure 2 also shows that “ experience”, “workstation design”, and “maintenance manuals” are independent factors. In other words, they have strong driving power and weak dependency on other factors. They may be treated as the key factors affecting the probability of human failure. This study can provide valuable information for the formulation of guidelines to improve the quality of maintenance activities. The results can assist maintenance management in taking remedial actions. The proposed ISM-based model provides a very useful explanation of the relationships among the factors.

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Role pf ICT in Knowledge Management, Research and Innovation

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ABSTRACT

This paper defines the knowledge cycle with its processes and outcome. It also looks in detail at how innovation comes about, how ICT plays a role in knowledge management, research and innovation.

Keywords: ICT, Innovation, Knowledge, Research.

INTRODUCTION

The Information Communication Technology (ICT) is considered the driving force behind the long unprecedented economic growth period of the last decade. It provided the infrastructure for economic development, helped create the knowledge society, contributed to innovation and created value for the economy. More importantly, it brought the world closer together by improving the dissemination of knowledge, accelerating research, stimulating innovation and facilitating collaboration.

Research is needed to use existing knowledge and to create new knowledge. It is the means for maintaining intellectual leadership. Knowledge management is the solution for sustaining a competitive edge in a knowledge economy. We shall explore the ICT factor in research, innovation and knowledge management. The whole question will be how and where value is created and what ICT contributes to this value creation process.

ROLE OF ICT

ICT can be both the means and the end in research, innovation and knowledge management. As the end by itself, the advent of ICT emerged through intensive efforts in Research and Development (R&D) and it can demonstrate its value to businesses and society; it was the main cause for the unprecedented economic growth of the last decade.

ICT contributes to resources/infrastructure and tools/assets for innovation, but, at the same time, requires a higher level of human capacity to fully exploit ICT capabilities.

ICT IN KNOWLEDGE MANAGEMENT

As mentioned above knowledge management is the process of managing the knowledge cycle. ICT provides a wide spectrum of tools and means to facilitate value creation. The Intellectual Capital Management (ICM) system is an effective means to preserve and disseminate the experiences and memory of an enterprise. There are a number of collaborative software tools available on the market that can help mobilize collective wisdom and knowledge to improve business performance.

ICT IN RESEARCH

- ICT provides the infrastructure (computers, broadband, wireless, etc), data collection and storage, processing, computing power, visualization, simulations.
- It helps convert data into useful information then business knowledge, presumably profitable knowledge.
- It also helps reap collective wisdom through community collaborations such as Open Sources and community software, wikis, and blogs to enhance quantity, quality, and thoroughness. However, the collaboration needs to be structured and have well defined orientation to be effective.
- Further, it helps accelerate research and innovation with Open Sources and Open Standards For example, the Blue Brain project is the first comprehensive attempt to reverse engineer the mammalian brain, a discipline of computational neuroscience.

ICT IN INNOVATION

Innovation as described above is knowledge development: in particular the application of knowledge or technologies to business or societal challenges, or the intersection between technologies and business or societal challenges as we see in the Global Innovation Outlook .

CONCLUSION

This paper discussed the knowledge/technology cycle consisting of acquisition, assimilation and value development. The role of ICT in the knowledge management and its involvement in the value development process (i.e. research and innovations) are also illustrated.

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Study of Students' Performance using Data Mining Model with Excel 2007

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ABSTRACT

Data Mining is used to extract meaningful information and to developed significant relationship among variables stored in large data warehouse. Knowledge Discovery and Data Mining (KDD) is a multidisciplinary area focusing upon methodologies for extracting useful knowledge from data and there are several useful KDD tools to extracting the knowledge. Indian education sector has a lot of data that can produce valuable information which an be used to increase the quality of education. Educational data mining (EDM) provides a set of techniques which can help educational system to overcome this issue in order to improve learning experience of students as well as increase their profits[3].

In this paper we present the educational data mining process with "Data Mining Client for Excel 2007" and explain how actuaries can use Excel to build predictive models, with little or no knowledge of the underlying SQL Server system. The Students' past performance data is generate to produce data mining model. The students' performance is evaluated by considering factors which include PSM marks and Current semester internal marks such as ATT, CAT, SSM, CDC and PW. The various data mining techniques are used to predict the students' performance. This study will help the teacher to reduced drop-out ratio to a significant level and improve the performance of students.

Keywords: Data Mining, Educational Data Mining, Clustering, Classification, Knowledge Discovery in Database (KDD)

1. INTRODUCTION

Data mining in educational environment is called Educational Data mining, concern with developing new methods to discover knowledge from educational database in order to analyze student's trends and behaviors towards education. The students' performance plays an important role in producing the best quality graduates and post-graduates who will become manpower for the country's economic and social development. Academic achievement is one of the main factors considered by the company in recruiting workers especially the fresh graduates. Thus, students have to place the greatest effort in their study to obtain a good grade in order to fulfill the company demand.

The data collected from different applications require proper method of extracting knowledge from large repositories for better decision making. Knowledge discovery in databases (KDD), often called data mining, aims at the discovery of useful information from large collections of data(Mannila,1996).

The main functions of data mining are applying various methods and algorithms in order to discover and extract patterns of stored data (U. Fayadd, Piatesky,1996). Data mining tools predict patterns, future trends and behaviors, allowing businesses to effect proactive, knowledge-driven decisions. The automated, prospective analyses offered by data mining move beyond the analysis of past events provided by retrospective tools typical of decision support systems.. There are increasing research interests in using data mining in education. This new emerging field, called Educational Data Mining, concerns with developing methods that discover knowledge from data originating from educational environments (J. Han and M. Kamber, 2000).

The main objective of this paper is to use data mining methodologies to study students' performance in the MCA course. Students' academic achievement is measured by the Aggregate Marks scored in an academic session. Aggregate Marks shows the overall students' academic performance where it considers the average of all examinations' grade for all semesters during the tenure in university. Data mining provides many tasks that could be used to study the students' performance. In this research, the classification task is used to evaluate student's performance. Student's information like previous semester marks, Attendance, Class test, Seminar and Assignment marks were collected from the student's database system, to predict the performance at the end of the semester examination.

Clustering is one of the basic techniques often used in analyzing data sets. This study makes use of cluster analysis to segment students into groups according to their characteristics.

2. BACKGROUND AND RELATED WORKS

Although, using data mining in higher education is a recent research field, there are many works in this area. Baradwaj and Pal [10] applied the classification as data mining technique to evaluate student' performance, they used decision tree method for classification. The goal of their study is to extract knowledge that describes students' performance in end semester examination. Han and Kamber[3] explained that k-means is a well known clustering algorithm tends to uncover relations among variables already presented in dataset. Hijazi and Naqvi [5] conducted as study on the student performance from a group of colleges affiliated to Punjab university of Pakistan. By means of simple linear regression analysis, it was found that the factors like mother's education and student's family income were highly correlated with the student academic performance. Khan [6] conducted a performance study on 400 students from the senior secondary school of Aligarh Muslim University. A sample of data clusters was selected for further analyses. It was found that girls with high socio-economic status had relatively higher academic achievement in science stream and boys with low socioeconomic status had relatively higher academic achievement in general.

El-Halees *4+, gave a case study that used educational data mining to analyze students' learning behavior. The goal of his study is to show how useful data mining can be used in higher education to improve student' performance. Galit, [8] gave a case study that use students data to analyze their learning behavior to predict the results and to warn students at risk before their final exams. Ayesha et al. [11], used k-means clustering algorithm as a data mining technique to predict students' learning activities in a students' database including class quizzes, mid and final exam and assignments. The information generated after the implementation of data mining technique may be helpful for instructor as well as for students. Z. J. Kovacic [7] presented a case study on educational data mining to identify up to what extent the enrolment data can be used to predict student's success. The algorithms CHAID and CART were applied on student enrolment data of information system students of open polytechnic of New Zealand to get two decision trees classifying successful and unsuccessful students. The accuracy obtained with CHAID and CART was 59.4 and 60.5 respectively. Pandey and Pal [12] conducted study on the student performance based by selecting 600 students from different colleges of Dr. R. M. L. Awadh University, Faizabad, India. By means of association rule they find the interestingness of student in opting class teaching language. Al-Radaideh et al. [9] applied the data mining techniques, particularly classification to help in improving the quality of the higher educational system by evaluating student data to study the main attributes that may affect the student performance in courses. The extracted classification rules are based on the decision tree as a classification method, the extracted classification rules are studied and evaluated. It allows students to predict the final grade in a course under study. Bray [13], in his study on private tutoring and its implications, observed that the percentage of students receiving private tutoring in India was relatively higher than in Malaysia, Singapore, Japan, China and Sri Lanka. It was also observed that there was an enhancement of academic performance with the intensity of private tutoring and this variation of intensity of private tutoring depends on the collective factor namely socioeconomic conditions.

3. DATA MINING PROCESS

The Data Mining Client is designed to walk you through the data mining process. The basic process in any data mining project is shown in Figure 1 (a).

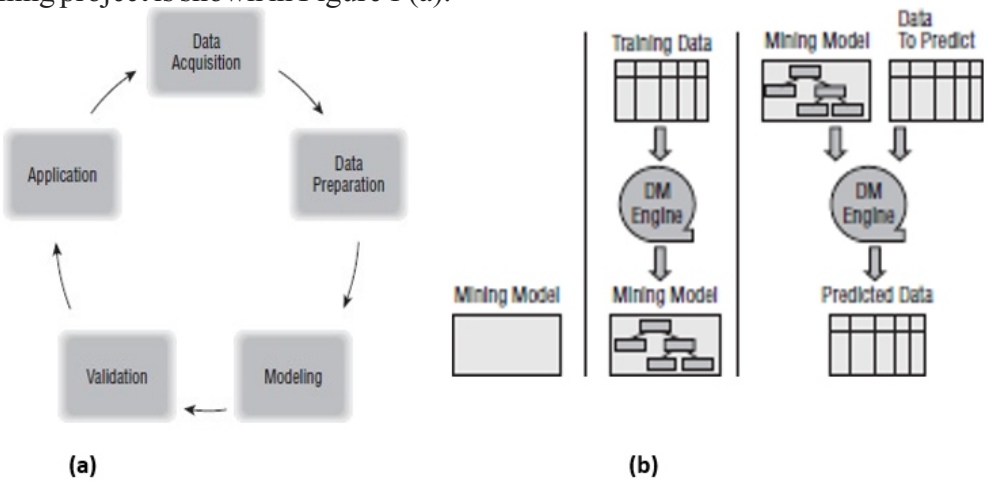


Figure 1 Data mining process for Data mining client Add-In [17]

Data acquisition tools are provided natively by Excel with the Data Mining Client. The Data Mining Client adds an additional method beyond those. Many users already have data in Excel-accessible formats, and Excel has tools for data importation. The other pieces of the data mining process are supported directly from the Data Mining Client ribbon, as shown in Figure 2. Each chunk of the ribbon indicates a step in the process.

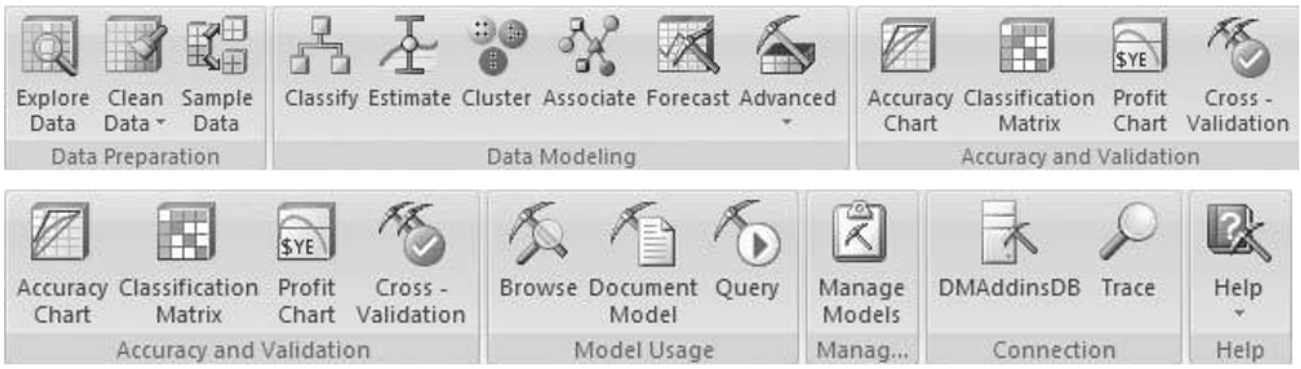


Figure 2 Data Mining Client ribbon [17]

4. APPLICATION OF DATA MINING TECHNIQUE

4.1 Application Software:-

In this study, data is collected from college students were analyzed using a data mining technique like classification and clustering. The data set used in this study was obtained from department of Master of computer Application (M.C.A.), Priyadarshini college of Engineering, in Mar-2013. SQL Server 2008 Data Mining Add-Ins for Microsoft Office 2007 is a freely downloadable package that allows you to unleash the power of SQL Server Data Mining. The Data Mining Client is available as a free download on the Microsoft website. The programming environment use for application was Excel 2007 with data mining Add-Ins for building data mining model and SQL Server 2008 is used to store the data. Data Mining Client for Excel This add-in enables advanced users to go through the full development life cycle for the data mining model within Excel by using either worksheet data or external data from SQL Server Analysis Services.

Excel is the business intelligence platform of choice for most actuaries, its statistical modeling capabilities are limited. Neural networks, classification and regression trees, and other data mining algorithms simply are not available in standard Excel installations. There is a good reason for this; most data mining algorithms require fast processors and largeamounts of memory, which are typically available only on servers. The Data Mining Client acts as a link between Excel (which is typically installed on a laptop or desktop computer) and a server running Analysis Services.

4.2 Data Preparations

The data set used in this study was obtained from Nagpur University, Nagpur (Maharashtra), India on the sampling method for MCA (Master of Computer Applications) course from session 2009 to 2012.

Initially size of the data is 48. In this step data stored in different tables was joined in a single table after joining process errors and missing values were removed.

4.3 Data Selection and Transformation

In this step only those fields were selected which were required for data mining. The data values for some of the variables were defined for the present analyses which are as follows:

- **PSM –** Preceding Semester Marks are obtained in MCA course. It is divided into five grades values: Distinction>=75, First >=60% , Second > =50% ,Third > = 40% , Fail < 40%.
- **ATT –** Attendance of Student. Minimum 75% attendance is compulsory to participate in University examination. Students with low attendance can also give university exam on ground of genuine medical issue. Attendance is divided into different classes as : Poor <45%, Average > = 45% and < 65%, Good > = 65% and<75, Excellent >=75 .
- **CAG –** Class Assignment grade obtained. In every semester two class tests i,e unit test are conducted and average of two class test are used to calculate total class assignment marks. CAG is split into three classes: Poor < 30%, Average >= 30% and <= 50%, Good >=50% and<70%, Excellent>=70%
- **CDC –** Career Development Carrier Performance are obtained. In each semester different CDC activity are planned like Group discussion, seminar, Mock interview, Aptitude test and extra curriculum activity to check the performance of students. Each student is supposed to take part for at least two extracurricular activities such as paper presentation, technical, cultural event, etc. The performance of students are evaluated according to the performance which can be categorized as 1 – Unsatisfactory, 2 – Satisfactory, 3 – Good, 4 – Exceptional
- **PW –** Practical Work / Project Work. Practical work is divided into two classes: Yes – student completed practical list or project assigned by teacher, No – student not completed practical or project assignment work.
- **SSM –** Semester Sessional Marks obtained. In every semester Sessional exam are conducted which is based upon complete syllabus. It is divided into five grades values: Distinction>=75, First >=60% and <75, Second > =45% and < 60%, Third > = 36% and < 45%, Fail < 36%.

4.4 Data Set

The data set used in this study was obtained from Nagpur University, Nagpur (Maharashtra), India on the sampling method for MCA (Master of Computer Applications) course from session 2009 to 2012. Initially size of the data is 48.

Name	PSM	ATT grades	CAT Grades	SSM	CDC Grades	PW
ABHIJIT GINAGULE	First	Excellent	Good	Poor	Good	YES
ABHISHEK Dinesh KUMAR	First	Excellent	Good	Average	Satisfactory	YES
ABHISHEK Shankar KUMAR	Third	Good	Good	Poor	Satisfactory	YES
ANAS M. KHAN	First	Excellent	Good	Average	Good	YES
ANUP KUMAR JHA	Second	Excellent	Poor	Poor	Satisfactory	NO
ASHVANI K. BHARADWAJ	First	Excellent	Good	Poor	Good	YES
ATUL SUROSHE	First	Good	Good	Poor	Satisfactory	YES
BHIMRAO GAYAKWAD	First	Excellent	Good	Poor	Good	YES
DINESH UDAYPURE	Third	Average	Poor	Poor	Satisfactory	NO
GHOUSIYA FARHEEN SHEIKH	First	Excellent	Good	Average	Good	YES
GITESH CHARPE	Second	Poor	Poor	Poor	Satisfactory	NO
GOPAL BADHE	Second	Excellent	Good	Poor	Good	YES
GULSHAN TRIVEDI	First	Excellent	Good	Poor	Good	YES
HARSHA NANDURKAR	First	Excellent	Good	Average	Good	YES
JAYASHRI ZADE	First	Excellent	Good	Average	Good	YES
KANCHAN KARWATKAR	Second	Good	Good	Poor	Good	YES
KRANTI SHRIKHANDE	First	Excellent	Good	Poor	Good	YES
MAHENDRA K.RATNAKAR	First	Good	Good	Poor	Satisfactory	NO
MAYUR TIRARMARE	Second	Excellent	Good	Poor	Good	YES
MAYURI NAGPURKAR	First	Excellent	Good	Average	Good	YES
MEGHA GANER	Second	Excellent	Good	Poor	Satisfactory	YES
NEELAM WASNIK	Third	Excellent	Good	Poor	Satisfactory	NO
NEHA SHINGNAPURKAR	Second	Excellent	Good	Poor	Good	YES
PIYUSH ITKHEDE	Second	Good	Good	Poor	Good	NO
PRACHITI MESHRAM	Second	Average	Average	Poor	Good	NO
PRAVIN KUMAR	Second	Good	Good	Poor	Satisfactory	NO
PRIYANKA BORKAR	Fail	Poor	Poor	Poor	Good	YES
REWATI BOREKAR	First	Excellent	Good	Poor	Good	YES
ROSHANI WASEKAR	Second	Excellent	Good	Average	Satisfactory	YES
ROSHNI BAJIRAO	First	Average	Good	Poor	Good	YES
RUSHIKESH PATTEWAR	First	Excellent	Good	Average	Satisfactory	YES
SANKET KAPSE	Second	Good	Good	Poor	Good	YES
SHAGUFTA ANJUM	Second	Excellent	Poor	Poor	Unsatisfactory	NO
SHEET KUMAR	Second	Excellent	Good	Average	Good	YES
SHILPA DAKHORE	Second	Excellent	Good	Poor	Good	YES
SHRUTIKA POTWAR	First	Excellent	Good	Average	Good	YES
SHUBHAM NEMA	Third	Poor	Average	Poor	Unsatisfactory	NO
SUJAY NERKAR	Second	Excellent	Good	Poor	Good	YES
SWAPNIL KAMBE	First	Good	Good	Poor	Good	YES
TEJAS BHAGWATKAR	First	Good	Good	Poor	Good	YES
VARUN KUMAR	First	Excellent	Good	Average	Satisfactory	YES
VINOD K. PUSHPATODE	Third	Poor	Poor	Poor	Unsatisfactory	NO
YOGITA HEDAOO	First	Excellent	Good	Poor	Satisfactory	YES

Table 1:- Sample Records of Students' Data Set

4.5 Implementation of Data Mining Model and result discussion

With the release of Excel 2007 and SQL Server 2008, it is possible to build complex statistical models directly in Excel. The visualizations offered for the Microsoft Naıve Bayes algorithm suggest a different kind of application: analyzing the key influencers for a specific target.

A. Analyze Key Influencers

The Analyze Key Influencers tool analyzes the correlation between all columns in your table and a specified target column. The result is a report that identifies the columns having significant influence on the target and explains in detail how this influence manifests itself. The Analyze Key Influences tool will create a report as shown in figure 3, that shows how strongly PSM, affect the CDC, ATT and PW

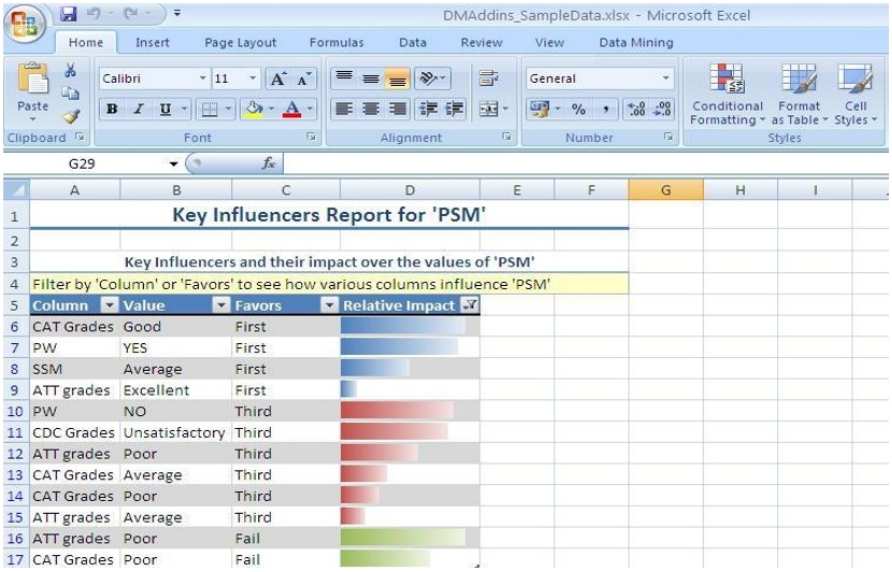


Figure 3:- The main output report generated by Analyze Key Influencers tool for 'PSM'

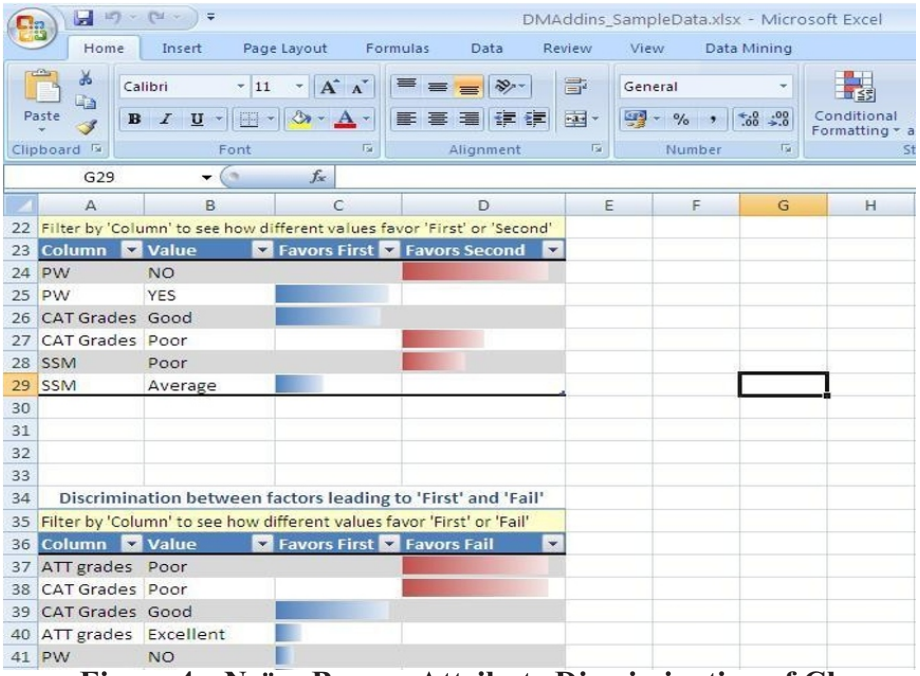
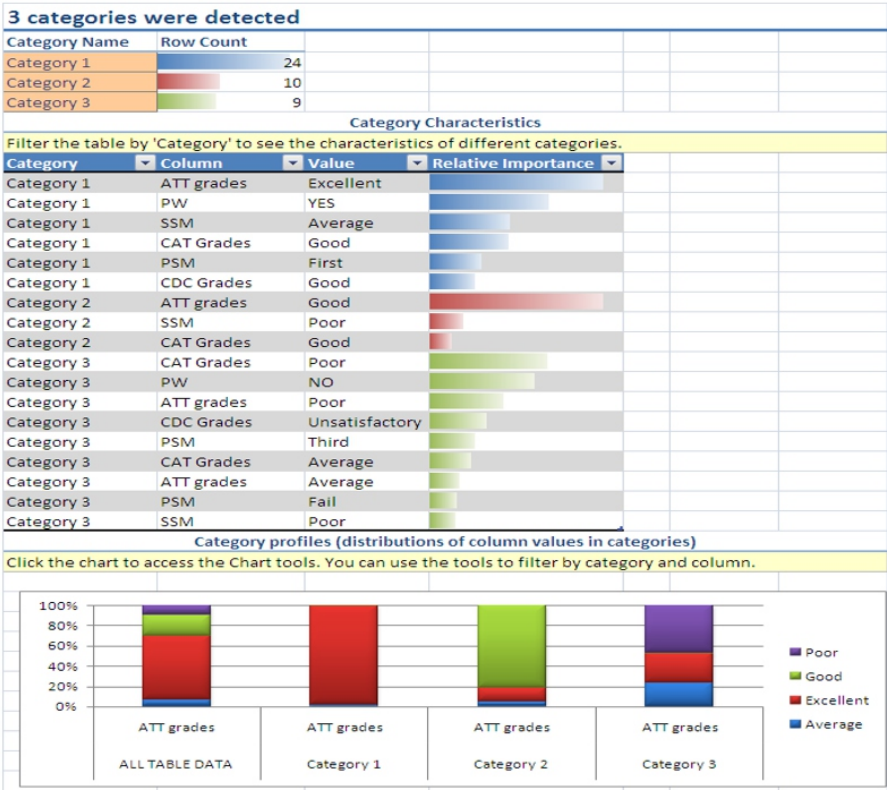


Figure 4:- Naïve Bayes : Attribute Discrimination of Class

From above figure 4, it is cleared that relative impact of PSM First category is more for those who have done practical/project work and scored good marks in Class assignment test.Relative impact of PSM Second Category is more for those who have not performed Practical/project work and scored Poor grades in CAT.

B. Detect Categories

The Detect Categories tool uses a clustering algorithm. It identifies rows in the table that are similar and assigns the similar rows to a category. The final number of categories will depend on the number of identifiable groups of similar rows.



3 categories were detected

Category Name	Row Count
Category 1	24
Category 2	10
Category 3	9

Category Characteristics

Filter the table by 'Category' to see the characteristics of different categories.

Category	Column	Value	Relative Importance
Category 1	ATT grades	Excellent	
Category 1	PW	YES	
Category 1	SSM	Average	
Category 1	CAT Grades	Good	
Category 1	PSM	First	
Category 1	CDC Grades	Good	
Category 2	ATT grades	Good	
Category 2	SSM	Poor	
Category 2	CAT Grades	Good	
Category 3	CAT Grades	Poor	
Category 3	PW	NO	
Category 3	ATT grades	Poor	
Category 3	CDC Grades	Unsatisfactory	
Category 3	PSM	Third	
Category 3	CAT Grades	Average	
Category 3	ATT grades	Average	
Category 3	PSM	Fail	
Category 3	SSM	Poor	

Category profiles (distributions of column values in categories)

Click the chart to access the Chart tools. You can use the tools to filter by category and column.

Figure 5:- Evaluation of categories based on ATT(Attendance variable)

From figure 5, it is cleared that according to ATT factor the data was categorized into three groups, Category 1 having excellent attendance, Category 2 students having good to average attendance and category 3 students having average to poor attendance.

C. Clustering Algorithms

Classification and estimation algorithms are two classes of supervised algorithms. The term "supervised" is used to describe data mining algorithms that model a pre-selected dependant variable. "Unsupervised" algorithms, such as clustering algorithms, look at all of the available data in order to identify patterns. All patterns, rather than just those affecting the dependant variable, are reviewed and analyzed. Clustering algorithms try to split records into similar groups. The Data Mining Client for Excel makes it easy to interpret the groups identified by the clustering algorithm.

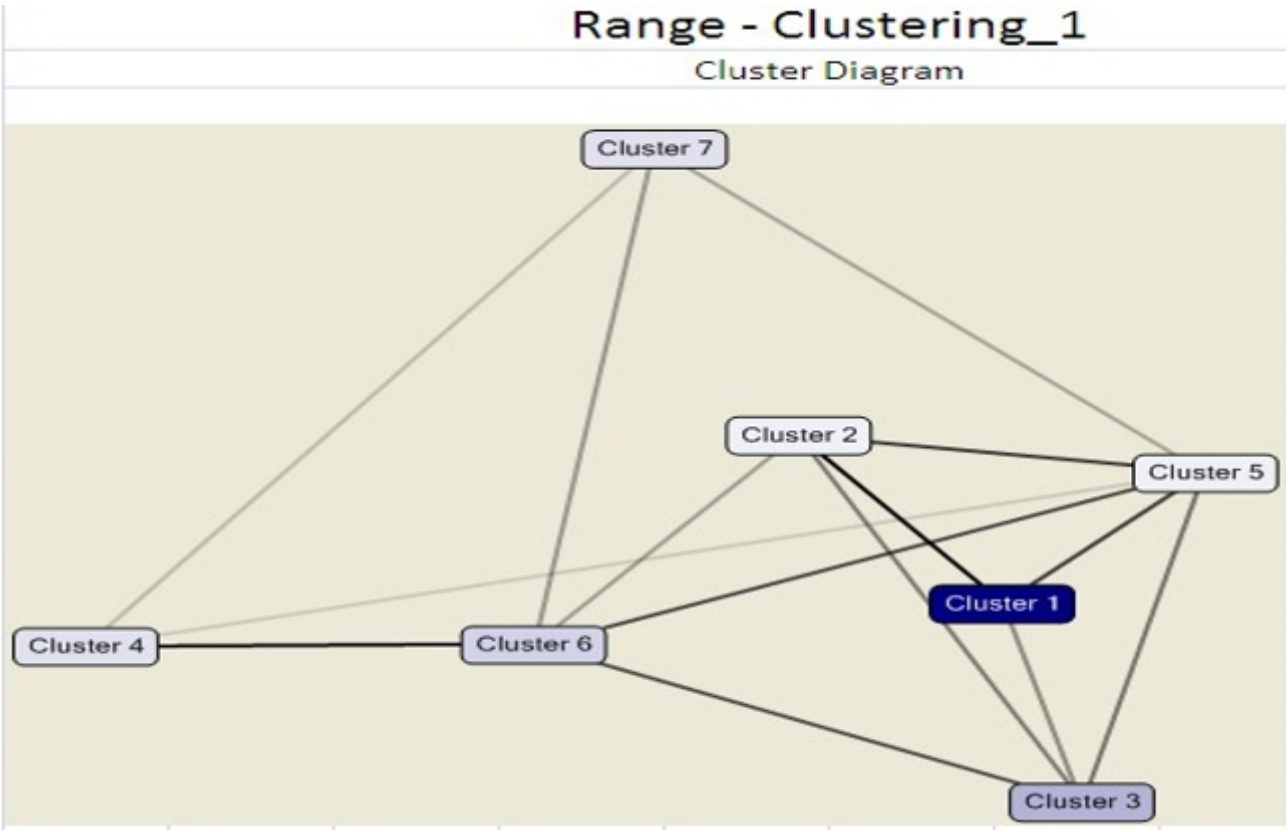


Figure 6:- Cluster Diagram

A cluster diagram allows the analyst to see the relationship between various clusters, based on different attributes. The darkest line in Figure 6 shows that clusters 3, 4, 6 and 7 are most similar, while the various shades of color show how the cluster are related with respect to the "population" variable.

Range - Clustering_1

Cluster Profiles

Variables	States	Population (All)	Cluster 1	Cluster 3	Cluster 6	Cluster 7	Cluster 4	Cluster 2	Cluster 5
Size		31	17	5	3	2	2	1	1
ATT grades	Excellent	10	82 %	54 %	29 %	1 %	15 %	69 %	44 %
ATT grades	Good	5	12 %	46 %	44 %	9 %	28 %	11 %	37 %
ATT grades	Poor	3	0 %	0 %	13 %	52 %	30 %	14 %	4 %
ATT grades	Average	3	6 %	0 %	14 %	38 %	28 %	5 %	15 %
CAT Grades	Good	15	100 %	100 %	73 %	10 %	43 %	86 %	84 %
CAT Grades	Poor	3	0 %	0 %	26 %	1 %	57 %	14 %	4 %
CAT Grades	Average	2	0 %	0 %	1 %	89 %	0 %	0 %	12 %
CDC Grades	Good	12	100 %	2 %	9 %	45 %	0 %	95 %	97 %
CDC Grades	Satisfactory	6	0 %	98 %	79 %	3 %	70 %	5 %	2 %
CDC Grades	Unsatisfactory	2	0 %	0 %	12 %	52 %	30 %	0 %	1 %
PW	YES	12	100 %	77 %	18 %	0 %	2 %	100 %	56 %
PW	NO	8	0 %	23 %	82 %	100 %	98 %	0 %	44 %
SSM	Poor	16	71 %	70 %	93 %	100 %	99 %	74 %	84 %
SSM	Average	4	29 %	30 %	7 %	0 %	1 %	26 %	16 %

Figure 7:- Cluster Profiles

The figure 7 shows "cluster profiles", which are essentially a univariate statistical analysis of each of the variables, for both the overall population and each cluster individually. This view makes it possible to identify the differences between the clusters.

Range - Clustering_1

Cluster Characteristics

Population (All)

Variables	Values	Probability
SSM	Poor	81 %
CAT Grades	Good	77 %
PW	YES	62 %
CDC Grades	Good	58 %
ATT grades	Excellent	50 %
PW	NO	38 %
CDC Grades	Satisfactory	32 %
ATT grades	Good	24 %
SSM	Average	19 %
ATT grades	Poor	13 %
CAT Grades	Poor	13 %
ATT grades	Average	13 %
CDC Grades	Unsatisfactory	10 %
CAT Grades	Average	10 %

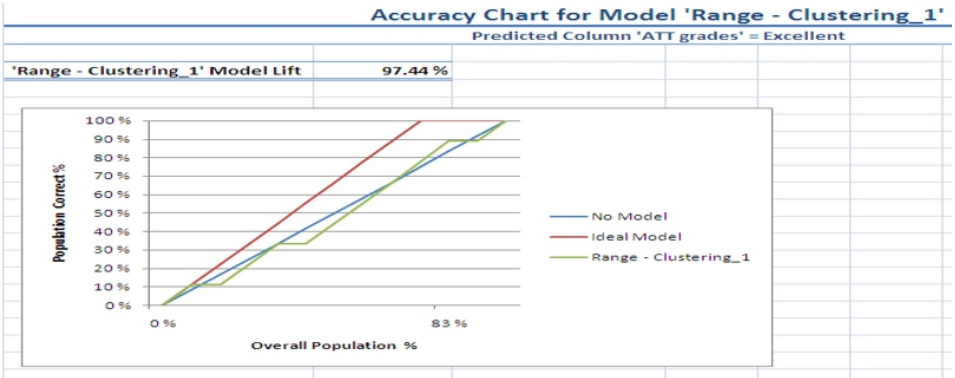
Figure 8- Cluster Characteristics

The figure 8 shows "cluster characteristics" makes it possible for an analyst to understand the nature of a given cluster. Characteristics are values of a given variable that help distinguish one cluster from another.

D. Accuracy and Validation

The Accuracy and Validation section of the data mining toolbar allow analysts to evaluate the quality of a data mining model. Models can be evaluated using accuracy charts, a classification matrix, profit charts or the cross-validation method. Lift chart, this graph shows how a chosen model compares to a perfect model and a model based on random guessing.

Accuracy Chart – Evaluates the performance of the model against test data by drawing a lift chart for classification models and a scatter plot for estimation models.



Percentile	Ideal Model	Range - Clustering_1
0 %	0.00 %	0.00 %
8 %	11.11 %	11.11 %
17 %	22.22 %	11.11 %
25 %	33.33 %	22.22 %
33 %	44.44 %	33.33 %
42 %	55.56 %	33.33 %
50 %	66.67 %	44.44 %
58 %	77.78 %	55.56 %
67 %	88.89 %	66.67 %
75 %	100.00 %	77.78 %
83 %	100.00 %	88.89 %
92 %	100.00 %	88.89 %

Figure 9:- Accuracy chart of Clustering model Attendance class

The figure 9 shows how accurate the data mining model is; in this example, the 50% of students whom the model selects as most likely to have ATT grades='Excellent', 44.44% of the total students who will actually have excellent attendance grades.

E. Classification Matrix

Displays a matrix of correct and incorrect classifications by evaluating your model against test data. To create Classification Matrix, click the Classification Matrix button in the Accuracy and Validation Section of the Data Mining ribbon.

Counts of correct/incorrect classification for model 'Range - Clustering_1'

Predicted Column 'ATT grades'
Columns correspond to actual values
Rows correspond to predicted values

Model name:	Range - Clustering_1	Range - Clustering_1
Total correct:	58.33 %	7
Total misclassified:	41.67 %	5

Results as Percentages for Model 'Range - Clustering_1'

	Average(Actual)	Excellent(Actual)	Good(Actual)	Poor(Actual)
Average	**0.00 %**	0.00 %	0.00 %	0.00 %
Excellent	0.00 %	**77.78 %**	100.00 %	0.00 %
Good	0.00 %	22.22 %	**0.00 %**	100.00 %
Poor	0.00 %	0.00 %	0.00 %	**0.00 %**
Correct	**0.00 %**	**77.78 %**	**0.00 %**	**0.00 %**
Misclassified	**0.00 %**	**22.22 %**	**100.00 %**	**100.00 %**

Results as Counts for Model 'Range - Clustering_1'

	Average(Actual)	Excellent(Actual)	Good(Actual)	Poor(Actual)
Average	**0**	0	0	0
Excellent	0	**7**	2	0
Good	0	2	**0**	1
Poor	0	0	0	**0**
Correct	**0**	**7**	**0**	**0**
Misclassified	**0**	**2**	**2**	**1**

Figure 10:- Correct and misclassified Classification of Attendance category

5. CONCLUSION AND FUTURE WORK

In this paper, we gave a case study in the educational data mining. It showed how useful data mining can be used in higher education particularly to improve students' performance. We used post graduate students data collected from the department of MCA, Priyadarshini college Engineering, Nagpur. This study will help the students and the teachers to improve the performance of the students. This study is also helpful for those students who need special attention and will also lower failure ratio by taking proper action for the nextsemester examination. The information generated after the implementation of data mining technique may be helpful for a teacher as well as for students.

FUTURE WORK:

Our future work include applying data mining techniques on an expanded data set with more distinct attributes to get more accurate results. The future work can be done using more data mining techniques such as neural nets, genetic algorithms, k-mean, and others data mining model. Some different software's may be exploited using various factors to refine our technique in order to get more accurate outputs.

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Application of M-Commerce in India

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ABSTRACT

Mobile computing has spread almost every aspect of life - personal, social and economic systems. The maturity of the technology and its affordance has allowed its application to commerce thereby yielding the area of mobile commerce. It encompasses interactive business activities and processes related to a commercial transaction conducted through communications networks that interface with wireless devices. These systems provide a new way to organizations and users for performing various commerce-related tasks without regard to time and location. The purpose of this article is to explore how mobile applications have been applied in various domains of life in India. We hope that this study will provide useful insights into the application of m-commerce. The authors conclude that M-Commerce may, become the most prevailing method of conducting business transactions because of its obvious benefits.

INTRODUCTION

Mobile commerce (M-commerce) can be viewed as a subset of E-commerce [1, 2] and refers to any transaction with monetary value that is conducted via a mobile network. It is defined as a value-added service that enables mobile users to conduct reliable and secure transactions using well designed mobile applications. Its features may be summarized as follows:

- It allows the user to network with a mobile application everywhere, even while driving or moving.
- It has the ability of an application to offer a service specific to the location of the customer i.e. it provides location based services.
- It has the ability to amend an m-commerce activity according to a customer profile, and use the customer's account for payment.
- The applications are available at any time & anywhere.

These features can be described as ubiquity, Locality and personalization and accessibility. M-Commerce is slowly becoming a dominant force in business and our social setup. There has been substantial advancement in technology and also the people demand for communications which are not only cost effective but can also deliver fast and easily accessible from anywhere anytime and this has revolutionized the telecommunications industry over the past two decades.

The market for mobile technologies has seen significant growth in the past few years. This is creating new openings for the expansion of m-commerce. According to a study conducted by Forrester Research Inc. Mobile Commerce Forecast 2012-17(US), Total M-Commerce growth will be 129% in 2012, 62%

in 2013, 40% in 2014, 29% in 2015 & 21% in 2016.Ericsson estimates that by 2018, 85% of the world's population will have access to mobile-broadband coverage via 3G networks, and 50% will have 4G.

CLASSIFYING M-COMMERCE RESEARCH AREAS:

M-commerce is relatively a new area. Research in this area has been conducted starting from 2'000s. Varshney and Vetter developed a 4-level framework for m-commerce within which M-Commerce operates. It includes M-commerce applications, Wireless user infrastructure, Mobile middleware, and Wireless network infrastructure. M-commerce applications need the technology of wireless user infrastructure, mobile middleware platform , and wireless network base. [3,4,5] whereas Wireless Use Infra structure includes Mobile Interfaces and , Mobile handheld devices.

This framework includes:

1. Theory of Mobile Commerce covers application development and guidelines for M- Commerce behavior issues, economics, strategies ,business models and legal issues
2. Wireless Network Base covers Networking requirements and Wireless and mobile network
3. Mobile Middleware is software that connects disparate mobile applications, programs and systems. It covers software Agent Technologies, Database Management, Protection issues, Wireless and mobile communication systems, Wireless and mobile Network protocols.
4. Wireless User Infrastructure deals with Mobile networks and Mobile handheld device.
5. Cases & Applications of M-Commerce includes Location-based services(LBS), Mobile marketing, Mobile leisure services and games, Mobile monetary applications, Product locating and searching, Wireless re-engineering etc.

APPLICATION AREAS OF M-COMMERCE:

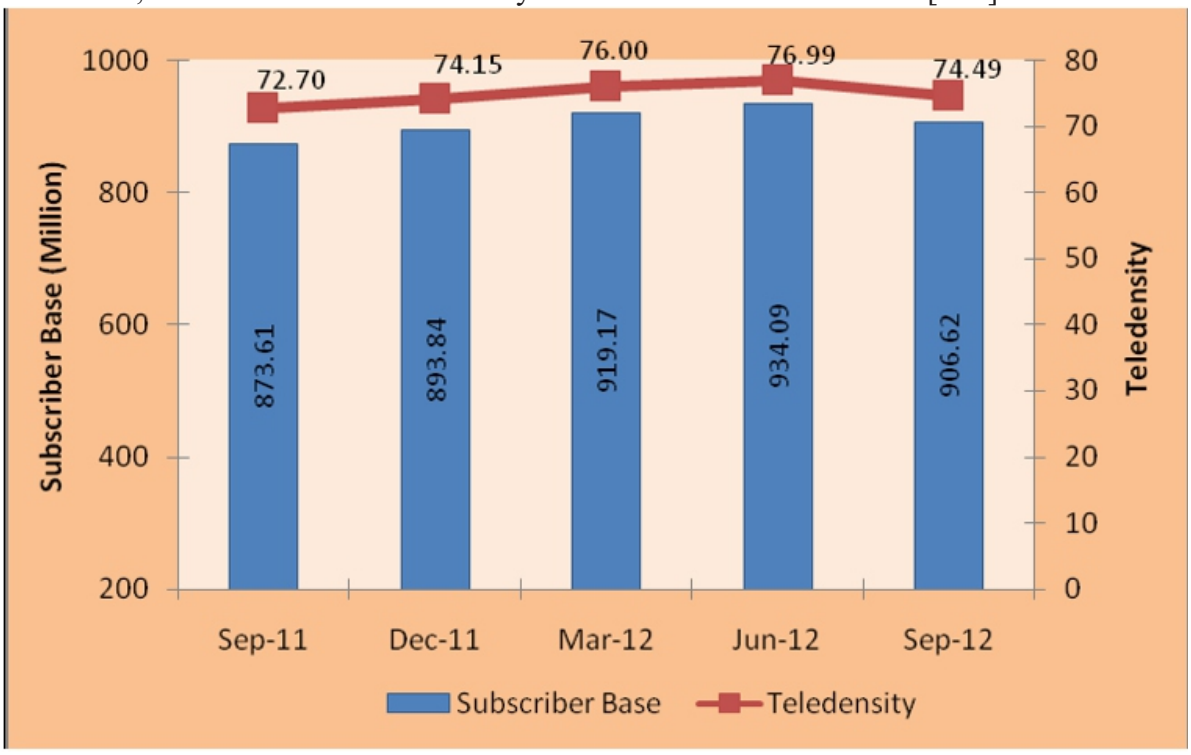
M-commerce has opened new ventures for mobile phones and services. Mobile Phones which were initially used to make voice calls are now have full spectrum of uses in terms of entertainment (games, songs, videos etc), social networking (facebook, twitter, whatsap etc.) and commercial transactions and much more. These services are expected to overtake voice in revenue generation for operators. The market for mobile phones – smart phones, handheld computers and wireless PDAs is increasingly motivated by multimedia-based Internet applications M-Commerce applications can be divided into three areas [6]. These are Mobile Payment, Mobile Entertainment and Mobile Business.

- Mobile Payments: Local Payment, E-Tickets, Transportation and ,Remote Payment Stock Trading Banking
- Mobile Business: Enterprises, Public Organizations, Medical Insurance and Financial Sales
- Mobile Entertainment: Content Download and ,Town information

M-COMMERCE IN INDIA:

HomeShop18 promises that M-commerce will contribute more than 25 per cent of the total traffic in e-commerce (online shopping) by 2015. Its CEO & founder Sundeep Malhotra says "In the next three years mobile commerce will constitute more than 25 per cent of the total traffic in e-retailing,"

- As per IAMAI (Internet and Mobile Association of India) and IMRB (Indian Market Research Bureau), India is expected to have close to 165 million mobile Internet users by March 2014, up from 87.1 million in December 2012 since more people are accessing the web through mobile devices.
- TechNavio's report of the "Mobile Commerce Market in India 2012-2016" estimate the Mobile Commerce market in India to raise at a CAGR(Compound Annual Growth Rate) of 71.06 percent over the period 2012-2016. One of the prominent factors accelerating this market is the growth in mobile subscriptions. The M- Commerce marketplace in India has also been receiving government and regulatory support.
- Acc. To TRAI's The Indian Telecom Services Performance Indicators July-Sept 2012 released on 11 Jan. 2013 ,the mobile subscribers for the year 2011 & 2012 are as follows: [ibid]



PROMISES & PROBLEMS:

M-commerce revolution is bound to create a deep impact in India where the Mobile phone usage is on increase (all companies including Apple, Samsung, Blackberry, Nokia, Micromax, LG, HTC, are majorly promoting these) and new customer friendly applications are being developed so as to improve upon the services and to make them more personalized, time bound and those which create awareness. The potential of M-commerce is being utilized by corporate and there is much more to happen in coming years. The upcoming 4G systems are considered to have better security, higher speeds, more capacity,

less costs, and intelligent devices which will help in achieving m-commerce applications. Improved wireless security and privacy using data encryption and user education and the wide deployment of 4G systems, it is likely that m-commerce may, become the most prevailing method of conducting business transactions. We are already witnessing payments, ticket bookings, data transfer including photographs with lesser times, easy access to information worldwide etc. through mobile applications, But M-commerce has certain limitations in terms of security, limited bandwidths, low data transmission speeds, inadequate coverage, limited access to financial services, health concerns and government regulations. These resources are much better in developed countries as compared to India.

CONCLUSION:

Although M-Commerce is novice, it is promising a great Business revolutionary change in India. It has a big market in India which is yet to be explored. A large population having access to mobile devices is a potential market for M-Commerce applications. There is a growing awareness among the business community in India about the would-be benefits of M-Commerce. On the other hand, M-commerce has presented certain challenges such as lack of trust, expensive, security in Indian business environment .But one thing is certain that is Mobile commerce is anticipated to grow by leaps & bounds in India . It has a great scenario in the second most populated country of World.

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