Data, Information and Knowledge & Reuse Management Techniques

O. K. Harsh

Abstract— **I propose and analyze the data, knowledge and information in three dimensions and conclude that they along with the factors mentioned below play a major role in managing knowledge. I also discuss the role of knowledge reuse management in the technological environment. Discussion on several issues like reusable knowledge creation, reusable knowledge validation, and reusable knowledge interaction has been given.**

It has been proposed that to effectively apply the knowledge reuse and management programs, an organization will have to consider knowledge reuse as an independent activity which should be carefully dealt with management activities. We propose that by considering the time factors a three dimensional model on knowledge reuse may be suggested.

It can be concluded that inclusion of knowledge reusability and time as independent quantities can provide us a better picture for the reuse knowledge management as well as it helps us in understanding the effective interaction between technologies, people and techniques.

Index Terms— **Knowledge Management, Knowledge Reuse, Knowledge Reuse Management, Three Dimensional Model**

I. Introduction

Software quality and productivity are mainly concerned when we want to manage and reuse software. Management especially reuse management is a complex process and under this process it is very difficult to select or predict an appropriate type of metrics to allow an organization to benefit optimum.

Knowledge management term is not well defined as data, information and knowledge .According to Sallis and Jones [7] knowledge management may be defined as the systematic way of managing individual, group and organizational knowledge with the help of appropriate means and technology. Knowledge management solution can not be derived from the technology because important knowledge is in the human brain and it flows from one person to another person and one organization to another organization in making decisions. However, Knowledge management takes the power of technology, communication and social interaction.

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O. K. Harsh is with the University of New England, Armidale, Australia (00968 9267 3249; email: oharsh@gmail.com)

The importance of Knowledge management and reuse is connected with the cost, effort and savings which are closely related with the quality of the knowledge. Reusable knowledge management is more complicated due to repeated application of the qualitative knowledge. Selection of qualitative knowledge is also associated with the types of data, information which constitutes the knowledge.

Any technique which makes improvement in the quality of data and information can create a qualitative knowledge. The power of qualitative knowledge may be further enhanced by the application of technology, technique and the culture of the people.

Knowledge management has been becoming an active area for business around the world. People believe that an organization can manage its knowledge (including reuse knowledge) by managing knowledge management programs. However, people are not aware of effective knowledge reuse and management programs in terms of technologies, techniques, people and culture. People are also not aware about the creation of data, knowledge and information with the intention to reuse them in near future. Thus aside from knowing from knowledge management programs we must also know the proper interaction of technologies, techniques and methods as well as proper data and information to handle the knowledge reuse and management programs. In addition to these we should also take into account the social and cultural issues.

Many large organizations have been working with knowledge management so that they can improve profits and can survive in the competitive world [1-6]. Proper exploitation of technology can make enable to organizations to derive knowledge from data and information collected during the progress of the business which can help in decision-making or product development.

From the available literature on Knowledge Management we can infer that there is much debate about the related knowledge with regard to data and information.

Based on the literature, one can divide Knowledge into two main categories: explicit knowledge and tacit knowledge. We take the explicit knowledge which can be defined as things that are clearly stated or defined, while tacit knowledge can be defined that are not documented or can not be defined straight forward but rather it is implicit [7- 10].

According to Jim Highsmith [12] "When we attack reuse as a knowledge management problem we begin to ask new

questions, or at least look for different avenues for finding solutions to the problem. How do we go about finding the component we need? How do we gain confidence that the component does what we want it to do, and doesn't do strange things that we don't want? How should we go about testing this component? How easily will this component integrate into our environment"?

Transformation of one form of knowledge to another and their reuse with the help of different types of technologies techniques and methods is very complicated. It becomes more complicated if we consider the simultaneous involvements of technologies, techniques and techniques on the reuse programs.

Hastings and Sajeev [13] measured software size from requirements specifications. According to them Specification-based size measures are desirable since they are available early in the life cycle thus helping with timely estimation of effort. They have proposed a two dimensional model based in the functionality and complexity to measure the software reuse in the form of OP's. Their work was based on the argument of Fenton (1991) that software size, S, is a function, f_S , of length, functionality, and problem complexity. Harsh and Sajeev [14] extended the work of Hastings and Sajeev [13] to three dimension to explicitly involve the reusability by proposing a three dimensional model by accounting reusability as a separate third dimension. This model was not only successful to calculate the reuse empirically while it also analysed all the eight properties proposed by Devanbu *et al* [15].

However, there is a lack of research related to reuse management with reference to data, information and knowledge. No one so far tried to incorporate the concept of time with data and information. Therefore, in the present work an effort is being made to discuss these issues.

Thus in the present work we discuss that how data, knowledge and information are related with time in a three dimensional environment. We intend to analyze the reuse management techniques. We also discuss a three dimensional model by proposing an independent concept of knowledge reusability and then discuss its applications.

Thus in the present paper we decided to (a) describe the Data, information and Knowledge in an integrated three dimensional environment with the intention to reuse in future (b) explain the types of knowledge reuse and management concepts in the three dimension and finally (c) effect of involvement of time on the reuse management systems

Present paper notices the valuable outcome to academic and business arena. Both academic and industry started to consider the reuse and management as an additional knowledge and repository for the future applications. Reuse helps the organization to create better projects for less and hence builds the Competitiveness with less efforts and investments. We can build a reuse knowledge management base by considering reuse parallel to knowledge management. We see in the present work that as a result of reuse knowledge, we find a hope of new wave with the existing infrastructure.

II. DATA, INFORMATION AND KNOWLEDGE

According to the Bellinger [16] "data is a meaningless point is space and time. It may be regarded as an event out of context, a letter of context, a word out of context". According to this author "data is out of context and therefore it is without meaningful relation to anything else". As we know that without relation data is no more information. It is possible that piece of data may describe information.

We can label the components in the system as differentiation [17] because they are the context independence while it is appropriate to label the integration word (integration of components) as integration.

We can describe same set of data as knowledge to some people while information to others. Knowledge may be regarded as context dependent and therefore understanding knowledge reusability for a given system is an important quantity. Human mind is responsible which see the knowledge to data or data to the knowledge in the relevance of a given task. Work of Marakas [18] suggests that "knowledge may be regarded as a context dependent because it is a particular paradigm which is responsible for its interpretation".

The work of Csikszentmihalyi's [17] (on data, information and knowledge) was extended by the Gene Bellinger [16], (see Fig 1, 2 and 3). If we see this work then one can guess that reusability can reduce the overall dependence of data and information from the knowledge point of view. Reusability of knowledge can not only intensify the entire knowledge while it creates a qualitative or verifiable knowledge. However, we do not know exact value of the knowledge reusability for a given system because it is not only varies with data and information while at the same time we do not know about the particular type of knowledge in context to its applicability and therefore it is always desired to mention the effective knowledge reusability. Further, this entire knowledge of any given system always increases as the time increases. In modern technological environment increasing data and information can not be avoided and thus the time should also be considered along with the effective reusability. Thus our proposal is that in Fig 1 reusability (data, information and knowledge) and time should be taken into account in the above model.

Thus present proposal is that inclusion of effective reusability over the time or effective reusability (data, information and knowledge) rate can manage data, information and knowledge more appropriately. Present model can also define relations

between data, information and knowledge in an organization more closely (see Fig 4).

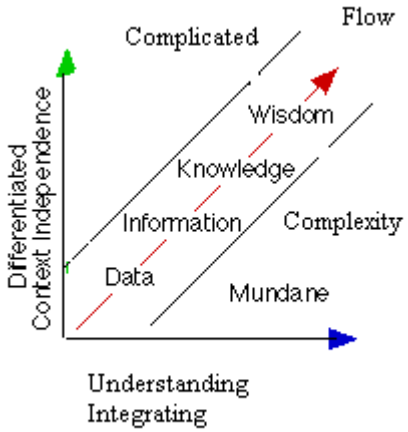

Fig 1: Graph between Context independence and Understanding [16].

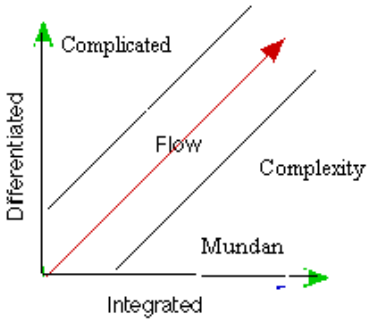

Figure 2: Graph between Differentiation and Integration [16].

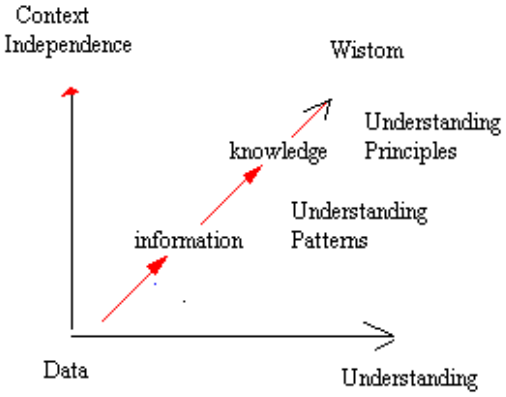

Figure 3: Graph between Representation of Data, Information, Knowledge and Wisdom [16].

The work of Ana Candida Cruz Natali and Ricardo de Almeida Falbo [19] suggest that there are two aspects of knowledge management in software engineering, they are the technical development for effective knowledge management and research involving effect of knowledge management on a given organization.

Fig 4 helps us in understanding the effective knowledge reusability rate with the growth of information and knowledge in a given system.

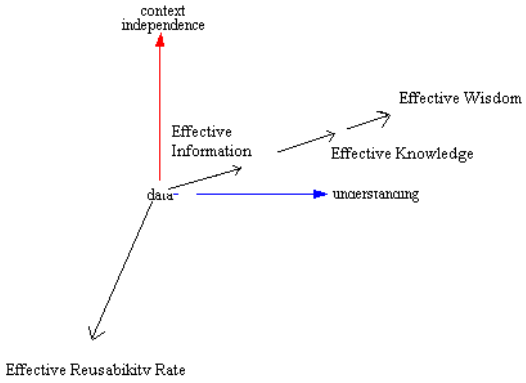

Figure 4: Proposed variation of Understanding, context independence with Reusability Rate

Inclusion of effective reusability rate (it could be data, information, knowledge or wisdom) is useful for any organization if we could exploit the component reuse properties.

Reusability without time can not be considered here because data are continuously being converted into information, information into knowledge and knowledge into wisdom as a result, knowledge component properties are affected. If we could select appropriate knowledge components at a particular moment (based on the reuse properties mentioned above) then

it not only can boost the faster knowledge while we will be able to make more qualitative knowledge.

When considering organisational reusable knowledge and the management of this reusable knowledge, what we need to make sure is that this is not seen simply as the acquisition of more data and information. Effective knowledge management is more about managing the human resource and its interaction with the technology. No doubt that People are the major factor in the making knowledge management success or failure. Thus Knowledge management is closely related with people management.

Now the question is that how the people perceive the data, information and knowledge from the given project point of view? How People do perceive the tacit and explicit knowledge?

Now wisdom which is beyond the knowledge (see Fig 2 or 3) may be the key to success. Thus we need experienced people who not only have substantial experience in their organization while at the same time they can make a learning environment for others. This can help the people not only in reusing knowledge while they can share and allow sharing the knowledge.

TYPES OF REUSABLE KNOWLEDGE AND ASSETS:

Reusable knowledge is necessary for a given project or organization. We can make a Reusable knowledge base by collected knowledge as well as through experience. We need to understand the history and needs of the organization. The reusable assets of an organization must be coupled with the existing and available technologies, techniques and methodologies. However, the interpreter is human mind which is only based on large number of factors. Ultimately management is done by people by adopting a sketch of series of past events or success related to the finished projects or tasks. Pattern of success will have to be identified and should be simulated in accordance with the requirements of present project.

Similar to the knowledge creation, validation, distribution and application processes as knowledge management, reusable knowledge also involve these steps. These processes may be within a project or between the projects. We can identify and collect reusable knowledge and assets at each stage of the project developments. Any organisation can learn from their past experiences and history in these areas. Knowledge management models are therefore essential for understanding the process of management of reusable knowledge. We therefore discuss reusable knowledge creation, reusable knowledge validation, reusable knowledge presentation, reusable knowledge distribution, reusable knowledge application and reusable knowledge cultures.

3 (a). REUSABLE KNOWLEDGE CREATION

In the later phases of a project it is important that management makes sure
to initiate learning from the project so that knowledge and experience are shared and leveraged in the organization in the subsequent projects.

Reusable knowledge creation varies over time in the different phases. As mentioned above the data and information is created with a view to reuse in the future, therefore, we have to monitor each phase of the project over the time. Motivation and inspiration should be used at each stage of the life cycle of the project to tape the reusable knowledge.

3 (b). REUSABLE KNOWLEDGE VALIDATION

Knowledge creation means the capability of an organization to develop new and useful ideas and the solutions. By reconfiguring and reusing foreground and background knowledge and reusing the available assets and different sets of interaction, an organization can build new asset of knowledge. It can not be recommended that in every situation we create a new knowledge. It is always desirable to use the existing knowledge in an appropriate way.

However, all existing knowledge can not be reused.
We can adapt some of the existing knowledge by compromising some of our requirements.

Reusable knowledge validation is a continuously monitoring process. It is a matter of experience.

3. (c) REUSABLE KNOWLEDGE PRESENTATION

Reusable knowledge presentation means the ways the reusable knowledge is displayed for the organizational members. It is up to the organizations that how it devise various procedures to structure its knowledge. Normally organizational knowledge is redistributed and it is not an easy to collect it for reusable assets.

Organisation has to set a separate cell to monitor such knowledge. This cell adapts the different types of people to work according to their styles. An organization has to adapt a standard, codification, and schemes to account such knowledge. Finally the presentation of styles of all employees has to be unified in a single pattern so that we can integrate such reusable knowledge into our practices.

3(d) REUSABLE KNOWLEDGE DISTRIBUTION

It is always required to distribute knowledge before it can be reused. Knowledge distribution is affected by the interaction between existing technologies, techniques and people. Monitoring of such processes minimize the problems for its reuse.

Reuse knowledge supervision minimize the problem of its recognition by individual member. However, the structure of the organization will also have to be taken before we create a strategy for its reuse.

3. (e) REUSABLE KNOWLEDGE APPLICATION

It is not possible to apply reuse knowledge to the problems unless it is easy to locate the right kind of knowledge in the required form. An organization should be capable to find the right type of the knowledge at the right time. Knowledge reuse application means having more knowledge available for reuse. It can create more values for the organization.

Criteria for evaluation of the reusable knowledge application should be set up including the priority of reusing particular type of the knowledge. It is also an important question that how the company understand about the reusable knowledge application?

3. (F) REUSABLE KNOWLEDGE CULTURES

An organization should allow its members to interact and nurture an environment for reusable knowledge sharing and integration. The members of the organization should coordinate with a view to reuse the knowledge. Reuse of knowledge is only feasible if is encouraged at all levels of the organization.

An organization should create and monitor the pattern of such activities which always encourages for the reuse of its assets. However it will also depend upon the way the people interact with the technologies and techniques.

4. IMPLICATIONS

Knowledge reuse is not only an asset for an organization while it sets a pattern between technologies, techniques and people. As mentioned in the Fig 4. time and reusability both are important and valuable assets for any organization. Knowledge management and reusable knowledge managements both are equally benefited by our present approach of Fig 4.

Reusable Knowledge management approach will have to be set right from the beginning of an organization so that the data, information and knowledge could be co-related in such a manner that they may be reused at any particular point of time. However, as time increases the knowledge of an organization will also increases which should be integrated into the existing repository of reusable knowledge.

The mathematical concept of data, information and knowledge (Fig 4) can be grouped into the relevant needs of the organizations. It means that before the reusable knowledge is defined, one can co-relate it with the requirements of the organization. It should be always remembered that reuse knowledge is a comprehensive process of knowledge recreation, reuse knowledge validation, reuse knowledge presentation, reuse knowledge distribution and reuse knowledge application.

Present work shows that reusable knowledge may be managed and applied effectively provided we understand the concept of knowledge reusability and time in relation to the data, information and the knowledge. It shows that management of reusable assets is not as simple as we think. It is highly co-related with the cultural of the organization, types of technologies uses, and the way the people interact with each other in a timely manner.

If an organization is serious to reuse its knowledge then it should consider our approach of time and reusability as shown in the Fig 4. Reusability and time concept should be integrated right from the beginning of any project in an organization.

Reuse knowledge adaptation is an important aspect where the organization must rethink about it. It is not bad to exploit the present knowledge by scarifying or transforming some of the requirements to some extent.

Reuse of existing knowledge not only saves the cost and efforts of the project while it will also enhances quality due to reuse of verifiable and the existing assets. Thus the integration of present knowledge becomes easy and friendly. Present reuse of knowledge management techniques may be extended to any organization irrespective of its culture and size.

Integration of existing knowledge into the new project is a novel idea where the requirements of the new project may not be exploited to large extent. A practical implementation of the present work is underway.

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