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Developing a Roadmapping System for Knowledge Management in an Organisation

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ABSTRACT

This study aims to develop a roadmapping system that can be used as a knowledge management tool for any organization. The study employed a structured action research to test the implementation of the proposed roadmapping system in a real industrial environment. An internal facilitator collected data through a clinical inquiry approach. The output is a roadmapping system for knowledge management for an organisation, which enhances strategic capability. It also helps to capture and handle the complexities of business strategies in a simple way or that is easy to understand. The proposed roadmapping system was only tested on one firm. Pending further research, these findings should not be generalised. The proposed roadmapping system improves the capability of an organisation to plan and implement its strategies. The proposed system can be used for strategic planning and knowledge management – it allows managers to "kill two birds with one stone." Unlike conventional technology roadmapping (TRM) research that focuses more on the hard aspects of technical and economic elements, this study explores the soft aspects of knowledge management for improving the strategic capability of an organisation. This research has extended the traditional boundary of TRM to include effective information systems.

Keywords: Action research; Clinical inquiry; Information systems; Knowledge management; Technology roadmapping.

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INTRODUCTION

While the hard aspects of Technology Road Mapping (TRM) research, such as technical and economic issues, currently dominate the literature, limited attention has been given to its soft aspects such as knowledge

management and information sharing. The technical aspects of TRM mainly address issues, such as the feasibility, usability and utility of the TRM process, the design of its architecture or formats, and the mechanism of how the technique is used. Works that focus on the technical aspects of TRM include the improvements of the TRM process (Fenwick *et al*., 2009), technique (Fleury *et al*., 2006), simplified format (Fujii & Ikawa, 2008), practical approach (Lee *et al*., 2009), and architecture (Phaal & Muller, 2009). The economic aspect deals mainly with an organisation's motivation and rationale of using TRM such as its accompanying benefits and returns. Studies that focus on the economic aspect include how to use TRM to improve business interfaces (Beeton *et al*., 2005), commercialise innovations (Gehani, 2007), align R&D investments and business needs (Gindy *et al*., 2008), and integrate business and technology (Groenveld, 2007).

Given that limited attention has been given to the soft aspects of TRM, it is not surprising that its implementation within organisations faces significant challenges that have resulted in failure in many cases. Among the challenges that many organisations face in implementing TRM are the struggle by managers to grasp its fundamental concepts, and the lack of ability to keep abreast of its techniques and development (Phaal *et al*., 2010). These challenges have prompted many managers to become less motivated to use it. Although TRM has been widely used by many firms from different industries (Barker & Smith, 1995; Gough *et al*., 2010; Kamtsiou *et al*., 2006; Lischka & Gemunden, 2008), its success rate of implementation is unknown. According to Phaal *et al*. (2010), it is the practitioners from companies, government agencies, and consulting firms – instead of academics – who have pushed for its implementation. Consequently, this results in less systematic research; and, owing to the confidential nature of most companies' policies, the success or failure associated with its implementation is difficult to track. Both technical and economic aspects of TRM are unlikely to feature prominently when TRM fails to deliver (as it so often does).

It is believed that a lack of focus and research on the soft aspects of TRM is the reason behind these problems. As such, a roadmapping knowledge management system is proposed as one possible solution towards improving the implementation process. A study was conducted to investigate the proposed system. In this study, a clinical inquiry approach, using the structured action research method, was designed to investigate the soft aspects of implementing TRM. An experiment was conducted to test the proposed process of implementing roadmapping within a firm. This paper, which reports those findings, is organised into six sections. In the first section, the concept of TRM is briefly defined. Then, a roadmapping system is proposed. The methodology used in this research is described in the third section, while the findings of a case study in a manufacturing firm are reported in the

fourth section. Next, the feedback and implications of this research are discussed. The paper concludes with the findings, limitations, and recommendations future research directions.

Technology Roadmapping

In general, Technology Roadmapping (TRM) is a structured visual tool that represents a strategy (Phaal *et al.*, 2010; Yee, 2013). Specifically, however, it has been variously defined as:

"… a tool for collaborative strategic planning, that enables us to make strategies and take actions towards the desired future, with special emphasis on anticipating changes in technologies and new business opportunities" (Kamtsiou *et al*., 2006, p. 164).

- … a visual tool that describes and identifies a strategic plan that links technology decisions to customer requirement, (Strauss & Radnor, 2004, p. 52).
- … a plan to determine the evolution of a product by linking a business strategy to product and technology (Albright & Kappel, 2003, p. 31).
- … forecast technology development by reducing complexities of strategy through the use of refined and synthesized representation of business information (Saritas & Oner, 2004, p. 57).

Overall, a technology roadmap represents a future scenario, objectives that need to be achieved, and strategic plans that help to set priorities of how these objectives could be achieved (Kostoff & Schaller, 2001).

As TRM comes in different forms, it is apparent that managers are sometimes unclear on which formats to use (Phaal *et al*., 2004). The most common technology roadmap consists of a timeline, multiple layers that show both commercial and technological perspectives, bars, texts, pictorial representations, flowcharts and arrows (Yee, 2007). Among the companies that have successfully developed effective technology roadmaps is Motorola (Willyard & McClees, 1987). According to Willyard and McClees (1987), a roadmap in Motorola was generated by assembling documents, charts, matrices, and graphs that supplied wide-ranging details of product lines from the past, present and future. It was created to support the processes of planning and managing a complex technological environment.

The benefits of TRM include:

1. Ensuring that key technologies are ready on time
2. Examining changes in opportunities
3. Assisting in developing a strategy for technology, monitor markets, products and technology
4. Increasing interaction between operational and marketing departments

(Albright & Kappel, 2003; Kamtsiou *et al*., 2006; Phaal *et al.*, 2010; Saritas & Oner, 2004; Strauss & Radnor, 2004).

The weaknesses of TRM include:

1. The roadmap is not updated on an ongoing basis

2. Many users do not know where and how to start the roadmapping process because there are many possible ways and procedures available
3. It is difficult to build a comprehensive and robust roadmap
4. Roadmaps come in several formats and users do not know which one to choose for their companies; and it is difficult to understand how one format is better than another
5. To produce the roadmap, companies need the assistance of well-trained academics or consultants, because managers who employ it are not equipped with the relevant skills and first-hand knowledge
6. There is a lack of formal educational opportunities to teach the technique. As a result, managers need time to learn the fundamental concepts of the new knowledge (Phaal *et al*., 2010; Saritas & Oner, 2004; Strauss & Radnor, 2004; Yee, 2007).

The Proposed Roadmapping System

It is widely accepted that effective knowledge management is essential to the success of firms today (Holste & Fields, 2010). Many firms spend millions of dollars annually to analyse, store, and retrieve knowledge. The effective use of information technology and databases should lead to improved capability to store, retrieve, and share knowledge.

Roadmapping is a strategic planning process. Sound strategic decisions rely on having the right knowledge, in the right place, and at the right time (McKenzie *et al*., 2011). Incorrect knowledge can be extremely costly; not only to the success of a company, but also to its survival (Yee, 2013). Hence, setting up a database for knowledge storage, without consideration for the useful manipulation of that knowledge, is dangerous.

The need for roadmapping

Far too frequently, top managements spend significant amounts of time developing full strategy reports, with detailed description and figures, which are passed down to managers at the operational level of an organisation for implementation. As these reports may look very complicated, employees may become intimidated and confused, and hence, overlook their priority and urgency. This is understandable because firms today are faced with complexity (Yee, 2013).

Due to the perceived burden of details, many firms today just need the "big picture" for their organisation's strategies. Managers today are quite unwilling to read lengthy reports that normally begin with a full description of the current economic situation, business environment, and market competitive analysis — brevity and time are of the essence! This would be followed by multiple recommendations on how to increase sales, capture competitor markets, or new investment plans, which then culminate in the presentation of a full budget with detailed financial analyses, risks analyses and feasibility studies. All these reports have something in common;

they are full of descriptions, figures, graphs, and bullet points. Is it any wonder that only a few strategies actually translate into performance?

Roadmapping aids strategy planning

Given the above scenario, it is easy to see how effective knowledge management is well placed to improve strategic planning and implementation. Managers today always face uncertainty and ambiguity (McKenzie *et al*., 2011). Providing them with the right knowledge will reduce their uncertainty and ambiguity. This will rely on an effective knowledge management system. An effective knowledge management system should also be able to retain good and useful knowledge (Levy, 2011) because knowledge – i.e., information – is rapidly becoming the main asset of organizations (Levy, 2011).

Traditionally, TRM, which is conducted in a workshop format, is a kind of knowledge generation system. After a workshop, one of the typical applications of roadmapping is the transformation of a roadmap into a computer-generated report that consists of a roadmap, its relevant strategies, and a detailed illustration for future action plans. This computer-generated report forms a knowledge system that can be used within an organization.

However, retaining and sharing the knowledge generated by an organisation is equally important — i.e., time and space utilities, and storage. This could be done by incorporating a knowledge management system into the traditional TRM. Based on the above discussion, a roadmapping system was proposed to incorporate knowledge generation, knowledge storage, and knowledge sharing into a unified system. Knowledge generation is done through the traditional roadmapping workshop, while knowledge storage is done through the normal application of software to produce computer-generated reports after the roadmapping workshop. Finally, knowledge sharing is done through a total knowledge management system for an organisation. It was proposed that such a total knowledge management system, which generates, stores, and shares knowledge, should be made up of the following five steps:

- Step 1: Roadmapping workshop
- Step 2: Analysing information
- Step 3: Computer-generated roadmap
- Step 4: Action plans
- Step 5: Storage, retrieve, and share

Step 1: Roadmapping workshop

During the first step, a multi-functional team from a firm is formed. Team members should consist of representatives from various functional departments such as marketing, engineering, and product and process technology. The team should also involve top-level managers. At this stage, full support from top management should be obtained. Top management's support and involvement should enhance enthusiasm for attending the workshop, ensure that time and resources are made available, and remove administrative and other barriers.

After the team is formed, a team-building activity will be conducted to improve the relationships of the team's members. The focus is on building teamwork that can reduce human barriers, enhance ownership of the roadmap produced, and reduce usage discontinuity. This is a good solution to organically building the roadmapping system into the current and larger organizational system. It is vital to consider how to integrate the roadmapping system into the people's system.

After the team building activity, the next task is to provide formal training on the theories and concepts of strategic planning, technology management, and technology roadmapping. The purpose is to educate the team about the background knowledge and concepts, as well as details of the process. At the end of this training session, the participating managers should be familiar with the terms used and the steps involved. They will also be able to implement the roadmapping system with confidence.

Next, the actual implementation of the roadmapping exercise is carried out. During the mapping exercise, a strategy roadmap is constructed on a sheet of flipchart paper that is attached to the wall. Strategy and business related activities and decisions are written on sticky notes and stuck onto the roadmap at the relevant layer and time period – this will map the company's future strategic plans. This provides an opportunity for the team members to express their opinions and thoughts on the same platform. During this exercise, the top-level managers should seek to clear any obstacles that may appear such as non-cooperative behaviour from team members. It is believed that top-level managers have the influence and power to remove these obstacles – this is why they are invited into the workshop. Fig.1 shows the activities of the roadmapping workshop.

Fig.1: Roadmapping workshop

Step 2: Analysing the information

During this step, the participants are required to link the information on the roadmap, bringing together the market, product, capability and resources of the business, in order to identify links on a final roadmap. Links between market, product and capability elements are recorded and analysed. The data generated here can be turned into two inter-linking analyses that provide a roadmap layer spanning mechanism. Arrows are used to show the connections between strategies and business related activities and decisions. Fig.2 shows how the strategies are linked to each other.

Fig.2: A strategy roadmap

Step 3: Computer generated roadmap

During this step, the roadmap generated from the previous steps is transformed into a computer file. The diagram below shows a sample computer generated roadmap file (see Fig.3).

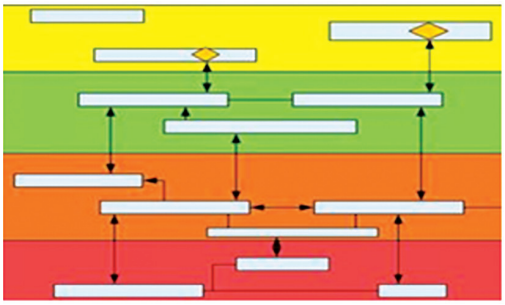

Fig.3: A Computer generated roadmap

Step 4: Action plan

During the fourth step, an action plan is produced based on the discussions made in the workshop. Together with the computer generated roadmap, the action plan forms a roadmapping report that describes the future strategic plan of a company. The report usually consists of (but is not limited to) the following content:

A Executive summary
- Overview
- Vision and mission
- Trend and drivers
- Evaluation criteria

B Detailed roadmap landscape
- Format and structure
- Market, product, capability and resources
- Links

C Roadmap detail content
- Future needs and challenges
- Priorities
- A roadmap to the future

D Summary
- Next steps
- Action plan
- Participants

The roadmapping report will be stored in a computer, in a form of knowledge management system, for future reference purposes.

Step 5: Storage, retrieve, share

The fifth step stores, retrieves and shares the roadmapping report with the related departments (or individuals) from the organisation.

The greatest value of the roadmapping tool is not the immediate output, but rather the activities that follow that retrieve and share the knowledge with other parts of an organisation (users group) in order to communicate the company's plans and coordinate the relevant activities (Fig.4).

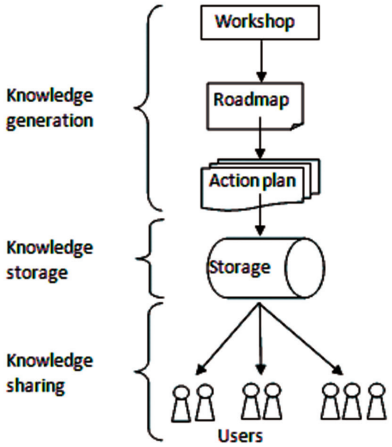

Fig.4: A knowledge management system

In order to avoid a 'one-off' process, the company's management should use the knowledge management system effectively. They should identify the departments (or individuals) that need to be connected and allow them to access the roadmapping report. They should also develop an information sharing system to use the information within the company. Policies should be developed to make systematic use of the information.

Together with the workshop activities and the computerised reports, the knowledge management system can be used to generate, store, and share knowledge among departments and individuals within an organization. The diagram shown in Figure 4 illustrates how this system functions as a knowledge management system (see Figure 4). In order to test the applicability of the proposed system, a research was conducted using an action research methodology within a manufacturing firm.

RESEARCH METHODOLOGY

Structured action research was adopted as the primary research methodology in this research. Susman and Evered (1978) strongly advocate the adoption of action research when conducting an applied research. They believe that action research has a far greater potential than positivist science for understanding and managing the affairs of organizations. In this study, the use of an action research methodology enabled an active intervention into the current company's system, in order to allow managers to use TRM while actively participating in the research. It is called 'structured' because the intervention is organised into a step-by-step process, based on the five steps of the proposed roadmapping system (as explained previously). An experiment was conducted to test this 'structured' process of the proposed roadmapping system. A clinical inquiry approach was used to observe, generate, and record most of the invisible soft aspects of implementation throughout the whole research. Although action research has often been criticised for its lack of replicability, and hence lack of rigor, a growing body of academics recognise and support action research as being a valid research approach (Coghlan, 1994; Eden & Huxham, 1996; Harland *et al*., 1999, Reason & Bradbury, 2010). Action research is considered ideal in fulfilling the objective of this research because the development of new and useful scientific knowledge depends more on its practical usage in a real world setting. This

research method is especially useful in the area of industrial application of strategic management tools (Platts, 1994; Phaal *et al*., 2010).

The effectiveness of conventional research techniques such as surveys, interviews, or focus groups, in exploring the views and opinions of business executives or managers on company's strategies and performances, is increasingly being called into question. This is possibly because this group of respondents have been approached so often that they hesitate to either complete yet another questionnaire or answer even more questions. Indeed, some might even be totally unwilling to respond at all or others might even resort to answering questions in a frivolous manner. Many have complained of being over-surveyed and obtaining limited benefits from the survey.

Earlier TRM researchers dealt more with the 'action' rather than the 'research' element. That is, they focused more on how to successfully generate a roadmap, being more concerned with how to improve the technical aspects of the TRM process and the format used such as the T-plan (Phaal *et al*., 2001) and the workshop-based approach (Phaal *et al*., 2007). This research, however, deals with 'research' rather than 'action'. In this study, the soft aspects of the implementation process play a more critical role. A 'clinical inquiry' approach was adopted in order to explore the human factors of the TRM implementation – i.e., knowledge sharing. Clinical inquiry deals with the elicitation, observation and reporting of available data, when the researcher is engaged by an organization to help with or solve problems (Schein, 1995).

According to Schein (1993), clinical inquiry is particularly suited to organisational research on culture. It also enables intervention and inquiry into an organization to take place concurrently. In this research, the participating company appointed its R&D executive as the internal facilitator to coordinate this project. Apart from taking such role, the internal facilitator of the clinical inquiry was also responsible for observing the participants and generating useful information that promotes the successful implementation of TRM.

The use of an internal facilitator is consistent with the action research approach, because it mandates a close involvement between the organisation and the researcher. This deep involvement provides a richness of insight, which could not be gained in other ways (Whyte, 1991). Researchers in an action research act as facilitators, rather than as consultants (Gill & Johnson, 1997). In general, a consultant will independently assess the firm under study and make recommendations based on his or her observations. However, a facilitator will catalyse the process of using the technique within the subject firm; without imposing personal views that may affect the decisions made by the firm. The facilitator will ensure that the personnel within the firm participate fully in the process of using the technique (Platts,

1994). In addition, the internal facilitator will investigate the issues from an insider's perspective. An insider approach provides an opportunity to develop insider's knowledge of an organization (Evered & Louise, 1981).

In this research, the internal facilitator worked with the researcher, who trained the internal facilitator and provided her with the required technical knowledge and support, as well as advice on how to implement the proposed roadmapping system. Data were collected mainly through observations, question and answer sessions, and discussions between the internal facilitator and the participants.

The participants were interviewed before, during and after each of the research sessions. All grievances, comments, and opinions were gathered from each participant. The findings were enriched with additional feedback and insights through team discussions, reflections, and question and answer sessions.

A CASE STUDY

Fuelled by the need to adopt a more suitable and established tool to manage technology planning amid the current global economic uncertainties, a local manufacturing firm [YCL (anonymous name)] boldly adopted the proposed roadmapping system.

Determining the project's aim

The company identified, as its main objective for adopting TRM, the need to formulate an effective future strategy to optimise the power of technology. In order to fulfil this aim, the company decided to adopt TRM to chart its Research and Development (R&D) strategies for the next five years.

Project team formation

After the formulation of the project aim was completed, the company proceeded to form the team required to implement TRM. The individuals involved in the project were the CEO, R&D manager, business development manager, R&D senior executive, R&D executive, and finance manager.

The critical role of the CEO

The CEO's support and involvement in the project are important to drive the usage of TRM, especially during the early stages of implementation. Not with standing that, the CEO's participation is expected to ensure that resources are made available when needed, while involvement among team members can be improved. It is crucial for the CEO to clear any obstacles present during this stage of the project. Challenges such as non-cooperative behaviour from participants and other parts of the organisation in providing data to construct a detailed roadmap, are expected to surface during this stage. The CEO's role is also crucial because he/she possesses the power to remove these hurdles. The research also

brings together people from different functional areas of the organisation in order to improve coordination between them.

According to the CEO, the firm operates in an ever increasingly competitive environment; and thus, needs an effective yet flexible method to make strategic decisions for technology. The business development manager was quoted as saying that "amid the current global economic uncertainties, the current business environment was challenging." With 160 employees, the company (which does not wish to disclose its identity, in order to protect its competitive interest) is a privately owned medium size business that manufactures consumer goods.

Technology mapping and communication

The R&D manager said "I feel that having a tool for technology strategic planning would be good for our organisation. This is especially true for our R&D department, so that we can plan for our R&D department's direction for the next five years." The R&D manager also said that wrong decisions being made on technology investment could cost the organisation a lot of money. As such, the communication between the business and R&D departments of the company was extremely important.

Technology planning – the process

The whole research process, which is based on a structured action research with a clinical inquiry approach, was conducted over a period of three weeks. The design of the experiment was based on the five-step roadmapping process (as mentioned previously).

In this research, the internal facilitator (i.e., the R&D executive) assisted the participants to use the TRM techniques, in order to generate a roadmap and produce the computer generated roadmapping reports, as well as to formulate the knowledge sharing guidelines within the firm.

After the workshops and the reports were generated, the participants were asked to gather again one month later. During this meeting, the participants were required to draw a plan of how to use the knowledge in future, based on the computer generated roadmaps and reports. The meeting began with a presentation by the internal facilitator on the final roadmap and report. The session was followed by a discussion on how to carry out subsequent works based on all of the strategies identified. After intense deliberation, it was found that not much change was needed, because some of the strategies, such as the R&D project, were currently on-going. Furthermore, the need to initiate a new R&D project and acquire a new resource was being feasibility assessed by management. The company would keep the roadmap for now but plan to further develop it in the near future.

Positive downstream effects accruing to roadmapping

The greatest value of any managerial tool is not confined to the immediate output, but rather the follow-up activities that are built into the existing organisational system. Therefore, in order to avoid a 'one-off' process, all the participants were responsible for selling the outputs to their respective functional areas within the whole organisation. The participants also identified the resources required to improve the use of the knowledge; and, collectively, they formed a new company policy to share that knowledge. As such, employees would have to comply with the policy to further develop roadmaps and those who implement the strategies effectively would be well rewarded. As a result, the participants produced many procedures and policies during the meeting.

DISCUSSION

The application of the roadmapping tool resulted in a number of insights into the aspects of knowledge management, which have added to academic understanding, and could form the basis of further work. The following section discusses the wider implications of the system for both managers and academia.

This research has shown that the implementation of the proposed roadmapping knowledge management system in a manufacturing firm generated useful feedback from all the participants involved. Not only has the study revealed the soft aspect of knowledge management, it has also reflected its economic and technical dimensions.

Similar to the economic aspect, feedback from participants has indicated that TRM is able to help managers generate a roadmap that allows the company to better visualise and plan strategies, achieve better communication and understanding between the business and R&D departments, and obtain new perspectives on future strategies. The participants agree that TRM is useful in helping them to map the company's current resource constraints and generating effective strategies for future growth.

On the technical side, feedback from the participants shows that TRM is easily understood by managers and could well be employed without prior knowledge or special training. There are no sophisticated mathematical formulas or computing software involved. For instance, the R&D manager commented that the process is easy to follow, and that he faced no difficulties in using it. The R&D senior executive also felt that the process was simple and well structured. She said the architecture was easy to understand, and that the technique taught could be mastered within a short period of time. Overall, the findings from the technical and economic aspects of the workshop are consistent with those of previous works by Phaal *et al.* (2001, 2004, 2010).

Although the underlying theories and practices of roadmapping based on the technical and economic aspects are not entirely new, the application in the form of a *roadmapping system* provides an effectively way to generate, store, and share knowledge among individuals or departments within an organisation. As a knowledge management process, it plays an important role in a firm by providing a practical and usable system for managerial decision-making.

Far too often, managers face information overload within a company. Companies might spend significant time developing a long list of strategies and objectives, which are then passed down to a manager to carry out. As there is a lack of tools to enable managers to generate, store, and share the right information, there is a tendency for them to end up with too many strategies, aims, and objectives. Usually, by way of coping, managers will restrict the boundary of strategic planning to the areas they are familiar with. This is understandable, because in the face of complexity and the need to act quickly, managers will tend to seek the comfort of the known. A formal roadmapping system provides a mechanism for combating this deficiency. In this system, it has been demonstrated that managers can be guided by the five steps of the knowledge generation, storage, and sharing system. The system helps managers to decompose the complexity of understanding and managing information into smaller, more manageable steps. Furthermore, the developed strategy roadmap assists the managers to better understand their organization's future direction. The value of multiple participations in the workshop was also clearly demonstrated. Group discussion, challenge, and review helped the participants to crystallise their thoughts and reduce inconsistencies each step of the way.

The steps for generating and storing the roadmapping report gave the managers new insights, not just into the way the information was used, but also in the way in which their colleagues shared and perceived similar information using the same platform. These insights are clearly of considerable value.

The system is educative — it encourages learning both at individual and group levels. By iterative modelling and group discussion, managers learned to modify their understanding, ideas, beliefs and thoughts over time. The developed roadmapping report provided a way of recording, storing and disseminating the strategies of an organisation in such a way that could easily be retrieved or accessed. This allows the knowledge management system to be built up over time, and to be revisited and amended as changes occurred. This technique is evidenced to be both robust and dynamic.

One of the most challenging tasks in any company today, is the handling of

too much information, i.e. information overload. Too much information generated from a strategic planning workshop, in a practical sense, is very difficult to analyse. This tool is, therefore, concerned with the ways of handling 'messy' information in effective ways. This research proposed a knowledge management system for handling the complex issues associated with complicated business strategies. The system consists of a roadmapping workshop to generate relevant strategies, which are then mapped, i.e. the roadmap is created. This roadmap is then transformed into a data storage system with action plans and reports. The roadmap and reports reduce the complexity of information to a level that can be analysed by managers. This provides managers with a holistic view of their company's strategies and future directions, and helps them to manage their company better.

The main benefit of this knowledge management system is that it results in knowledge that is directly applicable to industry (i.e., in the form of a roadmap and action plan). In this sense, managers can use this knowledge without having to modify it. Furthermore, the documentation within the system allows for its retrieval at any time. Policies and guidelines enable user groups to share relevant knowledge. The advantage of this system over other tools or techniques is clear.

In summary, the roadmapping tool can be used as an effective knowledge management system, to generate, store, and share business strategies. The roadmap combines the workshop approach for the whole roadmapping exercise; thus providing a way of generating useful and relevant data from company managers' inputs. It is successful in helping company managers to generate relevant strategic information for analysis. It promotes the integration of company managers' views, allows communications and clarification of information, and facilitates the identification of the most important business strategies (having traded-off those that are less important). By using inputs from managers, the system allows the development of strategic roadmaps based on accurate and valid data. This shows that the system provides greater benefits and capabilities than many other strategic planning tools.

The key feature of this system is its ability to continuously generate knowledge, store knowledge, and share knowledge in an organization. Consequently, the organisation can change or modify its strategies in response to environmental dynamics. A system that can be used for strategic planning and knowledge management allows managers to kill two birds with one stone. This kind of combined management technique is rare and unique.

CONCLUSION

Conventional research on TRM has often emphasised the hard aspects of the technical and the economic rather than the soft aspect of knowledge sharing. It is believed that it is the soft aspects that play a pivotal role in determining the successful implementation of TRM within an organization. The lack of understanding of these elements could reduce the effectiveness of using TRM, which will subsequently lead to its abandonment.

This paper introduced a new knowledge management system for generating, storing, and sharing of business strategies. The system was created in order to capture the complexity of business strategies in a simple and easy to understand way. This research promotes the development of a knowledge management system within a wider organisational information system. The paper has revealed and crystallised the roadmapping system into an information system. An effective information system can be critical to company performance. It provides a database that delivers practical guidelines and policies to enhance management's competitiveness. Roadmapping is a form of codified knowledge that improves understanding about business strategy, because it provides information to managers in a more descriptive, structured, and visualised form.

This knowledge management process can assist managers to generate, store, and share strategies of firms; thus enabling them to make complex business decisions quickly and efficiently. This research indicates that the knowledge management system has high utility and enables managers to visualise and monitor business strategies in an easier way. The storage system provides a platform for managers to retrieve, view, share, and discuss their strategies leading into the future. However, these findings are limited to a single case study; and thus, it cannot (as yet) be generalised to a wider industry context. Further research should be conducted to investigate a wider applicability of this knowledge management system, in a range of companies from different industries.

Overall, this study has broadened the scope of TRM by incorporating knowledge management as one of its key features. By taking into account the non-traditional context of the soft elements of knowledge sharing, this research has extended the scope of the literature work on TRM. However, there is scope to develop a more thorough theoretical framework with regards to TRM in the future.

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