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KM APPROACH FLEXIBLE DECISIONS IN REVERSE ENTERPRISE SYSTEM

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ABSTRACT

In order to successfully exploit the opportunities of recovering value from used products, enterprise need to design integrated reverse manufacturing and logistics structure that facilitates the arising goods flow and processing in an optimal way. This integrated approach of reverse enterprise system (RES) is to improve customer satisfaction, reduce costs, drive continuous improvement, and maximize return on assets. Emerging discipline of Knowledge management (KM) that promises to capitalize on organizations' intellectual capital can be utilized as the motivation for initiating flexible decision support in field of reverse enterprise system. Businesses have already discovered valuable commercial opportunities are embedded in returns. Objective of this paper is to communicate a critical review of knowledge management approach for improved and flexible decisions in the Reverse Enterprise System using framework of knowledge chains to outline findings. These knowledge chains is generally accepted as being the network of processes that increase the value of knowledge as it progresses from data to innovation. To face the challenges of knowledge based economy, companies involved in product return operations are required to be aware of how knowledge is created and disseminated in returns. This paper suggests the role of KM is not just to create information and knowledge, but also to efficiently disseminate their findings to develop flexible DSS for reverse enterprise system.

Keywords: Reverse Enterprise System Knowledge Management, Knowledge Chain

Introduction

Here concept of Reverse Enterprise Systems (RES) provides an integrated overview of the manufacturing and logistics aspects of the returns at the enterprise level. RES employs the term reverse manufacturing for the manufacturing aspects that include remanufacturing, disassembly, planning, scheduling, and disassembly process planning. Logistics aspect of RES is usually called reverse logistics as shown in figure 1. The ultimate success of any Reverse Enterprise System will depend on its ability to participate in one or more successful organizations, as well as its ability to integrate the enterprise's complex network of reverse chains. Today RES is finding itself compelled to react to mounting pressures resulting from globalization. This manifests as heightened competition and the demand for sustainable development from government and customers, which requires new approaches to manage and transform return of products.

The RES is also facing the increasing importance of new technologies like IT tools and

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developing knowledge based economy that provide new opportunities for return management.

These factors make real time information accessible and collaboration across reverse manufacturing and logistics functions easier. Therefore in order to succeed in this new economy based on knowledge, the RES needs to be innovative and develop new competencies.

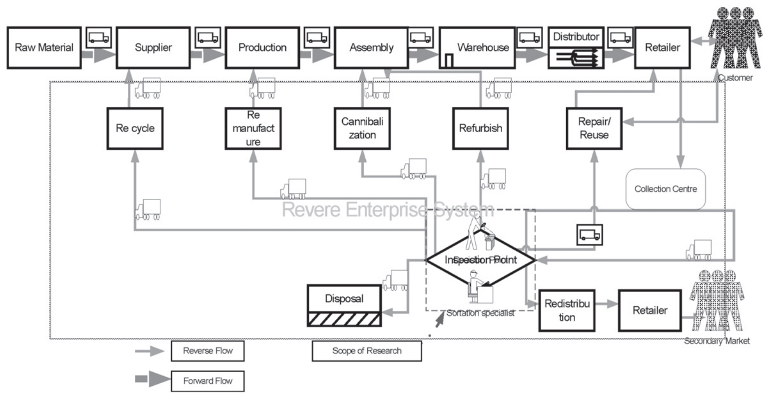

Figure 1: Reverse Enterprise System

Every organization's intellectual capital consists of tangible and intangible assets. Tangible assets, which correspond to documented, explicit knowledge, can vary for different industries and applications but usually include manuals; directories; correspondence with (and information about) clients, vendors, and subcontractors; competitor intelligence; patents; licenses; and knowledge derived from work processes (such as proposals and project artifacts). Intangible assets, which correspond to tacit and undocumented explicit knowledge, consist of skills, experience, and knowledge of an organization's people (Simard 2003, Simatupang 2002, and Yuva 2002). Management of these assets calls for a Knowledge Management System (KMS) as an emerging discipline that promises to capitalize on organizations' intellectual capital (Wadhwa & Rao, 2003). The concept of taming knowledge and putting it to work is not new; phrases containing the word knowledge, such as knowledge bases and knowledge engineering, existed before KM became popularized (Wadhwa et. al 2006). KMS is unique because it focuses on the individual as an expert and as the bearer of important knowledge that can systematically share with an organization. KM supports not only the know how of an organization, but also know-where, know-who, know-what, know-when, and know-why. Although most KM research has explored conventional forward chain yet product return as an RES has not been investigated. Therefore this paper communicate the potential of managing knowledge in product returns as an enterprise RES. Here RES focus on need to reduce operating costs by reusing products or components, requiring an efficient means to bring back obsolete, outdated or clearance items and prove quality and service to its customers, therefore it must consider its both forward and return chain "Knowledge Based Systems" KBS perspective. This KBS perspective accumulates knowledge from planning, production and distribution to customer followed by gate keeping exercises; collection; inspection and sorting; reconditioning; disposition; and redistribution. Among these entire return activities gate keeping is considered to be highly knowledge intensive, it is decided which products to be allowed in the returns, otherwise companies might be flooded with products which cannot be recycled, remanufactured or disposed. A Good KM assisted gate keeping can be the first critical factor in making the entire reverse flow flexible and profitable. This paper addresses the issues and looks at how knowledge management (KM) be used to help RES and react to the discussed challenges such as high uncertainty regarding locations from where used produced products need to be collected, their quantity, their quality and timing.

Literature Review

Although products have been returned since the early days of commerce, reverse logistics has only attracted academic attention since the early 1990's. As reverse enterprise system is a relatively new field of study, use of terminology is not definitively established. In this paper we use the definition put forth by the European working group on reverse logistics, RevLog [1998]

The process of planning, implementing and controlling flows of raw materials, in process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. Reverse logistics (RL) commonly refers to the backward movement of materials in the supply chain [Rogers and Tibben L 1999]. This does not imply that materials are necessarily ending up at their original manufacturers, but refers to the collection of product returns, disassembly and disposal aspects of RL, regardless of their final destination [Carter and Ellram, 1998]. While some authors limit reverse logistics to the sum of those activities that ensure a sustainable, or environmentally friendly, recovery of products and materials [Kopicki et al., 1993; Murphy and Poist, 2000], broader definitions extend this to the handling of all kinds of product returns, including the take-back of unwanted products, recalls and warranty returns [Stock, 1998; Rogers and Tibben-Lembke, 1998; Fleischmann, 2001]. Here use the broader definition of reverse logistics as reverse enterprise system in the sense that we include products flowing backwards for all kinds of reasons. Furthermore the terms product returns and reverse logistics are used interchangeably in this paper. A lot of previous research on product returns has concentrated on technical issues such as network design [Krikke, 1998], shop floor control [Guide and Srivastava, 1998] and inventory control [Inderfurth, 1997]. For a thorough review of previous research and gaps related to technical aspects of reverse logistics please refer to Fleischmann et al [2001]. Most of the earlier work on reverse logistics examines it from an environmental point of view. Surprisingly little has been written about implementation of KMS view to knowledge rich product returns operations. Though concept of KM emerged in the mid-1980s from the need to derive knowledge from the "deluge of information" and was mainly used as a "business world" term (Wadhwa et al, 2006). In the 1990s, many industries adopted the term KM in connection with commercial computer technologies, facilitated by development in areas such as the group support systems, search engines, portals, data and knowledge warehouses, and the application of statistical analysis and AI techniques. KM implementation and use has rapidly increased since the 1990s: 80 percent of the largest global corporations now have KM development [Simard, 2003]. In terms of product returning from the forward supply chain, the use of a KM as an integral part of the RES is appealing and can easily be incorporated to integrate the knowledge of reprocessing and logistics activities. Although it is important to investigate how KM can really help the reverse enterprise to solve problems they face while trying to achieve concurrent objectives of satisfying profit motive of management along with legislative policy favoring environmental laws. KMS has drawn widespread attention and has promising features, but it is too soon to say whether or not it will stay.

Motivation for Application KM in RES

In order to capture knowledge and implement KM from the field of RES which is known to be uncertain, involving many people contributing and coordinating knowledge at various nodes product return chain shown in figure 1. Most of the enterprises struggle to ensure a smooth flow of the products in forward chain but little consideration is given to flow of returned products either commercial of end of use. Again this lack of consideration can also partly be explained through the fact that managing product returns flows is complicated due to their cross-functional and cross-company nature (Meyer, 1999). Today liberal returns policies, direct sales channels and environmental legislation has contributed to the growth of returns flows; therefore now companies can look for rise in productivity and profitability through efficient and effective management of RES. Efficient and effective RES can help in recovering value from reverse logistics and manufacturing structures to be set up for the arising goods flow from users to producers. Capturing the knowledge about the product assembling and dissembling, along with logistical aspects both in forward and reverse direction can immensely help in effective and efficient management of RES (Wadhwa & Madaan 2004). Organizations involved in returns face problems organizing, identifying the content, location, and use of this knowledge. An improved use of this knowledge and its management is the basic motivation for identifying application KM in RES. Classifying important factors responsible for application of KM to RES includes:

Business Needs

Decreasing time and cost and improving quality of returned products:

Avoiding mistakes reduces time and resources consumed on reverse manufacturing functions; repeating successful return processes increases productivity and the likelihood of further success. So, organizations need to apply knowledge gained in previous return processes to future processes. Unfortunately, the reality is that development teams do not benefit from existing experience and they repeat mistakes even though some individuals in the organization know how to avoid them. Therefore RES could gain much more if they could share this knowledge.

Making Better Decisions

In RES, sortation specialist at the inspection points is involved constantly makes technical or gate keeping bout the products entering into return chain. There for individual knowledge of sortation specialist regarding the assembly and disassembly process long with logistical complicacy must be shared and leveraged at enterprise levels. RES need to define all reprocessing and reverse logistical activities and for sharing knowledge so that individuals at all levels throughout the organization can make correct decisions about the product return processes.

Knowledge Needs

During production, the product would have undergone various processes such as forging, painting etc which might change the fundamental properties of materials used or which necessitates special requirements for disassembly. For e.g., a part coated with a hazardous chemical might need to undergo special treatment before it can be handled for disassembly. Hence it is important that the one must have some degree of knowledge about all the processes and materials that were used in the manufacture of the products. RES have vast amounts of knowledge in various areas such as product life cycle, product attributes that is critical to achieve business goals. We now look at some of these knowledge areas and organizations' related needs.

Acquiring knowledge about new technologies

The emergence of new information system like Design/disassembly data sharing systems, Lifecycle information monitoring systems makes management of RES more efficient focusing on product identification and describes the procedure to disassemble the products. Soga et al.

(1999) illustrates information systems developed at Hitachi Corporation that uses Radio Frequency Identification (RFID) technology to store and retrieve information regarding product on an individual basis. If not managed properly these IMS they can turn out to be management's worst nightmare. It is difficult to become proficient with a new technology and managers to understand its impact and cost when using it. So, enterprise involved in returns must quickly acquire knowledge about new technologies and master them.

Accessing domain knowledge

Management of RES requires access to knowledge of product and information movement not only in forward but also in return direction. Meyer (1999) described product returns as if not managed properly they tend to cause excessive costs for all the parties involved. Therefore, Knowledge needs to be managed as cross-functional business processes in RES (Harrington 1991).

This can be done either by training or by hiring employees knowledgeable in return process and spreading it throughout organization.

Sharing knowledge about return processes

Having identified the knowledge and information requirements for decision making, we now establish knowledge sharing system that would provide appropriate decision support for RES management.

A knowledge sharing approach is proposed as a means to model KM systems. A knowledge sharing approach is where knowledge is maintained at product level and is updated as the product moves across the various stages of its lifecycle. This will enable decision support that handles the unique requirements of every product. A formal knowledge sharing also ensures that all individual involved in return processes to access it. So, organizations must formalize knowledge sharing while continuing informal knowledge sharing.

Capturing knowledge and knowing who knows what

When a key person managing the return process with all the critical knowledge suddenly leaves an organization, it creates severe knowledge gaps—but probably no one in the organization is even aware of what knowledge they lost like sortation specialists at inspection point having detailed knowledge about the particular product leaves. Knowing what employees know is necessary for organizations to create a strategy for preventing valuable knowledge from disappearing. Knowing who has what knowledge is also a requirement for efficiently staffing projects, identifying training needs, and matching employees with training offers.

Collaborating and sharing knowledge

Communication system often acts as means of reducing some degree of uncertainty in RES and knowledge transfer. The collaboration between supply chain partners would provide crucial feedback to manufacturers and other supply chain users for analyzing and improving the take back function of returned of the products. For instance, manufacturers would be able to determine the components that are most reusable and have maximum market value at or components that are most likely to break down during its usage. This state of mutual sharing of knowledge could be used to improve the design of the product for increasing its lifecycle performance.

KM Background

Before proceeding further let us introduce some key KM concepts that will help us to appreciate KMS implementation in RES. Here it is important to understand three basic levels of refinement to knowledge i.e. data, information, and knowledge. Data consists of discrete, objective facts about events but nothing about its own importance or relevance; it is raw material for creating information (Cook, 1999). Information is data that is organized to make it useful for end users who perform tasks and make decisions (Lee, 1997). Knowledge is broader than data and information and requires understanding of information. It is not only contained in information, but also in the relationships among information items, their classification, and metadata (information about information, such as who has created the information) and experience is applied knowledge (Nonaka, I., Noboru, 1998).

Data in RES

Considering RES we gather and sort data from a variety of sources. These include: partners in reverse enterprise system like suppliers, retailers, manufacturers, reverse manufacturing and logistics either by OEM or third party services providers. On site soration specialists who act as gatekeepers for the products to enter return chain can acts as critical source for data. Beside this literature, practitioners, scientists and surveys also act as data sources. The creation and treatment of return data is the goal of RES. This deals with the development of an experimental platform that will eventually permit the testing of various configurations for the return chain, and aid in the establishment of different operation planning approaches for each of the units coming from customer after use. The platform will be used as an integration tool for the various return activities to converge at one place. This experimental platform will be made up of intelligent software agents that will collectively manage return procurement, reverse manufacturing and redistribution operations through the use of raw, detailed local information.

Information in RES

Planning and control of RES is quite complex due to the uncertainty regarding the time, place of origin, and quality status of returns. In RES information flows coincide with product flows, but they have a phase delay compared to physical flows; that is, information are generated by a physical process performed on some physical flows. Here information can be used to get information on the upcoming return before the physical flow reaches the process. As outlined in [Kokkinaki, 2001], information and communication technologies (ICT) can be used to minimize uncertainty and volume of incoming returns. To this end, RES provides a secure intranet, extranet, internet connectivity on its servers to share information related to product design Information, product disassembly Information, location Information or lifecycle Information. In this virtual space, suppliers, customers, retailers, competitors and distributors can manage knowledge and activities related to returns at various levels as shown in figure 2. The information system gives access to external customers, third party, markets and competitors through links e.g. Market Information, Legislative Information, and Product and Process related Information. The objectives of such internet and extranet linkages are to save time and the resources of an RES.

Knowledge Management role in RES

KM deals not only with explicit knowledge, which is generally easier to handle, but also tacit knowledge. Explicit knowledge, also known as codified knowledge, is expressed knowledge. It corresponds to the information and skills that employees can easily communicate and document, such as processes, templates, and data. Tacit knowledge is personal knowledge that employees gain through experience; this can be hard to express and is largely influenced by their beliefs, perspectives, and values (Nonaka, 1998). The knowledge scope refers to where the knowledge is applicable, to whom it is accessible, and whose activity it supports. Along this dimension, knowledge can be at an individual, group, organization, multiple organization, or industry-wide level. The knowledge evolution cycle defines the phases of organizational knowledge (Innes, 2002). Organizations should have a knowledge management strategy in place for implementing these phases systematically (Mak, K-T. & Ram Prasad, 2003). The phases are

1. Originate/create knowledge. Members of an organization develop knowledge through learning, problem solving, innovation, creativity, and importation from outside sources.
2. Capture/acquire knowledge. Members acquire and capture information about knowledge in explicit forms.

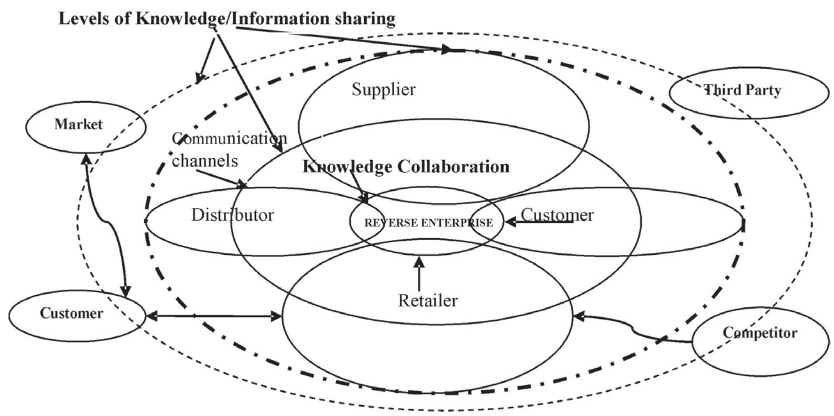

Figure 2: Knowledge Sharing in Reverse Enterprise System

3. Transform/organize knowledge. Organizations organize, transform, or include knowledge in written material and knowledge bases.
4. Deploy/access knowledge. Organizations distribute knowledge through education, training programs, automated knowledge- based systems, or expert networks.
5. Apply knowledge. The organization's ultimate goal is applying the knowledge—this is the most important part of the life cycle. KM aims to make knowledge available whenever it is needed (Tiwana, 2000).

It has been well noticed that a high level of uncertainty is also an important characteristic of RES therefore KM can play an important role in this domain. Reliable planning of collection and recovery may therefore be a difficult task for decision makers. Furthermore, the form of recovery and the sequence of processing steps required are often dependent on the quality of the input, knowledge, and information about the returned product which is another unknown factor. Therefore, to substantially benefit from the available technology, the decision maker should be able to efficiently locate and access the needed information about product return in a timely manner. So to begin with there is the goal of providing the library of information and materials, or "knowledge" to these executives about RES. In this direction this section discusses a novel intelligent decision model using KM based on RES performance criteria, dimensions of some critical supply chain drivers. The main issue with KM in RES is use of diverse and changing resources. Mainly KM focuses on understanding how knowledge is acquired, created, stored and utilized within an organization. Knowledge management in RES integrates the information both with the outside parts and inside parts of the process of returned product handling, help the partners in RES to make appropriate choices, support process, administrate collaborations. Information needed to be integrated in different phases shown in table I. Here, four processes enable end-users, while interacting with their KM system, to generate and share knowledge.

Knowledge Creation

Organizational knowledge creation is generative, where knowledge is actively constructed from information previously stored and new information drawn from the environment. Here systematically, and transferring and recording the "lessons learned from the previous return process" in a way that will be of maximum benefit to the enterprise.

Here important points regarding knowledge acquisition and creation; first, information, regarding number of collection centre, transportation distance, time, cost and product classification that organization ultimately accepts. Second, knowledge acquisition and creation systemically is guided by a firm's core competency strategy.

Knowledge Storage and Retrieval

In order to store and later to retrieve knowledge, generated at various functional points in RES, must first be determine: What is important knowledge to retain? How best to retain it?

Knowledge at various points in RES and who needs that knowledge is shown in table 1.It is important to note that functional and effective knowledge storage systems allow categorization around learning needs, user expertise, use of the knowledge, and location (where the information is stored). However, knowledge is not always present in its optimal form, is not available when needed, and is not present where the work activity is carried out. Some of the key enabling technologies are multimedia databases, query languages, text index, search engines, data mining and RFID and storage servers/advanced computer storage technology allow knowledge to be effectively stored and made accessible (Alavi and Leidner, 2001).

Knowledge Transfer

KT from an intra and/or inter-enterprise perspective involves the mechanical, electronic, and interpersonal movement of information and knowledge both intentionally/formally and unintentionally/informally. The various levels at which transfer occurs are transfer of knowledge between reverse enterprises partners. Workflow systems, groupware, database, GDSS, video teleconferencing, electronic bulletin boards, discussion forums, knowledge directories, list - servers and graphics applications are some of the key enabling technologies for KT.

Knowledge Application

Dramatic advances in communications and transportation, has speeded the flow and production of goods and/or services, eased the task of managing globally dispersed assets both in forward and reverse direction.

These factors have all combined to create highly- competitive global markets in which change is rapid and companies need to be quick and flexible, but able to retain benefits of economics of product return. The non-linear, radical and discontinuous changes in the competitive market require continual updates to the best practices archived in the knowledge database. Effective KM application in RES promotes an integrated approach to identifying, managing, reverse manufacturing and logistics options. Application of KM improves upon the current system in both macroeconomic and microeconomic respects. For sharing an enterprise's information assets, automatic inference expert systems, rule-based/case-based expert systems, workflow systems, workflow automation systems are the key enabling technologies for knowledge integration and application in RES. Next we describe the aspects of KM in RES and framework used in this study.

Table 1: Dimension of KM in RES

Source of Knowledge	Type of Knowledge	Application of knowledge
Collection Phase	Availability of Collection centre Transportation distance Transportation time Transportation Cost Product classification	Inspection/ Separation specialist
Recovery phase	Inventory Inspection/ Separation Knowledge Product design and technical knowledge Remanufacturing cost , time Knowledge Disposal Knowledge	Product design and Development Production planning and control collection and distribution phase
Distribution	Distribution Cost & time Customer feedback &orders disposal knowledge	Retailers Customers Recovery and Collection phase

Implementation of KM in RES

KM focuses on understanding how knowledge is acquired, created, stored and utilized within an enterprise. Through the synchronization of information that resides in both formal and informal KM systems RES can reduce product take back and reprocessing cycle times, reduce cost and deliver greater value to both its internal and external customers gaining competitive advantage through the reuse of remanufactured product and resource. The challenge of capturing organization knowledge throughout the return process still remains to be huge undertaking. Complexity increases by several magnitude when we consider volume and quality of returned products, the origin of returned products and the demand for recovered products in which numerous dynamic interaction happens between several customers, retailers, separation /inspection , remanufactures, resellers and back to manufacturers, distributors, retailers and customers. The flow of knowledge between these interfaces is critical to success of RES. If there is disconnection between constituents for RES chain the impact could include decline on value from product return, customer attrition and declining revenues.

To optimize a return chain all elements of the RES must be connected to enable the flow of knowledge. Connectivity is the first attribute to allow the flow of knowledge throughout the RES. The second attribute is the communication of knowledge in a fashion that allows all elements to make decisions that maximize customer value while reducing cost and cycle time for taking back the product and sending back to new potential user. The third attribute of KM in RES is ability to collaborate in a real time fashion, encourage knowledge sharing and allowing the flexibility in supply chain according to the market place changes.

This framework was developed integrated information and Knowledge management site for RES. Here different partners of RES may work together within the site. Since reverse manufacturing and logistics processes involves more participants, who may adopt various special professional information systems, the system we developed was derived from a collaborative information /knowledge integration supporting system. This framework does not directly support the professional activities in RES, but facilitates the information and Knowledge sharing and concurrent approach by involving the different participants of both forward and return process.

Further explaining Nonaka and Noboru (1988) contribution, knowledge generation can play

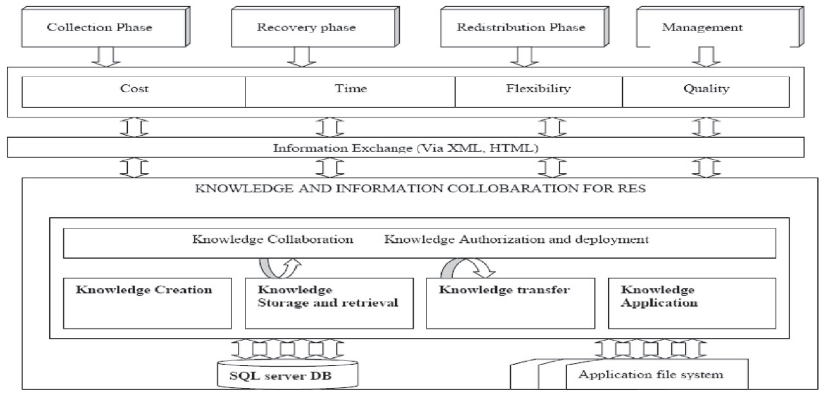

Figure 3: Information and KM collaboration framework for RES

key roles in value creation. RES often uses multidisciplinary set of activities such as inspection/ separation, reuse, re-manufacturing, recycling, re-distribution and disposal at this end. These types of activities also allow a great deal of tacit knowledge to be used, transformed and shared. If RES implementation and research are carried out in collaboration with industrial partners in effective way this can act as source to create knowledge. Thus RES is aimed at all aspects of returns, from strategic planning through tactical decision making for return operation and planning for final delivery from and back to customers (figure 4).

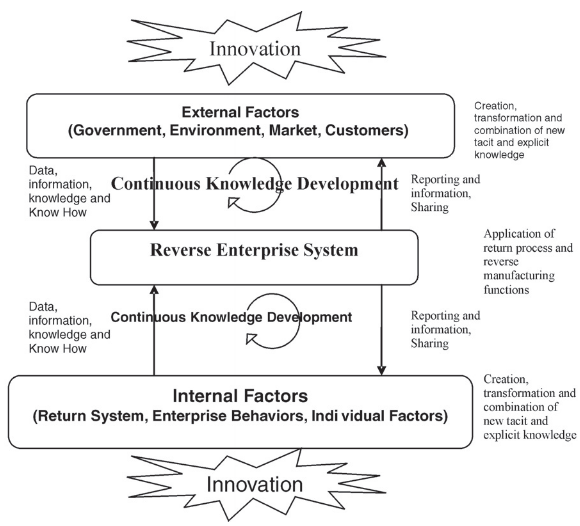

Figure 4: Knowledge Based Operation and Planning of Return

Socialization

The conversion of one's own tacit knowledge to another person's or an organization's tacit knowledge is accomplished in various ways. Here in RES socialization can occurs when researchers and management people are in direct coordination with staff directly involved in its application. Here, there is a transfer of the enterprise tacit operational know-how about the returned product to the equally tacit theoretical know-how of the researchers. The experimental platform is being developed through socialization. A small team of experts in computer programming, artificial intelligence, life cycle management and product design are working in close collaboration on it, exchanging their ideas and knowledge to create an innovative tool that can be used for efficient management of returns. This may be seen as a “combination’ tool, but it is created through the transfer and sharing of tacit knowledge among management and staff involved in returns.

Externalization

The conversion of tacit knowledge to explicit knowledge, so that it can be distributed and used by others, is a necessity for all organizations. RES can take this as a challenge, and, tries to develop tools to support this conversion. We can use the ICT as a medium to integrate and to get information on the upcoming return before the physical flow reaches the process. Thus this can serve to transform the tacit knowledge of the RES experts into explicit knowledge that can be widely distributed.

Combination

The conversion of explicit knowledge into more complex explicit knowledge is perhaps the most obvious output of a research in the field of RES. The application of e-Business for in the filed of product returns was just data until researchers studied the results, carried out research about e-Business in other industries. For example Dell Computer’s small and home business sales division found that returns for Web ordered PC’s were lower than PCs ordered by phone (source: www.dell.com). Here ICT can be used to substitute some of the operations involved in reverse logistics with information processing and lower uncertainty, costs and required time. Furthermore, these results are explicit knowledge that can be used by other research decide which directions to take, or not to take.

Internalization

The conversion of explicit knowledge into tacit knowledge is another place where RES requires research. Here we can use learning by doing, which allows staff involved in performing return operation to understand the dynamics (at least the basics) of a product returned. It illustrates the problems that can be encountered and the challenges that RES face today to integrate the reverse manufacturing and logistics to become more efficient and cost effective. The explicit knowledge of the product return is shared so that it can be understood by people with no background in handling product returns. This new tacit knowledge will hopefully enable participants to make better decisions and better understand the decisions that are made by others to handle the product after returns effectively.

Distribution

For any enterprise we not only need to come up with the raw material of the knowledge; we also need to discover the tools and methods necessary to distribute it. Learning, sharing and training are required to be regular activities for RES. As previously stated, an important part of the KM application for RES is training and the distribution of knowledge about when, how, where, what products are returned in which state.

Application

The experimental platform can be developed to simulate the reality of the planning and control of the returned products in RES through the application of algorithms developed to different configurations product and information in return process. Unless companies involved in product return adopt and use the tacit and explicit knowledge created and provided by researchers, they will be unable to fully benefit from the research at their disposal.

Innovation

A value added strategy, like the one adopted by RES is market oriented and based on innovation and knowledge (Harrington, 1991). Hereby we can create and distribute new and innovative products and processes to handle the product returns efficiently and cost effectively as a direct result of the knowledge management. Some examples of innovations are: RES model that integrate reverse manufacturing, reverse logistics, internet technologies, new configurations of the return chain. New operations planning and control methods to handle product returns at various stages that provide the most efficient use of an enterprise limited resources.

As we noted earlier, implementing KM is challenging because many resources and much time and effort are required before benefits become visible. Another obstacle is that most knowledge about product gives after return is not explicit. RES have little time to make knowledge explicit. Additionally, there are few approaches and tools that turn tacit into explicit knowledge. Technology's fast pace often discourages from analyzing the knowledge they gained during products return of particular variety of high technical end, believing that sharing the knowledge in the future will be useful.

Conclusion and Further Study

The main contribution of this paper is to develop a knowledge based framework that contains methodology and tools as a solution to RES. The framework comes from a knowledge point of view beyond technologies of a specific area. Being compared with the researches in reverse logistics and remanufacturing it provides a systematic knowledge based approach to achieve performance based integration. Therefore Knowledge management can be adopted by RES with good degree of success. The RES can use the knowledge management tools and models to turn the challenges of the future into business opportunities. The application and use of the generated tacit and explicit knowledge, for innovation and sustained competitive advantage is wholly the responsibility of RES and people involved in research in this direction. Therefore significant efforts still needs to be done to determine the contexts and methods through which Knowledge Management will have the most impact on returns, it is potentially a valid tool for that deserves further utilization and attention.

References

- Alavi, M. and Leidner, D.E.,2001, Knowledge management and knowledge management systems:conceptual foundations and research issues, *MIS, Quarterly Review,* 25(1), 107-136
- Carter, C. and Ellram, L. 1998, "Reverse logistics: a review of literature and framework for future investigation", *Journal of Business Logistics,* 19(1), 85-102.
- Chiesa, V., Manzini, R. and Tecilla, F., 2000. Selecting sourcing strategies for technological innovation: an empirical case study. *Journal of Operations & Production Management* 20(9), 1017-1037.
- Cook, P., 1999. I heard it through the grapevine: making knowledge management work by learning to share knowledge, skills and experience. Industrial and Commercial Training, 31 (3), 101-105.
- Fleischmann, M., Beullens, P., Bloemhof-Ruwaard, J. and van Wassenhove, L. 2001, "The impact of product recovery on logistics network design", *Production and Operations Management, 10(2), 156-173.*
- Guide, V. and Srivastava, R. 1998 "Inventory Buffers in Recoverable manufacturing", *Journal of Operations Management, 16 (5), 551-568.*
- Harrington, H.J.,1991., Business Process Improvement – The Breakthrough Strategy for
- *Total Quality, Productivity, and Competitiveness, McGraw-Hill, Inc.*
- Inderfurth, K. 1997, "Simple Optimal replenishment and disposal policies for a product recovery

system with lead times”, OR Spektrum, 19 (2), 111-122.

- Innes T., 2002.Sustainability, Forestry and Knowledge Management: Examining the International, Canadian and British Columbian Context. Master’s thesis, Athabasca, Canada.
- Kokkinaki A.I, Dekker R., M. B. M. de Koster, Pappis and W. Verbeke, EURO 2001, the European Operational Research Conference, Rotterdam, The Netherlands, 2001.
- Kopicki, R., Berg, M.J., Legg, L., Dasappa, V. and Maggioni, C. 1993, Reuse and Recycling – Reverse Logistics Opportunities, Council of Logistics Management, Oak Brook, IL
- Lee, C. and Yang, J., 2000. Knowledge value chain. *Journal of Management Development* 19 (9), 783-793.
- Krikke, H. 1998, Recovery strategies and reverse network design, PhD thesis, institute of Business Engineering and Technology Application (BETA), Universiteit Twente, The Netherlands.
- Meyer, H., 1999. “Many Happy Returns”, The Journal of Business Strategy, 20 (4), 27-31.Mak, K-T. and Ramaprasad, A., 2003. Knowledge supply network. *Journal of Operational Research Society* 5(4), 175-183.
- Murphy, P. R. and Poist, R.F. 2000, “Green logistics strategies: an analysis of usage patterns”, Transportation Journal, 40 (2), 5-16
- Narula, R., 2001. In-house R&D, outsourcing or alliances? Some strategic and economic considerations. In: Farok Contractor (Ed.), The valuation of intangible assets in global operations, Quorum Books Westport CT and London.
- Nonaka, I., 1988, Toward Middle-Up-Down Management: Accelerating Information Creation. Sloan Management Review, 29(3), 9-18.
- Nonaka, I., and Noboru, K., 1988. The Concept of “Ba”: Building a Foundation for Knowledge Creation. *California Management Review,* 40 (3), 40-54.
- Nonaka, I., 1991. The Knowledge-Creating Company. Harvard Business Review, 69, 96-104.
- Rogers, D., Lambert, D., Croxton, K. and Garcia-Dastugue, S. 2002, “The Returns Management Process”, *The International Journal of Logistics Management,* 13, 2, 1-17.
- Rogers, D.S. and Tibben-Lembke, R.S., 1999, Going backwards: R L trends & practices. Reverse Logistics Executive Council, Pittsburgh, P.A
- RevLog, 1998, What is reverse logistics? Available from: http://www.fbk.eur.nl/OZ/REVLOG/Introduction.htm, accessed 2006-09-21 Seng, C., Zannes, E., Pace, W., 2002. The contributions of knowledge management to workplace learning. *Journal of Workplace Learning* 14 (4), 138-147.
- Simard, A., 2003. Opinion piece: “On Science and the Knowledge Economy”. Report, Natural Resources Canada, Ottawa, Canada Simatupang T., Wright, A., Sridharan, R., 2002, The knowledge of coordination for supply chain integration. Business Process Management 8 (3), 289-308.
- Soga S., Hiroshige Y, Dobashi, Okumura M. & Kusuzaki T., 1999, “Products lifecycle management system using radio frequency identification technology”. IEEE.
- Tiwana A, 2000, *Knowledge Management Tool Kit,* Prantice Hall
- Wadhwa S. Rao. K.S., 2003, Supply Chain Flexibility and Knowledge Management: A Decision Knowledge Sharing Focus, Studies in informatics and control, 13(2), 92-100.
- Wadhwa S. and A. Saxena, 2006, Supply chain flexibility and knowledge management: a decision knowledge sharing focus, Studies in Informatics and Control, 15(1), 31-50.
- Wadhwa S, Saxena A, Kumar A, 2006, A KM motivated web-based supply chain simulator: facilitating e-learning for SMEs, *International Journal of Business Performance Management,* 8, 2-3, 207-228.
- Wadhwa, S. & Madaan, J., 2004, Role of Quality Management Self Assessment Model to Promote Reverse Logistics Operations, ICQCC–2004, Bangkok
- Yuva, J., 2002, Knowledge Management: the Supply Chain Nerve Center. Inside Supply Chain Management, July.